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1465 – SWIS – South West Interconnected System
Econnect response to points raised in Public Consultation
17 March 2006

Prepared For	**Office of Energy, Western Australia**

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Econnect

Overview

1 Introduction

In responding to the various submissions that were made in response to our report (‘Maximising the Penetration of Intermittent Generation in the SWIS’), we have focussed on addressing comments that fall within the scope of our initial brief and which also invite some form of response.

By way of clarification Econnect’s scope for this project was:

“*The consultant should identify, evaluate and assess the application of technologies, management practices and other strategies that can be applied in mitigating impediments to the increased penetration of intermittent generation technologies onto the SWIS*.

The discussion should proceed with reference to previous experiences or applications in other Australian or international jurisdictions and must in every case:

- *be framed with direct reference to existing or projected conditions on the SWIS;*

  and

- *ensure that key assumptions and any prerequisites, risks, limitations are clearly identified and described.*

The analysis should focus on the following strategy components:

- *SWIS characteristics and system practices,*
- *Intermittent generator technology and control systems, and*
- *Complementary strategies and actions*.”

As a consequence the fact that we have not responded to certain of the comments made does not mean that those comments are not significant; it is simply that we were of the view that no further comment or clarification was required.

1.1. Generic issues

Two issues in particular were raised by a number of respondents. Rather than make the same response on a number of occasions, we have addressed these two points, as ‘generic issues’, in this section. The two issues are;

- The relative economics, including the complete life cycle costs, of renewables vis-à-vis thermals

And

- The coverage given in the report to wind relative to other forms of renewable generation.

1.1.1. Relative economics. Wind & Thermals

A number of submissions commented on the relative economics of wind and thermals, they mentioned competitiveness, relative pricing, the avoidance of discrimination between fuel sources and the like.

Econnect response: Our report does not address issues related to the true economic and environmental costs of the various energy options available to WA. Instead our report is focussed on addressing the technical challenges preventing the increased uptake of renewable energy across the State. For this reason we have not responded to such economic and policy matters.

1.1.2. Focus on wind

A number of respondents were of the view that our report was overly focussed on wind energy and did not give sufficient consideration to other renewable energy options.

Econnect response: Our report is focussed on measures which could be adopted immediately and such measures will clearly have to be workable within existing policy mechanisms.

The current renewable energy policy environment is dominated by the MRET and this policy tool is structured in such a way that it favours the cheapest renewable options, i.e. wind. As a consequence the wind sector is the one on which we have concentrated our report. Nonetheless the points we raise within our report (for instance relating to market structure, access to information, system modelling and analysis etc.) can, in the majority of cases, be applied to renewable technologies other than wind.

Notwithstanding this point, there could be significant advantages to having a policy mechanism that provides support that goes beyond ‘most economic’. Such advantages, for instance provision of base load with biomass and geothermal, peak shaving with solar PV etc., could be most useful in offsetting some of the limitations of wind: for instance its variability.

This finding is supported in the Ilex SCAR report[1] (Pp ii of the Executive Summary) and is also supported by a recent European Commission report which looks at the effectiveness and efficiency of the various renewable energy support schemes currently in operation in the countries of the European Union[2].

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[1] Ilex consulting: *Quantifying the System Costs of Additional Renewables in 2020,* report to the UK Department of Trade and Industry. October 2002.

[2] European Commission: *The support for electricity from renewable sources.* Communication from the Commission. December 2005

2 Specific responses: Econnect comments

2.1. Chamber of Minerals and Energy (CME)

No comments

2.2. GE Energy (GE)

a) Item 1 states that "*The authors are silent on the participation of energy consumers (loads) in a FCAS market. We believe that provision for this should be included….*".

Econnect response: Our report discusses the participation of loads in a FCAS market in Section 3.1.1, 3.1.2 and 3.1.3.

Nonetheless the recommendation at the end of Section 3.1.3 does not specifically mention the inclusion of loads in any FCAS system and this omission, from the recommendation itself, may have caused the GE comment.

2.3. Independent Market Operator (IMO)

a) Pp 5. '**Impact of Intermittent Generators on other Generators**'. There are a number of comments made by IMO in this section and they are predicated on the statement at the beginning of their opening paragraph: "*The output of intermittent generators is …unpredictable over short time periods.*"

Econnect response: Many studies have been undertaken into wind speed forecasting. They show that accurate predictions are possible and that the accuracy of those predictions increases as the time period, between forecasting and wind farm dispatch, declines. Clearly and since wind turbine output is directly related to wind speed, wind turbine power output is not unpredictable.

Modelling of power output variations in other jurisdictions and countries shows that random power output variability in the short term (5 – 15 minute periods) due to gusting, local affects etc., are generally not significant due to intra- and inter- wind farm smoothing of these random variables.

Nonetheless it is clear that without a suitable wind speed forecasting system the output of intermittent generators may be somewhat unpredictable as IMO has stated. There is therefore a need to develop such a forecasting system. See also Para. 2.3 c) below.

b) Pp 5. '**Impact of Intermittent Generators on other Generators**'. Following on from the previous assumption, the IMO states that;

a. *An increasing proportion of OCGT plant must be kept in operation to give the power system the ability to accommodate variations in generation;*

b. *As the proportion of OCGT plant increases, it will force high efficiency gas fired plant off the system;*

c. *The proportion of electricity that can be provided by high efficiency gas fired plant will decrease;*

d. *The economic incentive to build gas fired plant rather than coal fired plant will decrease;*

e. *The overall efficiency of the non-intermittent plant will decrease*.

Econnect response: These concerns need to be quantified before their importance can be assessed. For this reason and as identified by the IMO, additional system modelling is required in order to objectively quantify the additional system costs of increased renewable energy penetration. Modelling the uncertainties raised by IMO will provide valuable information in terms of future planning of network augmentations and will also be of value to renewable energy proponents looking to enter the WA market.

c) Pp 7. **Recommendation 3:** "The *IMO recommends that wind farm owners and developers be encouraged to collaboratively develop a system to forecast the short and medium term output from their systems.*"

Econnect response: The nature of competition, between owners of wind farms, and the structure of the scheduling and dispatch process, means that there is competitive advantage to be had by one wind farm owner if they have better wind energy forecasts than any other wind farm owner. For this and a number of other reasons, it may be unreasonable to expect wind farm owners and/or developers to collaboratively develop a WA or Commonwealth wind forecasting system.

A degree of central planning would possibly be more appropriate.

d) **Comments on other matters**. Pp 7 of IMO response. Recommendation relating to Pp 27 & 28 of Econnect report. "*The IMO notes the arguments put forward by Econnect. However, if the penetration of intermittent generation is raised substantially, it may well be necessary to both increase the amount of generation capacity used and change the type of plant used.* "

Econnect response: Modelling is required to quantify the effect. See also Para. 2.3 b) above.

2.4. Rheem Australia

No comments.

2.5. Solar Sales (SS)

a) **Policy barriers.** Pp 1 of SS response, SS lists three of the 'real' barriers to renewables. The first of the three is 'policy support for renewable energy'.

Econnect response: Our understanding is that the WA Government has already undertaken a number of measures designed to reduce existing market barriers to increased renewable energy penetration. Further measures are under consideration.

Policy issues are outside the scope of this report: See 1.1.1 and 1.1.2 above as well as 2.11 a) below.

b) **General Comments.** Pp 1 of SS response. "*For instance a small wind farm project less than 10 MW connected to the distribution system faces an annual network access charge that amounts to around 20% of the total annual project turnover*."

Econnect response: See Para. 2.11 a) below.

c) **Point 4.** Pp 4 of SS response. Comment relating to Recommendation 4 ('*Collect and publish information on wind resources…*') on Pp 11 of Econnect report. SS have said "*It is not clear how useful this information has been in increasing investment in wind generation in other jurisdictions.*"

Econnect response: While some developers may not consider this information to be of value, experience shows that it is nonetheless of assistance to Government planners and other stakeholders, as it gives them a better understanding of the total resources available and the constraints faced by developers in examining sites.

d) **Point 20.** Pp 8 of SS response. Comment relating to Econnect Recommendation 20 (*'Develop a participatory process…by which permitted areas may be designated as 'permitted use zones'*). SS have implied that such a proposal would not be particularly advantageous if implemented.

Econnect response: The comments of Solar Sales about some of the difficulties and inefficiencies inherent in the 'permitted zone' planning concept appear to have some validity.

Many of the planning issues identified in this section could possibly be addressed by a re-think of the policy mechanism by which wind energy is supported (currently the MRET). However and since such policy analysis is outside the scope of this report, the options in Recommendation 20 of our report are proposed as the next best solution.

See also Para 1.1.1 and 1.1.2 above and 2.11 a) below.

2.6. Stanwell

No comments.

2.7. Western Australia Sustainable Energy Association

No comments.

2.8. Wesfarmers Energy Limited (WEL)

a) **Network stability.** Pp 1, Priority 2 of WEL response. WEL have said "*The report suggests that existing generators should be made aware of and comply with any new requirements that occur through the modifying of the transmission network to allow greater penetration of intermittent generation.*"

Econnect response: The comments made by Econnect were not intended to give the impression that existing generators should have to conform to changing connection conditions as a result of renewable generators that are connected to the system. The purpose of the four Paragraphs included under Priority 2 (Network Stability) of the report was simply to make the point that it is not always technically or economically efficient to impose blanket FRT requirements on all intermittent generators irrespective of their location on, or method of connection to, the network.

b) **Rules for constraining plant.** Pp 2 Priority 5 of WEL response. WEL have said "*The Wholesale Electricity Market rules have processes in place to recompense generators for costs incurred in constraining plant. These should be applied on a consistent basis across all generators…"*

Econnect response: Refer to Para. 2.11 j) below.

2.9. Western Power Generation Business Unit (GBU)

a) **Ancillary services payment for thermal generators.** Pp 1 of the GBU response says "*To achieve a level playing field, GBU should be properly compensated for the loss of energy produced brought about by increasing levels of intermittent generation. To achieve this, the ancillary services payment needs to provide an adequate income stream to offset the reduced net income stream from electricity sales from its fossil plant.*"

Econnect response: Modelling is required to quantify the amount of any such additional costs.
Refer also to Para. 2.3 b) above.

b) **Application process for network access.** Pp 1 of the GBU response says "*The report does not discuss the current cumbersome queuing system for proponents wishing to connect generation to the SWIS. GBU recommends that the process of applying for Network Access be reviewed against best practice elsewhere with the view to not prejudicing applications".*

Econnect response: Our experience of applying for Network Access to the SWIS is similar to that outlined by GBU. Nonetheless it is expected that the current regulatory process that is being carried out by the Economic Regulation Authority on Western Power's proposed Access Arrangement for the SWIS will result in significant improvements in the process of evaluating access applications.

c) **System wide issues.** Comment on Conclusions. GBU response Pp 2. *"The conclusion omits any mention of the issue concerning whether intermittent generation should be given a capacity credit for generation planning purposes and if so how it is to be determined.*"

Econnect response: Our response addresses this issue on Pp 29 (3.2.6 Application to the SWIS). However in the event that there is confusion regarding the recommendation made one could add to it as follows; "*…maintain current practices for determination of reserve (contingency) requirements **including the provision in the reserve capacity mechanism with its determination of the capacity credits for intermittent generation based on average capacity factors**.*"

d) **Frequency Stability.** Comment on Conclusions. GBU responses Pp 2. GBU notes; "*The report compares the SWIS with the similar sized Irish grid…but pays no attention to the more important factor – the type and size of fossil generation technology employed …*".

Econnect response. The GBU comments may be compared with those of the Independent Market Operator: Pp 8 of their response (which refers to Pp 17 of our report) states "*The IMO suggests that comparison with very small systems where generation would otherwise be provided by flexible and expensive, diesel generators, is not appropriate. The comparison, which Econnect makes with Ireland which has a similar plant mix to that in the SWIS, is more relevant*".

The reference to the Irish grid in the Econnect report was made in order to illustrate that substantial wind integration is possible on a variety of different grid systems. Our report calls for detailed modelling to be undertaken and notes that, before such modelling is carried out, direct comparisons between different grid systems are not appropriate.

e) **System Fault Recover.** Comment on Conclusions. GBU response Pp 2. "*The report includes mention of the positive aspects of geographical diversity in wind farm installations but makes no mention of size. For example it does not discuss the specific positive results of having many smaller geographically diversified wind farms as opposed to the current trend.*"

Econnect response: The point is valid and is addressed below: Para. 2.11 a).

f) **Generation Capacity Issues.** Comment on Conclusions. GBU response Pp 2. ('Generation Capacity Issues'). "*Appendix A indicates that it is now standard in 'best practice' jurisdictions to count a proportion of intermittent generators' installed capacity as firm capacity. The report does not mention what has been proposed by the Interim* [sic] *Market Operator, who has proposed that wind farms on the SWIS be given a capacity credit in proportion to their capacity factor…*".

Econnect response: See Para. 2.9 c) above.

2.10. Wheatbelt Development Commission

No comments

2.11. Western Power Networks (WPN)

The SWIS is a very different network to the strong, interconnected, pan-European grid that E.ON's network sits at the heart of. Consequently the E.ON requirements (discussed extensively in Para. 2.11 p) q) and r)) cannot necessarily be transferred 'as is' to the SWIS and we would not wish to give the impression that this is our view based on the comments in the following paragraphs.

We appreciate many of WPN's concerns and note that many of them have been common to many grid owners the world over when faced with the sudden addition of large amounts of non-dispatchable generation. Nonetheless and while we recognise many of the concerns expressed; we view them as issues to be addressed rather than as insurmountable barriers to the increased integration of renewables on the SWIS.

a) Information – **Development of Scenarios**. Pp 1. of WPN response. "*Wind generation is currently the least cost form of renewable generation, but probably the most inefficient user of the limited spare capacity of the SWIS….*".

Econnect response: Wind energy penetration can be best maximised on weak networks by means of small geographically dispersed clusters of wind turbines.

The development of large wind farms, located remote from major loads, is driven by a federal policy support mechanism (the MRET) that tends to encourage this type of wind farm development. The concerns expressed by WPN are best addressed by a review of the policy mechanisms used to support wind. Such a review, which may also consider network charges for small generators, is outside the scope of this report. See also Para 1.1 above.

b) **Network Stability:** Pp 3 of WPN response. "*..applicants for access to the SWIS have not experienced difficulty in meeting our requirements*".

Econnect response: Econnect undertakes grid connection negotiations for a variety of clients around the country, including in Western Australia and WPN's statements do not conform with our experience.

c) **Network Stability**. Pp 3 of WPN response. Item 7. "*It should be noted also, because there has been some confusion, that the requirement to survive zero volts for 450 msecs in the SWIS refers to the point of connection rather than the generator terminals…*"

Econnect response: There is no confusion. The Econnect report states (Pp 31 3.3.3 Application to the SWIS) '*The interim technical code for access to the SWIS currently stipulates that a generating unit must ride through faults on the transmission system that cause the connection point voltage to drop to zero for up to 450 milliseconds, …*'.

d) **Network Stability**. Pp 3 of WPN response. Item 7. "*The most important fact is that we would not normally require prospective generators to fully meet the default performance requirements of Figure 3.5. This is because …. Western Power will perform computer simulation studies to define at the point of connection the range and duration of voltage dips that could occur.*"

Econnect response: This statement highlights the difficulty for individual applicants trying to secure a connection to the SWIS. As WPN has indicated, a connection application depends on modelling, carried out by WPN, before the connection conditions are known. This lack of clarity over the connection conditions increases uncertainty and cost for all developers of renewable energy projects that are seeking connection to the SWIS.

The FRT requirement of 450 ms at 0 volts at the point of connection to the SWIS is fundamentally more onerous than the FRT requirement of 175 ms at 0 volts at the point of connection for projects connecting within the NEM or indeed than the FRT requirements in other countries. The onerous nature of the WPN requirement is little altered by fact that WPN may, at its sole discretion, waive it.
See Para. 2.11 p) q) and r) below.

e) **Network stability.** Pp 3 of WPN response. Item 7. "*If the generators connected at distribution level are tripped at the same time as the larger generators connected at transmission level, this will increase the amount of spinning reserve required*".

Econnect response: The conclusion about the amount of spinning reserve required is correct; however it is not clear that the assumptions, from which the conclusion has been drawn, are themselves correct.

It is not clear what point is being made given the nature of fault propagation between transmission and distribution networks. A zero voltage fault on the transmission network is highly unlikely to translate into a zero voltage fault at the distribution level, other than in an islanding situation.

f) **Network Stability**. Pp 4 of WPN response. Item 9. This refers to Pp 11 of the report: Priority 2 – Network Stability. Recommendation 7 "*Make existing generators aware of the new requirements and ensure that they can meet these requirements*".

WPN commented "*We are not sure what is intended here.*"

Econnect response: Refer to Para. 2.8 a) above.

g) **Frequency Control Ancillary Service**. Pp 5 of WPN response. WPN has commented on the ILEX report mentioned in the Econnect study. They state that "*The ILEX report estimates in Table 1 that at 30% penetration the system cost per unit of additional renewable generation is 10.8 GBP/MWh, i.e. about 50% of the estimated UK wholesale price of electricity.*"
(This is equivalent to GBP1billion ($2.4billion) annually when spread across UK annual power consumption of 400 TWh).

Econnect response: Since the ILEX report was written in 2002, UK wholesale power prices have more than doubled to GBP55/MWh ($130/MWh). This increase has been almost exclusively due to the sharp decline in natural gas output from the North Sea oil and gas basin. Market anticipation of increased carbon charges in the future has also played a small part.

This increase in wholesale power prices equates to an increased cost for electricity consumers of about GBP10 billion ($23.5billion) per annum. Increased uptake of renewables, which are exposed to zero (or minimal) fuel price volatility, would have lessened the impact of this substantial increase in thermal fuel prices.

The point is that both the costs and benefits associated with renewable energy need to be included when considering the additional system costs associated with the increased uptake of renewable energy. This is an economic issue and further consideration is consequently outside the scope of this report.

See also Para. 1.1.1

h) **Geographical Diversity**. Pp 6 of WPN response. "*It is difficult to imagine that intermittent generation that is inherently un-schedulable could be relied on to reduce network reinforcement.*".

Econnect response: Network reinforcement requirements are calculated by means of a probabilistic analysis of load and generation. Intermittent generation therefore has a role to play in reducing network reinforcement requirements.

i) **Energy Balancing and Reserve Capacity: Load Following**. Pp 7 of WPN response. "*In this regard the system load fluctuations will be relatively small compared to SWIS wind farms…*"

Econnect response: Modelling is required in order to quantify the potential impacts. See Para. 2.3 b) above.

j) **Additional Recommendations. Constraints**. Pp 7 of WPN response refers to Pp 13 of the Econnect report (Additional Recommendations – Item 18) which says "*Due to the low demand at night on the SWIS….wind generation may need to be constrained…wind generation must be paid for the constraints imposed on it, at the full value of its output..*".

WPN have said; "*What does full value of its output mean?*"

This Econnect recommendation could have been more clearly worded. The aim here is (to use WPN's words) "*to develop a cost reflective 'causer pays' set of charges so that efficient technologies are encouraged.*"

k) **Additional comments. 2.3 Background & Policy Objectives.** Pp 9 of WPN response. WPN notes that it is inappropriate to compare the Danish system (Econnect report Pp 22 - The Impact of FCAS) with the SWIS as Denmark is linked to the European network.

Econnect response: The example of Denmark was cited in the Econnect report to highlight the point about the relative magnitude of changes in output from wind farms relative to other factors that impact on system frequency.

The point of the Danish (and Irish) examples was to show that the output swings associated with intermittent generation are less than those which occur from unanticipated output changes from conventional generation or demand changes. Whether or not the network under consideration is part of a larger network (as in the case of the Danish grid) or is not (as in the case of SWIS) is not relevant to the point being made.

See also Para. 2.11 m)

l) **Additional comments. 2.3 Background & Policy Objectives.** Pp 9 of WPN response. WPN says "*The report does not indicate how backup is provided for low wind conditions and what impact this has on energy prices for these systems.*"

Econnect response: Detailed SWIS-specific modelling is required before specific conclusions can be drawn about the potential costs and benefits of renewables on the SWIS. Such modelling is outside the scope of this report. See also Para. 2.3 b) above.

The Ilex findings may also assist: Para. 2.11 g) above.

m) **3.1.3 Application to the SWIS.** Pp 9 of WPN response. "*The instantaneous loss of the largest generator is a low probability event …regular wind lull events of a similar* *magnitude will result in regular tripping of loads.*"

Econnect response: A trip of the 300 MW Collie plant would, as WPN have noted, result in load shedding. This would be required in order to maintain system frequency in the face of an instantaneous loss of a major block of generation.

It is hard to imagine any instance when 300 MW of wind in WA could be lost over a period of a few seconds. Experience from Ireland indicates that if the SWIS had 400 MW of distributed wind generation then in a worst case scenario WA could expect to lose 300 MW of wind over a period of 4 hours. It is not clear that a loss of this magnitude, over this time period, would result in 'regular tripping of loads' as stated.

Detailed modelling is clearly required in order to quantify the effects.
See also Para. 2.3 b)

n) **3.2.1 Load Following Ancillary Services.** Pp 9 of WPN response refers to the Econnect report Pp 27 (3.2.1 Load Following Ancillary Services) which states "*from an energy balancing point of view there is no difference between an intermittent generator and a conventional load of equivalent size*".

WPN states "*This does not take into account that the load is large and diverse with uncorrelated changes in the short term*".

Econnect response: It is not clear what is meant by 'short term'; notwithstanding this point there is clearly significant correlation of load changes every hour, through the day and also the year. While, as noted by WPN, the daily and seasonal load changes are predictable, they nonetheless have to be catered for at a cost. This cost is unknown as is the additional cost imposed by the superimposed wind variability.

WPN's comments need to be validated by modelling. Such modelling is outside the scope of the Econnect report. See also Para. 2.3 b)

o) **3.3.2 Fault Ride Through.** Pp 10 of WPN response. WPN states that "*The exemption of small generators (<10 MW) is proposed. However if there are* [sic] *a large number of small intermittent generators connected in a particular area a fault will impact a number of these units and the combined loss of MW input to the system may be significant.*"

Econnect response: Small generators by their nature tend to be remote, separate from other small generators and embedded on the low voltage network. Faults on the other hand are of greatest concern on the high voltage network and HV faults tend to be isolated on the HV network.

Notwithstanding the concerns raised by WPN on voltage support and while we can understand that WPN may not wish to give a complete exemption to small generation units, there would nonetheless seem to be significant justification for relaxing the zero volts, 450 ms FRT requirement currently applicable to small generators.

See also Paras. 2.11 c) d) above and 2.11 p) q) and r) below.

p) **A.4 Fault Recovery. Point a**. Top half of Pp 12 of the WPN response. "*Reference should be made to the German Technical Transmission Code rather than the requirements of the particular network service provider – E.ON*".

Econnect response: The German Technical Transmission Code to which WPN refers comes from VDN (Verband der Netzbetreiber) which is the organisation that represents the D-NSPs (up to 900 in Germany) and the T-NSPs (of which there are 4).

The VDN Technical Code is a general document for conventional power plants. Special requirements for generators that are to be treated in accordance with the Renewable Energy Sources Act (EEG - Erneuerbare Energien Gesetz) are contained in a summary to the Technical Code called 'Renewable Energy Sources Connected to the High and Extra High Voltage Network'. ('EEG Erzeugungsanlagen am Hoch- und Höchstspannungsnetz').

In any event, and since the VDN doesn't own or operate any grid in Germany, the requirements in practice are given by the T-NSPs which are E.ON Netz GmbH, Vattenfall Europe Transmission, EnBW Transprotnetze AG and RWE Net AG. E.ON and Vattenfall are the two T-NSPs with the most wind on their systems: 42% and 38% respectively.

It is for these reasons that reference has been made within our report to the E.ON Code and not to the German Technical Code as recommended by WPN.

q) **A.4 Fault Recovery. Point b**. Top half of Pp 12 of the WPN response which refers to the German Technical Code. "*Specifically, renewable units are required to remain connected for all network faults outside the unit's protection zone, refer to clause 2.3.11.5*".

Econnect response. The following response is given notwithstanding the point raised in Para. 2.11 p) above: Namely that the E.ON Code takes precedence over the German Technical Code which is for guidance only.

The requirements relating to Renewable Energy are, as mentioned in Para 2.11 p) above, contained within a summary to the Technical Code called 'Renewable Energy Sources Connected to the High- and Extra-High Voltage Network'.

Pp 81 of that document (**3.2 Behaviour after faults close to the point of connection**) states that generating plants must ride through 0 voltage faults for 150 ms in the event that "*the short circuit power available on the network side is higher than 6 times the active connection power of the generation plants after fault clearance.*" One would not expect an induction generator to meet this requirement during a fault as a result of which such generators do not have to meet the 0 volts 150 ms rule and instead are expected to ride through 15 per cent of nominal voltage for 600 ms. See Para. 2.11 r).

r) **A.4 Fault Recovery. Point c**. Pp 12 of the WPN response refers to Pp 56 of the Econnect report (**Fault Recovery**): Specifically "*German utility E.ON Netz … stipulates fault ride through for up to 600 ms at 15 per cent of nominal voltage. Generators may disconnect if voltage falls below 15 per cent of nominal.*"

WPN have said; "*This paragraph gives an incomplete and misleading account of the E.ON requirements because it ignores the requirements of Figure 5a that apply to nearby faults: the immunity to 0 (zero) Volts for 150 milliseconds is required*"

Econnect response. WPN is correct that our response did not make mention of this requirement. Nonetheless our conclusion (top of Pp 57 of our report – "*The German example shows that not all jurisdictions require generators to tolerate transient reductions in voltage all the way down to zero*") remains valid.

Pp 18 of the E.ON Grid Code states "*Figure 5a shows the voltage limit curve at the network connection with a near-to-generator short circuit above which generating units with a large symmetrical short-circuit current component must not be disconnected from the network*".

A 'high symmetrical short circuit current' is defined in the E.ON code at the beginning of 3.2.6.1 as "*A high symmetrical short circuit current component of a generating unit is given, if the contribution of the generator at the network connection point to a short circuit is higher than twice the rated current for longer than 150 ms*".

For induction machines (a significant majority of globally installed wind turbines) a zero voltage fault will lead to a loss of excitation in the stator windings and a subsequent decline in fault current from the generator. Most induction machines will therefore not have a fault current contribution of twice the rated current for greater than 150 ms. As a consequence the FRT requirements illustrated in Figure 5 a. will not apply to most induction wind generators.

3.2.6.2 Response of generating units with low symmetrical short-circuit current component states "*A low symmetrical short-circuit current component of a generating unit is present if the contribution of the generator to a short-circuit does not satisfy the condition of 3.2.6.1".*

3.2.6.2 stipulates a 600 ms ride-through requirement at 15 per cent of nominal voltage. This is in accordance with the statement in our report.

We therefore conclude that inclusion "*of the requirements of the German Transmission Technical Code and Figure 5 a of E.ON's technical requirements*", as requested by WPN in the middle of Pp 12 of their comments, would not materially alter the conclusions of our report regarding German fault ride through requirements.

s) **A.4. Fault Recovery Point a**. Bottom half of Pp 12 of WPN response refers to the first sentence on Pp 57 of the Econnect report which states "*The German example above shows that not all jurisdictions require generators to tolerate transient reductions in voltage all the way down to zero*".

WPN commented; "*The statement in the first sentence … is incorrect…*"

Econnect response. See 2.11 p) q) and r)

t) **A.4 Fault recovery Point b**. Bottom half of Pp 12 of WPN response. "*The remaining two sentences contain rather arbitrary statements that are inconsistent with the source document they are referring to*".

Econnect response. It is not clear which sentences are being referred to although it appears that it is the end of the first paragraph on Pp 57 of the Econnect report ("*A threshold of 15 per cent of nominal voltage … ensures that a sufficiently high proportion of intermittent generators remain connected such that there is no threat to system security*").

Detailed modelling, which takes into account the specifics of the SWIS network, is required in order to confirm this statement. Nonetheless this is the experience from modelling on other networks around the world.

u) **A.4 Fault recovery Point c**. Bottom half of Pp 12 of WPN response. "*the statement indicates …that the Econnect report does not distinguish between the generator terminals and connection point.*"

Econnect response. Our report does make a distinction between the two – see Para. 2.11 c) above. However we agree with WPN that the inclusion of this statement at this location may have caused the reader to believe that we were not making a distinction between the generator terminals and the point of connection.

Nonetheless we are of the view that the focus on generator terminals vis-à-vis the point of connection, risks missing the point. That point is that the WPN FRT requirements are onerous when compared with other jurisdictions.

v) **A.4 Fault recovery**. WPN recommendations. Pp 13 of WPN response. "*This paragraph and the remainder of Section A.4 should be re-written to report the fact that all surveyed technical jurisdictions require generators to tolerate transient reductions in voltage down to zero*".

Econnect response. See Paras. 2.11 p) q) and r) above.

2.12. Western Power Corporation

a) Almost all of the WPC response is in response to Econnect recommendation 18 which is about the manner in which wind energy should be recompensed in the event that it has to be constrained off during periods of high wind output and low load.

Econnect response: See Para. 2.11 j) above.