Our Ref: D09/79068

TRANSEND

5 August 2009

Dr John Tamblyn
Chairman
Australian Energy Market Commission
PO Box A2449
Sydney South
NSW Australia 1235

Dear Dr Tamblyn,

Review of Energy Market Frameworks in Light of Climate Change Policies 2nd Interim Report

As the owner and operator of the Tasmanian transmission system Transend Networks (Transend) welcomes the opportunity to respond to the AEMC's review of energy market frameworks 2nd interim report. Transend has contributed to the development of the Grid Australia submission and would like to provide the following additional comments in relation to chapter 9, system operation with intermittent generation.

Transend specifically addresses the following four matters relevant to the realisation of large scale renewable energy projects, in particular wind generation:

1. For relatively small networks like the Tasmanian power system, it is foreseeable that deliberate management of system inertia will be necessary to ensure power system security is not compromised;

2. It is recognised that the impacts of this particular issue are likely to affect only Tasmania in the short to medium term (5 – 10 year time frame). However, given the recognised quality and quantity of wind resource in Tasmania, Transend believes that this issue should be considered during the current review;

3. Transend is of the opinion that existing market arrangements do not provide an effective mechanism for management of system inertia; and

4. A suggested process for progressing inertia related issues is presented for consideration.

Each of these matters is addressed in more detail below.

1. Inertia and system security

As noted by the AEMC, the Tasmanian power system has different technical characteristics to other regions within the National Electricity Market (NEM). The predominance of hydro

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generation and a direct current (DC) coupling to the greater NEM via Basslink will tend to amplify the impacts of renewable energy sources (expected to be predominantly wind generation) if installed in large numbers.

A significant issue identified to date is the lack of inertia offered by existing wind generation technologies to assist with network frequency control. Increasing concentrations of such plant will tend to displace traditional generation sources (and their inertia contributions) unless deliberate mechanisms are put in place to recognise inertia as a power system security function.

A reduction in system inertia will impact on system security in three distinct ways:

i. Rate of change of frequency

As far as Transend is concerned, this is the most significant issue. The Tasmanian power system cannot sustain rates of change of frequency (ROF) greater than 3 Hz/sec (positive or negative).

For rates of change greater than this figure:

- It is not possible for some existing Tasmanian generators to remain connected to the power system. The physical limitation of plant and equipment is therefore a real consideration;
- It becomes increasingly difficult (and eventually impossible) to obtain sufficient discrimination between control and protection systems that are designed to manage large system frequency excursions following both credible and non-credible contingency events, e.g. the existing Frequency Control System Protection Scheme (FCSPS)[1] and the Tasmanian Under Frequency Load Shedding (UFLS) Scheme.

ii. Provisioning of sufficient Fast Frequency Control Ancillary Services (FCAS)

With high rates of frequency change (following contingency events), it will become increasingly difficult to meet the revised Tasmanian Frequency Operating Standards[2] without the availability of what could be interpreted as unrealistic volumes of FCAS. Consideration needs to be given to the availability of local FCAS capability and the corresponding impacts on inter-regional power flows via Basslink. Also to be considered is the ability of the Tasmanian network to operate independently from the rest of the NEM when Basslink is unavailable.

It has been noted by the AEMC that a reduction in system inertia, combined with a tightening of the Tasmanian Frequency Operating Standards, will result in significant challenges with respect to FCAS.

iii. Indirect relationship with system fault levels and voltage control

This is an area of ongoing investigation by Transend and is a further factor to be considered as part of any discussion on inertia.

While not directly related to system inertia, historically a "low inertia" system can be categorised as a "weak network" that is prone to both large frequency and voltage

[1] The FCSPS is a control scheme designed to assist with managing the contingent loss of Basslink
[2] Refer AEMC Reliability Panel Tasmanian Frequency Operating Standard Review Final Report – 18th December 2008

excursions due to relatively low fault levels. This is due to the characteristics of traditional synchronous generating plant (that dominate our existing power systems) given that they offer both inertia and voltage control capability by default. The same is not true for various generation types used in the renewable energy sector.

For some renewable generation technologies, a weak network gives rise to issues associated with fault ride-through, namely, the ability of plant to maintain continuous service during and following fault events. Such issues have to date been mitigated via the appropriate specification of static and dynamic reactive compensation installed adjacent to the connection point, e.g. as part of a new wind farm development. While such solutions have been found generally acceptable so far, it should be acknowledged that the ratio of new generation types to traditional synchronous plant is still relatively low.

Prior to large scale renewable energy developments occurring, the dynamic response of a network having a proposed higher concentration of these new forms of generation needs to be carefully studied. The dynamics of such a system will likely be quite different to what is currently experienced and new issues are likely to emerge. One of these is expected to be the decreasing ability of the network to sustain and recover adequately from fault events. Maintaining the right mix of generation types so as to maintain power system security is expected to be a challenge and will be strongly influenced by continuing technological advances.

2. Tasmania as a special case

Transend understands that in the short term, inertia and related matters are unlikely to become a material issue in other NEM regions. South Australia is likely to be the next most affected region.

It should be understood that Tasmania is facing these issues now and further connection enquiries from large scale wind developers will only exacerbate the situation. A need to actively manage system inertia in real time is fast approaching. The issue will need to be addressed if power system security is to be maintained with higher wind penetration figures.

Attached is the executive summary of a technical report on future wind generation in Tasmania. Transend welcomes the opportunity to further discuss the issues raised in this report with the AEMC.

The Tasmanian jurisdiction recognises the significance of managing problems with system inertia and has instigated a working group that is investigating the impact of a reduction in system inertia on the Tasmanian power system. The Inertia Issues Working Group (IIWG) is a technical working group consisting of representatives from AEMO, Transend, Roaring 40s, Hydro Tasmania and Aurora Energy. Transend is Chair of the IIWG andwould be pleased to discuss the work of the IIWG with the AEMC.

Developing and modifying market systems to suit single regions is difficult and not preferred so the issues presented herein need to be considered by the AEMC in its present review.

3. Existing market arrangements

The AEMC has stated that it is of the view that the existing market frameworks enable the system operator to maintain secure system operation.[3]

Transend agrees that this may be the case for the rest of the NEM regions at this point in time. However the Tasmanian network is different by virtue of its small size, lack of generation diversity and reliance on special control systems to maintain secure operation. It is inherently operated much closer to its technical limits than other NEM regions.

In Transend's view, the main deficiency within existing market arrangements is that the description of the Technical Envelope (NER Clause 4.2.5) does not contemplate inertia as a limitation. If it were recognised as such, there would appear to be opportunities to implement specific arrangements to manage its availability, or at least properly quantify its impacts on market outcomes.

The other concern is that inertia is a whole of system issue and there needs to be certainty and clarity on how the cost of managing inertia will be met. More specifically, what is the likely cost impact to potential new generation projects?

Using existing market arrangements to manage this emerging issue may limit the connection of new generation sources inherently dependent on such services. These technical considerations should be reviewed by the Australian Energy Market Operator (AEMO). Transend agrees with the AEMC that the AEMO's Network Support and Control Services (NSCS) Review should be completed as soon as practicable. As previously stated in the submission to AEMO's NSCS Review, Transend is of the view that AEMO should be actively pursuing mechanisms to manage the technical impacts of low inertia dispatch scenarios prior to it impacting on the capability and security of the Tasmanian system.

4. Approach to managing system inertia

Transend suggests that efficient management of inertia related issues could be achieved by undertaking the following processes:

i. Have system inertia clearly defined as part of the technical envelope;

ii. Give consideration to the most cost effective means of procuring system inertia;

iii. Determine whether inertia should be managed as a local or a NEM wide issue;

iv. Develop and implement a real-time system for monitoring system inertia; and

v. Develop a dispatch mechanism for system inertia.

[3] Section 9.2.4 AEMC 2nd Interim Report, Review of Energy Market Frameworks in light of Climate change policies, 30 June 2009.

If you have questions or require any further information please contact me on (03) 6274 3909.

Yours sincerely

Bess Clark

Executive Manager Corporate Strategy and Compliance

Transend Networks

Attachment: Future Wind Generation in Tasmania: Executive Summary

Future wind generation in Tasmania

Executive Summary

CONTACT

This document is the responsibility of the Asset Strategy & Planning Group, Transend Networks Pty Ltd, ABN 57 082 586 892.

Please contact Transend's Manager Asset Strategy & Planning Group with any queries or suggestions.

REVIEW DATE

This document is due for review not later than March 2011.

RESPONSIBILITIES

Implementation

All Transend staff and contractors.

Audit

Periodic audits to establish conformance with this document will be conducted by Transend's Asset Strategy & Planning Group.

Compliance

All Group Managers

Document Management

Asset Strategy & Planning Group
Strategic Grid Planning

MINIMUM REQUIREMENTS

The requirements set out in Transend's documents are minimum requirements that must be complied with by Transend staff and contractors, including designers and other consultants. The user is expected to implement any practices which may not be stated but which can reasonably be regarded as good practices relevant to the objective of this document without non-compliance with the specific requirement of this document. Transend expects the users to improve upon these minimum requirements where possible and to integrate these improvements into their procedures and quality assurance plans.

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Date	Action	Name	Position
26/01/2009	Prepared by	Martin Ringrose Ben March	Consultant Engineer Planning Engineer
05/05/2009	Endorsed by	Sead Pasalic	Manager Strategic Grid Planning

EXECUTIVE SUMMARY

Transend was involved as a part of Tasmanian Large Scale Wind Integration Group into analysis of connection of up to 300 MW of wind generation in Tasmanian system in 2003. This study did have limited scope and was conducted with limited information and prior Tasmanian entry into National Electricity Market and Basslink, DC link with Victoria commissioning. Since 2003 and Tasmanian Entry into National Electricity Market in May 2005 and commissioning of Basslink in May 2006 one wind farm, total capacity 140 MW was commissioned in Tasmania. Transend has received a lot of connection inquiries for additional wind farms installation. A lot of knowledge has been acquired about market operation, wind resources and wind generation operation in Tasmania since 2006 and a review of maximum wind generation integration in Tasmanian system was required. This report presents the results of such review of the integration of additional wind generation in Tasmania. The study was conducted from May 2008 to May 2009 as a part of Transend's 30+ year grid vision framework.

Wind generation is more difficult to integrate into the Tasmanian power system than conventional generation due to a number of technical issues including:

(a) the variable nature of wind generation;

(b) wind generators do not provide inertia to the system;

(c) they generally provide a reduced level of, or no frequency control ancillary services (FCAS);

(d) some wind turbine types provide reduced voltage control capability;

(e) they provide a reduced contribution to system fault levels;

(f) some wind turbines cannot ride through network faults;

(g) they often connect into weak parts of the network; and

(h) they can cause power quality problems.

The study was broken up into two main components: a study on the effects of wind generation on the operation of the Tasmanian power system that are not affected by the location of the developments (so called system wide issues) and a study on local issues using as examples the potential developments in North West, Midlands and Central Highlands regions of Tasmania.

SYSTEM WIDE ISSUES

System wide issues studied in this report were: generation scheduling and reserve requirements, system inertia, Frequency Control Ancillary Services (FCAS), Basslink constraints, wind generator fault ride through and system fault levels.

The results of the study indicate that the most pressing issues are:

(a) system inertia, which requires immediate action due to its impact on rate of change of frequency, FCAS requirements and system protection schemes coordination. A mechanism needs to be put in place for maintaining system inertia above current minimum levels. Current minimum system inertia is between 3500 and 4000 MWs. Under the new frequency operating standards for Tasmania, system inertia will need to be maintained above the current minimum. As there are many hydro generators in Tasmania that can operate in synchronous condenser mode, one possible mechanism is to bring generators online in this mode when inertia falls below minimum levels. Synchronous condensers are traditionally used for voltage control support; however, they also provide inertia and fault contribution to the system as added benefits. Where new supplementary voltage control equipment or dynamic reactive power sources are required, synchronous condensers should also be considered in place of power electronic devices (SVC, STATCOMs) which do not provide inertia and fault contribution;

(b) fast FCAS supply, which will soon require action if other significant sources of the services do not become available. With the imminent change in frequency operating standards in Tasmania, the future supply of local frequency control ancillary services is highly uncertain at present. In order to maintain system security and to allow Basslink flow direction reversal, wind generators may be required to provide FCAS;

(c) wind generator fault ride through, which is a requirement to ensure the frequency operating standards and allowable voltage ranges are not exceeded following faults on the transmission network. When faults occur, the wind generators must remain connected and their active power must return quickly following fault clearance.

Issues that the study indicated are less of a concern are:

(d) system fault levels, which will be maintained above minimum acceptable levels so long as system inertia is maintained. Although it is possible to have very low fault levels with high levels of wind generation, fast FCAS requirements become unmanageable before the fault levels drop below current minimum levels;

(e) generation scheduling and regulation reserve requirements, which should be manageable, even for very high wind penetrations. A modest increase in regulation FCAS requirements is likely to be required;

(f) Basslink import constraints, which will not be adversely affected if system inertia is maintained;

(g) Basslink export constraints, which again will not be adversely affected under most circumstances if system inertia is maintained; although, import conditions were concentrated upon in this study and export conditions with very high levels of wind generation require further study.

The effect of increasing the level of wind generation in the state on Basslink constraints, system inertia, frequency control ancillary services and fault levels was studied using simplified market simulation. Market simulations were first performed without any mitigation measures for falling system inertia and fault levels and reduced frequency control ancillary service availability. The simulations indicated that:

(h) for the new frequency operating standards any increase in wind generation will at times cause system inertia to fall below current minimum levels and cause difficulty in supplying the Tasmanian fast FCAS requirements locally;

(i) the increased wind generation would have a negative impact on Basslink import constraints, reducing import capability. However, the reduction would be significantly less than the increase in wind generation so total energy supply capability would be increased;

(j) the increased wind generation would also have a negative impact on Basslink export constraints under some conditions, particularly when the Tamar Valley combined cycle gas turbine is offline;

(k) the reduction in system inertia causes fast FCAS requirements to increase. As local supply of fast FCAS services is tight, Basslink capability is used to transfer FCAS from the mainland, also reducing energy transfer capability on Basslink;

(l) due to Basslink's no-go zone, achieving a flow direction reversal becomes increasingly difficult. In several simulations Basslink became trapped on import at around 440 MW of wind generation which caused the energy spot price in Tasmania to collapse in the model;

(m) with Basslink out-of-service, the capacity for wind generation in Tasmania is around 630 MW at minimum Tasmanian load.

Simulations were then performed with the system inertia maintained through the use of generators operating in synchronous condenser mode and with wind generators offering FCAS. Maintaining system inertia has the added benefits of improving the Basslink import and export constraints and increasing system fault levels. Although some difficulty in achieving Basslink flow reversals was still seen, the simulations showed that up to 1300 MW of wind generation could be incorporated into the Tasmanian system with Basslink in service if these mitigation measures are put in place. This figure reduces to around 630 MW with Basslink out-of-service. In both cases higher wind penetrations would occasionally require wind generation curtailment.

To remove the problems in achieving Basslink flow reversals, which are an issue even at present, either significant quantities of inexpensive fast FCAS must become available in Tasmania, or the mechanisms for handling flow reversals must be changed.

LOCAL ISSUES ANALYSIS USING NORTH WEST, MIDLANDS AND CENTRAL HIGHLANDS OF TASMANIA DEVELOPMENTS AS EXAMPLES

Local issues are the focus of connection studies performed once a development reaches the connection application stage and as such are not normally of concern from a strategic point of view.

However the North West, Midlands and Central Highlands of Tasmania developments are of strategic interest because some of the proposed locations are in close proximity to 220 kV transmission network backbone but some of them are far from the transmission network backbone and in order to incorporate these developments into the Tasmanian network, significant transmission corridor capacity upgrades may be required.

In particular the Burnie to Sheffield and Sheffield to Palmerston corridors are of strategic interest also due to the age of the 220 kV transmission assets (these lines are first 220 kV transmission lines built in 1957).

The issues studied were:

1. transmission network thermal limitations, including the relationship between wind generation and transmission line thermal ratings;
2. reactive support requirements;
3. transient stability for faults on the Sheffield to Palmerston 220 kV circuit; and
4. power quality (although not in deep detail).

The study revealed that:

(a) there is a strong correlation between wind generation and transmission line thermal ratings in the north west of the state, potentially allowing higher levels of wind generation to connect without circuit upgrades;

(b) stage 1 of the north west Tasmania developments of up to 180 MW or more could connect into Burnie at 220 kV without any significant shared network upgrades provided that a run-back scheme was implemented and mitigation measures for voltage collapse (such as dynamic reactive power support) were put in place for a trip of the Burnie to Sheffield single 220 kV circuit;

(c) stage 2 of the developments will require significant upgrade of the Burnie to Sheffield transmission corridor or connection directly into Sheffield. Dynamic reactive support may not be required at Burnie if the existing Burnie to Sheffield 220 kV line is replaced with a new double circuit 220 kV line or north west Tasmania wind farms are connected directly to Sheffield Substation via a new double circuit 220 kV line;

(d) upgrade of the Sheffield to Palmerston 220 kV transmission corridor would lift network constraints under Basslink import and high wind generation scenarios;

(e) transient stability issues will require close study if the Sheffield to Palmerston 220 kV circuit is up-rated using a higher capacity conductor rather than replaced with a new double circuit 220 kV line. The additional capacity may not be fully utilised due to a transient stability limit.

Some proposed locations for the future wind farms in Midlands and Central Highlands of Tasmania are in close proximity to the main 220 kV backbone in Tasmania. This backbone would be soon further reinforced with Transend's new double circuit 220 kV from Waddamana in Central Highlands of Tasmania to Lindisfarne Substation located in Tasmanian Southern region on Hobart eastern shore. The further reinforcement of the 220 kV backbone is planned in Transend's 30+ year grid vision. Consequently, wind farms proposed in close proximity to the 220 kV backbone would have advantages for connection to the more robust and stronger 220 kV network.