OTTER Regulation of FCAS Supporting Documentation

(Links to documents are provided here. Original pack contained the actual documents)

Provided to OTTER 10 September 2009

1 Reliability Panel Consultation Process Appendix B of Final Determination (pages 45-47)
http://www.aemc.gov.au/Media/docs/Final%20Report-83b9ab86-e33f-463a-bc29-f3d62a74b0fb-0.pdf

2 TFOS Final Decision Table of Options
http://www.aemc.gov.au/Media/docs/Final%20Report-83b9ab86-e33f-463a-bc29-f3d62a74b0fb-0.pdf

3 Alinta Submission to Reliability Panel 29 July 2008
http://www.aemc.gov.au/Media/docs/Alinta%20-%20supplementary%20submission-66b3a22c-bde0-4e12-90be-ad9e186517fc-0.pdf

4 ETAC Inertia Paper
(Full text included)

5 AEMC Causer Pays Rule Change Draft Determination
http://www.aemc.gov.au/Media/docs/Draft%20Rule%20Determination-f49d4d71-7ebe-4b36-b02f-722985e2a601-0.PDF

a. Aurora / AETV submissions to Draft Determination
http://www.aemc.gov.au/Media/docs/AETV%20Power%20Submission%20-%207%20September%202009-308ce1e7-d634-4b0a-a685-d30f8e7f1f5a-0.PDF

http://www.aemc.gov.au/Media/docs/Aurora%20Energy%20Submission%20-%208%20September%202009-208c21ad-f695-464b-af3d-df864d4a6a21-0.PDF

b. Hydro Tasmania submission to Draft Determination
http://www.aemc.gov.au/Media/docs/Hydro%20Tasmania%20received%2017%20July%202009-95b31f2e-b504-458f-926b-633876628a79-0.PDF

http://www.aemc.gov.au/Media/docs/Hydro%20Tasmania-70f89f1b-e213-44c8-8c2d-18428509a097-0.pdf

c. CRA Final Report for Reliability Panel Draft Determination 27 Aug 08 pages 46-48
http://www.aemc.gov.au/Media/docs/CRA%20Report%20for%20Draft%20Report-fafa1aaa-bd57-4aa7-bdbb-44b37dedecf6-0.pdf

Item 3 Header Sheet

TFOS: Alinta Representations to the Reliability Panel 2008 Points Relevant to OTTER Notice

Alinta Energy Tamar Valley, the previous owners of the Tamar Valley CCGT submitted various material to the TFOS review, which demonstrated that they were aware of the key issues surrounding the supply shortage and cost of raise contingency FCAS in Tasmania. Hydro Tasmania, at the time, did not concur that the assumptions used were correct and as a consequence the modelling did not accurately reflect the expected outcomes. Hydro Tasmania is still of the view that the modelling is not correct and with the benefit of hindsight can now point out some of the incorrect assumptions with certainty. Leaving this to one side, through out these documents it is apparent that Alinta were acutely aware of the technical issues associated with raise FCAS provision and through this work would be well aware of the commercial implications for the operators of this plant. The following key points are evidenced in the document;

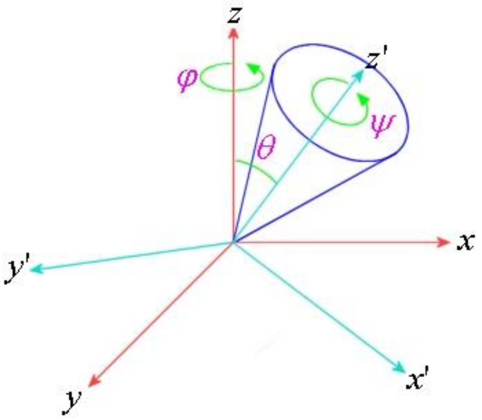
- All the modelling includes FCAS capability from both AETV and Gunns, both raise and lower (stage 2 report - table 4.1)
- There is recognition of contingency size, Tasmanian demand and inertia as key elements in the calculation of the requirement (stage 2 report – section 4.1)
- Basslink's unique operation in terms of transferring FCAS between regions is acknowledged (stage 1 report – section 2.3)
- "Generally, the proposed frequency operating standard change and introduction of the initial large thermal generator in the Tasmania region is a short term transient problem" (stage 2 report – section 6.1)
- The most significant error in the assumptions is that the benefit thought to be provided by the CCGT inertia has now been discounted.
- Alinta were exploring actively exploring co-optimisation of contingency size with FCAS requirement. A concept that is not currently practised in the market, but certainly regarded as a possible mitigation utilising existing market processes i.e. NEMDE.

The Reliability Panel Presentation slides provide a high level acknowledgement of the key issues that were confirmed through the process.

- "FCAS local requirement is higher due to FOS change; however local FCAS supplies will increase substantially following subsequent new entry of thermal plant in Tasmania" (slide 12)
- Slide 13 shows transient rise in FCAS R6 price until Gunns thermal plant is commissioned.
- "Incidence of Basslink importing at the limit reduces from ~15% to ~3% mitigating market power" (slide 14)
- "FCAS cost plus energy costs in the Tasmania region are reduced. FOS change provides a net benefit in terms of total energy supply cost in Tasmania" (slide 15)
- "Proposed standard brings efficiency gains in total energy supply costs" (slide 16)

(Trim: D09/070925) Item 4 Inertia paper

Inertia Issues Working Group



Introduction to Inertia and Wind Turbines

Rev	Date	Revision Description
1.04	6/07/2009	For Submission to ETAC

CONTACT

This document is the responsibility of ETAC.

1. PURPOSE

This high level briefing document has been prepared by the Tasmanian Inertia Issues Working Group (IIWG) to provide the members of the Electrical Technical Advisory Committee (ETAC) with a simplistic understanding of system inertia.

It is provided for information only and is intended as an internal ETAC document.

2. INTRODUCTION TO INERTIA AND WIND TURBINES

The inertia of a body is its tendency to resist change in its motion whether that motion is either spinning or in a straight line. Inertia determines how much energy must be applied to increase the speed of rotation of the object, and conversely, how much energy must be extracted from the object to slow it down. A power system is made up of many generators and motors all spinning at the same relative speed (or frequency) as they are connected together electrically by the transmission and distribution systems. The rotating part of electricity generators or motors exhibit inertia. The inertia of a machine is determined by its physical characteristics and in particular its rotational speed. Generally, the larger (*moment of inertia – dimensions' and weight*) the rotating object the greater is its inertia.

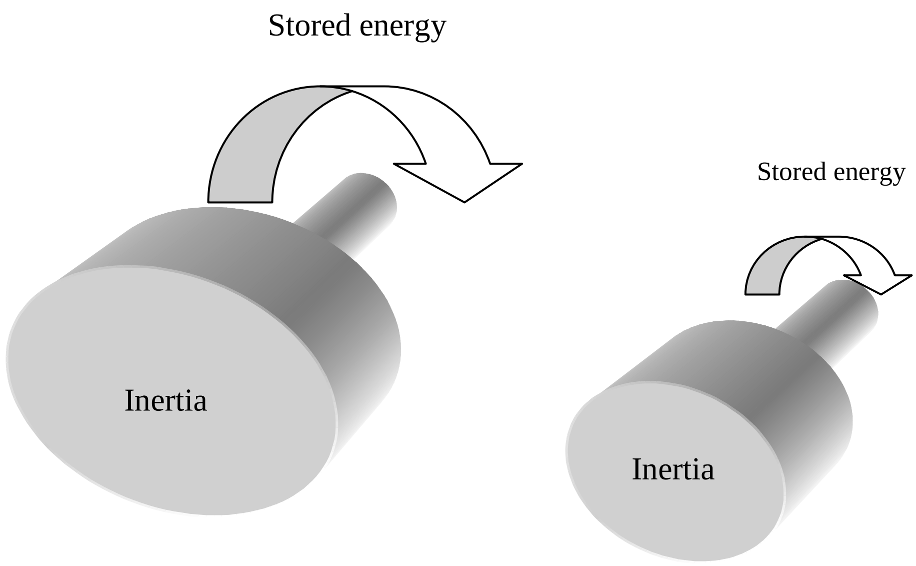


Figure 1 Relative amounts of stored energy in two rotating masses

One of the terms relating to the inertia of electrical machines is the inertia constant H. The inertia constant is the ratio of a machine's stored rotational energy and its rating and is expressed in seconds. For large hydro machines, this constant is around 2.5 to 4 seconds. Hydro turbine/generator are heavy, large in size, but rotate at 166 to 600 revolutions per minute much slower than thermal machines which rotate at 1500 or 3000 revolutions per minute and consequently, their inertia constant is lower.

The inertia time constant represents the time it takes the machine (turbine and generator) to change its speed by 50% under constant (accelerating or decelerating) torque, equal to machine ratings.

An inertia constant of 3 seconds means that the energy stored in the rotating part of a machine could supply its rated load for 3 seconds. For a hydro generator values typically vary between 2 to 4 seconds. The H value for the northern Combined Cycle Gas Turbine (CCGT) is approximately 6 to 7 seconds. The larger the value of H the higher the rotational stored energy of the machine. The actual value of rotational stored energy for any generator is given by the following expression:

Stored Energy = H × MVA rating (MW seconds)

The inertia of generators (and whole power systems) is usually expressed in terms of MW seconds.

To extract the stored energy from rotating mass there must be a change of speed (reduction). As the change in frequency following a single contingency is limited to 4%[1] only part of the stored energy will assist system recovery.

In a power system, when generation and load equal each other the system is in balance, generators rotate at a constant speed and the frequency will be stable.

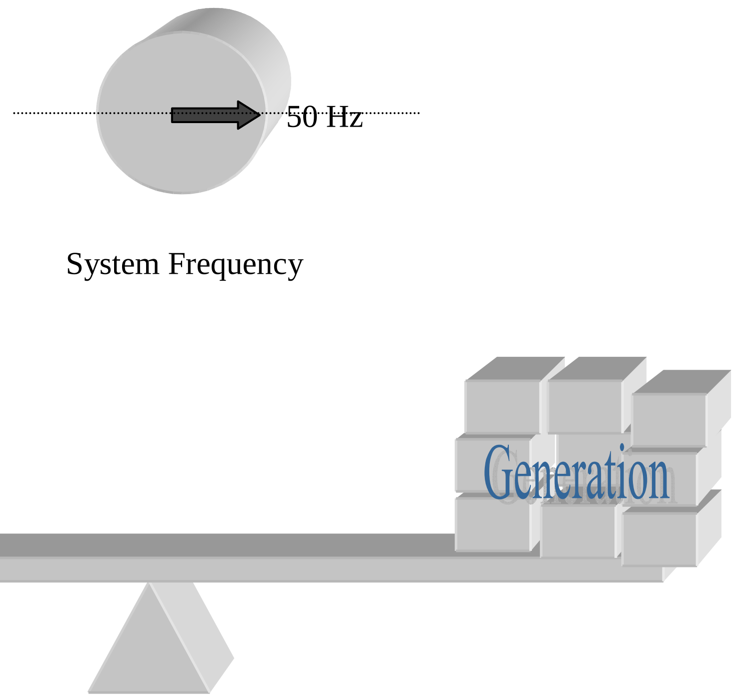


Figure 2 Load and generation balance

If a generator is disconnected from the power system, there will not be enough energy to supply the load, and the system slows down (frequency drops) as energy stored in the spinning machines is used to make up the shortfall. If a power system has a high inertia, it will slow down gradually as large amounts of energy stored in the rotating machines is released. Conversely, if the power system has low inertia it

[1] Reduction in frequency to 48 Hz is a reduction of 2 Hz which is 4 % of 50 Hz. FCAS should limit the frequency change to 2 Hz

will slow down very quickly as the energy stored in the rotating machines is quickly used up. This is analogous to the slowing down of a car (low inertia) when compared with a truck (high inertia) when the driver takes their foot of the accelerator. The car will slow down much faster than the truck.

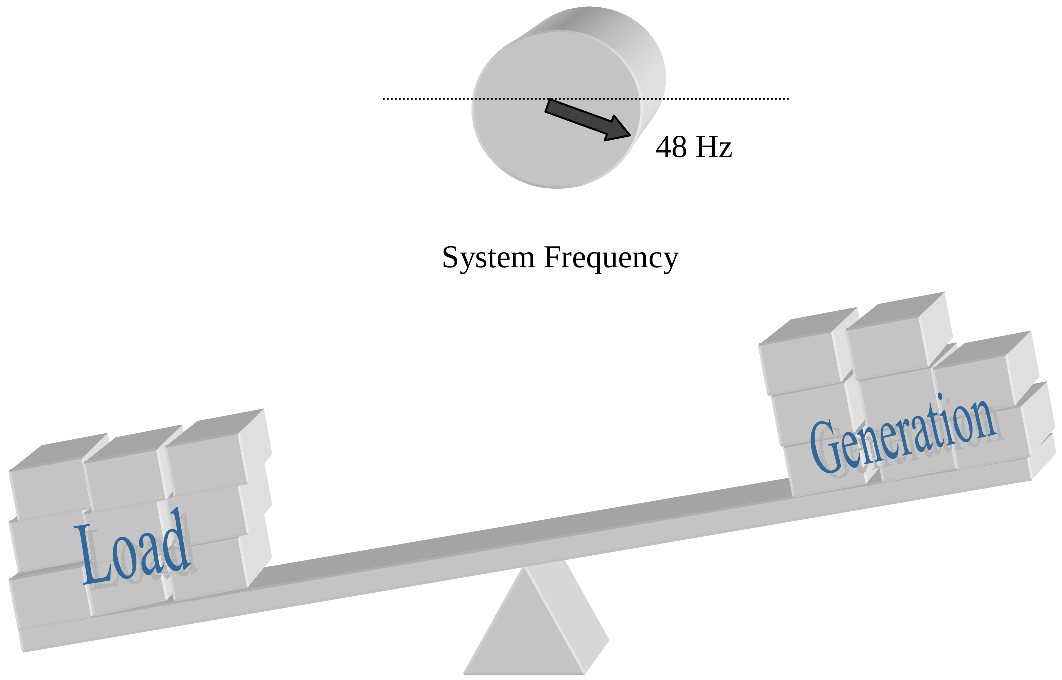
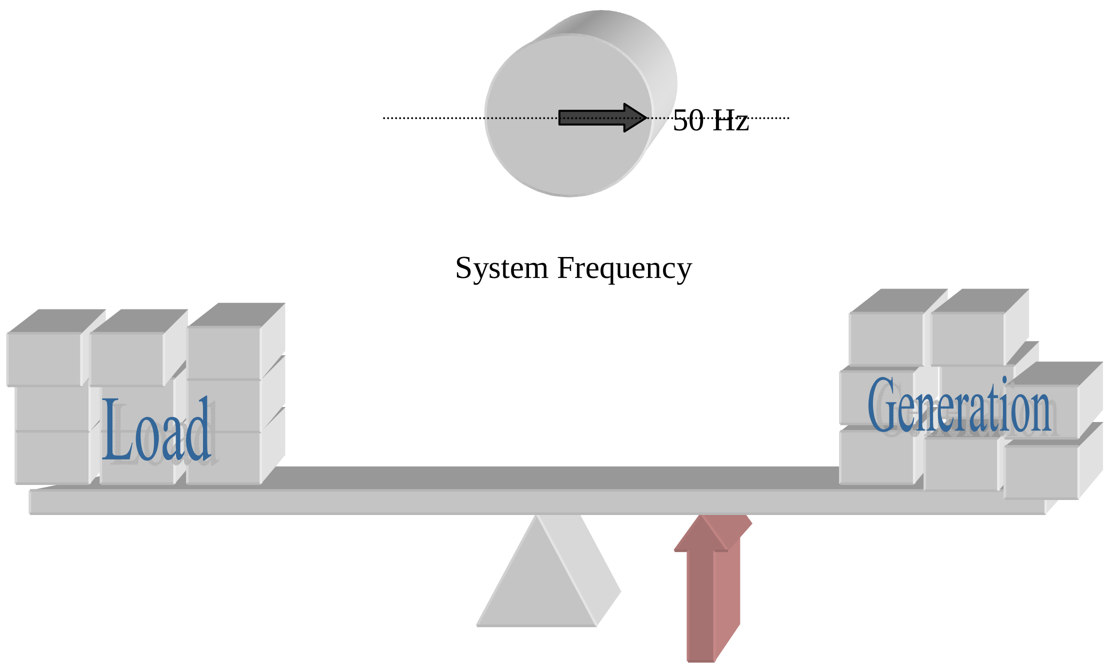


Figure 3 System with load greater than generation

In a similar way, disconnection of a load from the system will cause an excess of energy with subsequent speeding up of the system. A low inertia system will speed up quickly, while a high inertia system will speed up slowly.

A power system will quickly become unstable and collapse if it speeds up or slows down in an uncontrolled manner. So Frequency Control Ancillary Services (FCAS) are used to control the frequency of the system. Loads and generators control their injection or absorption of power from the system in response to changes in frequency, so restoring the balance between generation and load.



FCAS

Figure 4 Load and generation balance and the action of FCAS in restoring balance

Traditional generators driven at constant speed by governed hydro or thermal turbines are directly coupled to the power system and can't help but provide "inertial response".

If the frequency drops, their inherent resistance to change in rotational speed results in power transfer from the machine to the grid increasing, so slowing down the decline in frequency. Similarly, if the frequency increases, the power transfer to the grid decreases, so slowing the increase in frequency.

Continuing the vehicle analogy, stopping a truck in the same distance as a car requires the truck to have much greater capacity braking systems. The truck has greater inherent resistance to changes in its speed.

Traditional generation can be run efficiently at fixed speed due to control over the input energy source (i.e. gas, water or steam). Wind generation, on the other had, has no control (very slow control – pitch angle control) over input energy, and seeks to maximise aerodynamic efficiency by controlling the speed of the generator independently of grid frequency. As such; wind generators use a variety of different generator technologies ranging from standard induction motors to AC/DC/AC power electronic controllers.

Wind generation can not directly couple synchronous generator as the applying variable input torque produced by the wind to the fixed system frequency of 50 Hz would place unacceptable stresses on the gear box. Consequently shock absorbers in terms of induction generator with 2% slip or variable speed generators allowing for wide slip variations, have been introduced.

Variable speed generation allows wind turbine to operate at maximum efficiency and hence makes better use of the available wind resource .

Wind turbines using induction generators are sensitive to frequency and provide inertial response in a similar manner to traditional generation. Variable speed machines with a wider range of operating speeds such as "full converter" and "double fed induction" generators use power electronics to maintain optimum power output independent of grid frequency.

As such they are insensitive to grid frequency and provide no inertia response unless the control systems are programmed to do so, that is they have a H equal to 0 seconds.

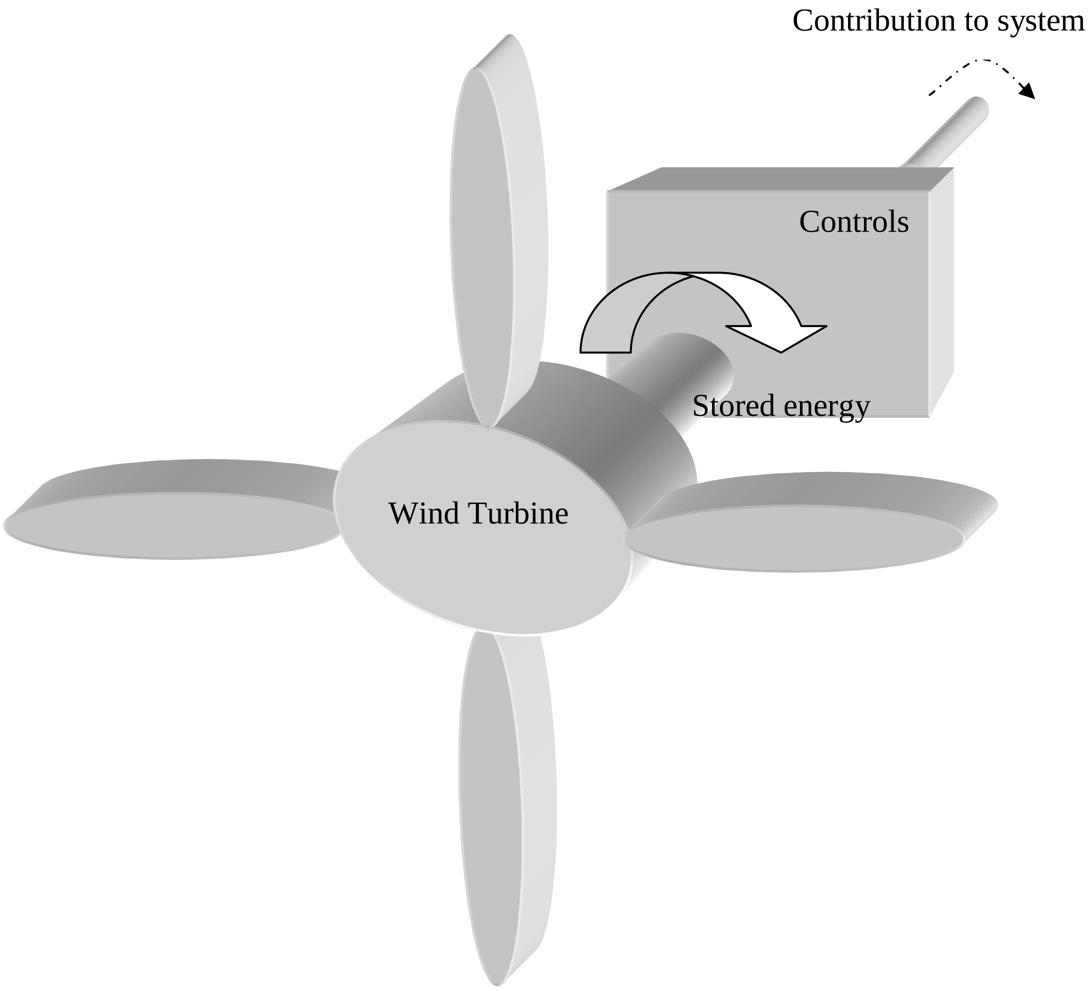


Figure 5 Contribution to system inertia by some wind turbine technologies

Variable speed wind turbines currently offered in the Australian and international markets are not configured to provide inertial response. There are no fundamental reasons why these turbines can't provide inertial response, as the forces on the turbine that would result from providing these services would be low relative to those experienced under an emergency stop or fault ride through conditions. Rather, the absence of this capability is a reflection of in-sufficient global demand for this feature to justify R&D effort in development of the capability.

It is likely that this situation will change over the next five years, with high wind penetration levels in number of major power systems around the world making inertial response from variable speed wind turbines economically attractive. It is considered likely that that all major turbine manufactures are now considering developing this feature to some degree, and General Electric has publicly announced such efforts.

In the Tasmanian context, the combination of excellent wind resource, small system size, DC coupling to the mainland and predominance of relatively low inertia hydro-electric generation create the potential for conditions of very low power system inertia.

Similarly, the introduction of other technologies such as solar voltaic and fuel cells have the potential to impact adversely on system inertia. Although wind generation does not reduce the power system inertia per se, market outcomes that result in changes to the make up of the generators dispatched has the potential to result in unprecedented low levels of system inertia. In the absence of other initiatives, such low levels of inertia will result in increased FCAS requirements and potentially reduce inter-regional transfer limits.

The issue for Tasmania is that if the system inertia was to become too low the existing market arrangements and process may not result in a secure power system, that is to say that the probability of a single event causing wide spread disruption could be significantly increased.

The inertia issues working group will seek to determine whether the current market design will result in the appropriate economic signals as the market moves into this un-charted and complex area of power system operation.

Header Item 5

National Electricity Amendment (Causer Pays for Ancillary Services to Control the Tasmanian Frequency) Rule 2009 Key points relevant to OTTER FCAS notice

The AEMC's analysis of the rule change proposal could be equally applicable to OTTER's proposed regulation;

Effect on investment signals – market intervention is likely to distort the market signals for investment in new generation (section A.3.1, p18)

"Weaker competition reduces the incentives generators face to generate electricity at its efficient cost. As well as failing to encourage generators to operate more efficiently, reducing competitive pressures prevents consumers from receiving the most efficiently priced electricity" (section A.4.1, p20)

"A barrier to entry does not include a cost or other impediment that applies more or less equally to any party wanting to participate in the market, irrespective of whether it is an established business or a new entrant" (section A.5, p21)

" The commission notes Hydro Tasmania's view that material provided by AETV Power and Gunns to the Reliability Panel indicating their respective intentions to provide contingency raise services, including R6, is evidence that New TFOS Units do not face a barrier to entry" (section A.5.1, p23)

In light of effects on investment signals, economic efficiency, barriers to entry and incentives to invest in new technology, it is unlikely that the proposed Derogation will promote competition in the generation sector in the Tasmania region or in the NEM. The commission is also concerned that weaker competition will preclude consumers from being offered a price for electricity that is based on the efficient cost of supply." (section A.7.1, p25)

"The commission also agrees that applying a cost recovery methodology consistently throughout the NEM, especially to the recovery of a given class of cost e.g. R6, promotes regulatory certainty." (section A.8.1 p27)

“Regulatory certainty can also be exacerbated where a decision to deviate from an existing market framework could be used to justify subsequent decisions to deviate from market frameworks.” (section A.8.1 p27)

“Derogations, by their very nature, introduce inconsistency into the NEM. In 2007, the Energy Reform Implementation Group reported that inconsistency, in the form of derogations and other state-specific legislation and regulatory instruments, was hampering efficient national competition and the emergence of a truly national energy market.” (section A.10.1 p33)

Aurora Energy and AETV Power expressed views to the rule change proposal that seem inconsistent with those expressed to OTTER;

“Aurora Energy did not agree that it is necessary to amend the current cost recovery mechanism. In its view, maintaining the current arrangements is unlikely to reduce the economic efficiency or distort future investment signals” (section A4, p20)

“As a market participant, Aurora’s experience is that the introduction and removal of jurisdictional derogations by their nature creates perceptions of regulatory unpredictability compared to the uniform application of rules across the National Electricity Market.” (section A8, p26)

“It should be noted that, if the Rule Change Proposal were to be implemented, Tasmania would have a markedly differently system for the settlement of FCAS costs than the mainland NEM participating jurisdictions, without there being any demonstrated net economic benefit either to the Tasmanian region of the NEM or to the NEM as a whole which justifies the differential cost treatment.”

And

“In AETV’s view, it would not represent good regulatory practice to move away from the current method of FCAS cost allocation in the absence of a compelling case and a well thought out and structured alternative which achieves an efficient and equitable allocation of FCAS costs in a manner which best contributes to the achievement of the national electricity objective.” (section A.10 p32)