WIND AND SOLAR ENERGY CONVERSION MODEL GUIDELINES CONSULTATION

DRAFT REPORT AND DETERMINATION

Published: AUGUST 2016

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

NOTICE OF SECOND STAGE CONSULTATION – **AMENDMENTS TO THE WIND ENERGY CONVERSION MODEL (ECM) GUIDELINES AND THE SOLAR ENERGY CONVERSION MODEL (ECM) GUIDELINES**

NATIONAL ELECTRICITY RULES – RULE 8.9

Date of Notice: 02 August 2016

This notice informs Semi-Scheduled Generators and any party having an interest in the Wind and Solar ECM Guidelines (**Consulted Persons**) of the publication of AEMO's draft report and determination, and commencement of the second stage of consultation on the Wind Energy Conversion Model Guidelines and the Solar Energy Conversion Model Guidelines.

This consultation is being conducted under clause 2.2.7(d) of the National Electricity Rules (**NER**), in accordance with the Rules consultation requirements detailed in rule 8.9 of the NER.

Invitation to make Submissions

AEMO invites written submissions on this Draft Report and Determination (Draft Report).

Please identify any parts of your submission that you wish to remain confidential, and explain why. AEMO may still publish that information if it does not consider it to be confidential, but will consult with you before doing so.

Consulted Persons should note that material identified as confidential may be given less weight in the decision-making process than material that is published.

Closing Date and Time

Submissions in response to this Notice of Second Stage of Rules Consultation should be sent by email to Op.forecasting@aemo.com.au with **Subject: ECM Consultation** to reach AEMO by 5.00pm (Australian Eastern Standard Time) on 25 August 2016.

All submissions must be forwarded in electronic format (both pdf and Word). Please send any queries about this consultation to the same email address.

Submissions received after the closing date and time will not be valid, and AEMO is not obliged to consider them. Any late submissions should explain the reason for lateness and the detriment to you if AEMO does not consider your submission.

Publication

All submissions will be published on AEMO's website, other than confidential content.

EXECUTIVE SUMMARY

The publication of this Draft Report and Determination (Draft Report) commences the second stage of the Rules consultation process conducted by AEMO to **consider proposed amendments to the Wind and Solar Energy Conversion Model (ECM) Guidelines** under the National Electricity Rules (NER).

In late 2015, AEMO identified an issue with the accuracy of the Australian Wind Energy Forecasting System ('AWEFS') dispatch forecasts. This issue had potential to affect Semi-Scheduled Generators at times when output is constrained by a local limit not reflected in the AWEFS forecast.

AEMO discussed the issue with a number of affected participants, and has identified a proposed solution, which would require Semi-Scheduled generators (wind and solar) to provide a new Supervisory Control and Data Acquisition (SCADA) signal, which gives AEMO information that identifies limits to the export of the plant. AEMO proposes that this signal be an additional data item, called "Local Limit", to be provided via SCADA in megawatts (MW).

During these discussions, further improvements to the dispatch forecast were also proposed. These included investigating use of a 'Possible Power' SCADA feed provided by Semi-Scheduled Generators in real time, and allowing the 'Wind Speed' SCADA feed to be an average of several representative wind speeds.

In March 2016, AEMO began a consultation on changes to the ECM Guidelines to implement these proposals, and received seven submissions. AEMO thanks these participants for their contributions to this consultation process.

The key issues raised in the submissions were:

- Overall support for the proposed changes' value in improving dispatch outcomes, but concern in one submission on the implementation costs.
- Concern that the proposed SCADA Local Limit has limited benefit for some farms unless distribution network limits are included.
- Concern that forecasting issues due to wind turbine cut-out during extreme wind conditions are not addressed by the proposed ECM Guidelines changes.
- Overall support for the proposed changes to the SCADA Wind Speed measurements, but concern about the implementation cost for existing wind farms.
- Overall support for the proposed SCADA Possible Power, but limited ability for some farms to comply, and substantial questions about its definition, its use and limitations on its accuracy.
- Discussion of related issues – how AWEFS should improve the dispatch forecast using the SCADA Possible Power signal, the concept of a forward-looking Possible Power, and the potential for semi-scheduled generators to participate in Frequency Control Ancillary Services (FCAS).

After considering the submissions received, AEMO's response to these issues is, as further detailed in this paper:

- To add the proposed SCADA Local Limit item to the Wind and Solar ECM as a mandatory provision for all new and existing semi-scheduled generating units except by agreement with AEMO, and make changes to AWEFS/ASEFS to apply that limit as a cap on the unconstrained intermittent generation forecast (UIGF) used in 5-minute dispatch.
- To investigate the longer-term approach of enabling Semi-Scheduled Generators to bid their maximum availability into the National Electricity Market Dispatch Engine (NEMDE).
- To explore the implementation of additional constraint equations in NEMDE to represent distribution network constraints impacting on the dispatch of *Semi-Scheduled Generators*.
- To add a new Turbines Extreme Wind Cut-out SCADA item to the Wind ECM as a mandatory provision except by agreement with AEMO, with corresponding changes to AWEFS.
- To implement the proposed ECM changes to the Wind Speed SCADA item and the required sampling rate of the SCADA signals, but exempt existing wind farms from those changes subject to approval by AEMO.
- To leave the proposed SCADA Possible Power out of the ECM Guidelines at this stage.

Through this consultation and otherwise, AEMO has identified other areas for improvement in AWEFS and ASEFS. Once this consultation is finalised, AEMO will engage with stakeholders on the next steps for future improvements.

AEMO's draft determination is to amend the Wind Energy Conversion Model Guidelines and Solar Energy Conversion Model Guidelines in the form published with this Draft Report.

Contents

1 Stakeholder Consultation Process

AEMO is consulting on **amending and publishing the ECM Guidelines** in accordance with the Rules consultation process in rule 8.9.

AEMO's indicative timeline for this consultation is outlined below. Future dates may be adjusted depending on the number and complexity of issues raised in submissions.

DELIVERABLE	INDICATIVE DATE
Notice of first stage consultation [and Issues Paper] published	18 March 2016
First stage submissions closed	27 May 2016
Draft Report & Notice of second stage consultation published	2 August 2016
Submissions due on Draft Report	25 August 2016
Final Report published	7 October 2016

The publication of this Draft Report marks the commencement of the second stage of consultation.

Note that there is a glossary of terms used in this Draft Report in **Appendix A**. Terms in italics are defined in Chapter 10 of the National Electricity Rules (the *Rules*).

2 Background

2.1 NER requirements

The matter under consultation is identified in clause 2.2.7(d) of the Rules. This clause provides:

> "AEMO must develop and publish guidelines in consultation with Semi-Scheduled Generators and such other person that AEMO, acting reasonably, considers appropriate setting out the information to be contained in energy conversion models. Any amendments to the guidelines are also to be made in consultation with Semi-Scheduled Generators and such other person that AEMO, acting reasonably, considers appropriate."

"Energy conversion model" is defined in Chapter 10 of the Rules as:

> "The model that defines how the intermittent input energy source (such as wind) is converted by the semi-scheduled generating unit into electrical output. That model must contain the information set out in the guidelines published by AEMO in accordance with clause 2.2.7(d)."

2.2 Context for this consultation

In late 2015, AEMO identified an issue with the accuracy of the Australian Wind Energy Forecasting System ('AWEFS') dispatch forecasts. This issue had the potential to affect Semi-Scheduled Generators at times when output is constrained by a local limit not reflected in the AWEFS forecast.

AEMO discussed the issue with a number of affected participants and identified a proposed solution, which would require Semi-Scheduled generators to provide a new SCADA signal to AEMO with information that identifies limits to the export of the plant. AEMO continues to investigate options for limits that do not fit within the proposed solution.

During these discussions, further improvements to the dispatch forecast were proposed. These included investigating the use of a 'Possible Power' SCADA feed provided by Semi-Scheduled Generators in real time, and allowing the 'Wind Speed' SCADA feed to be an average of several representative wind speeds.

2.3 First stage consultation

AEMO issued a Notice of First Stage Consultation on **18 March 2016**. **Refer to http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms for the *Issues Paper*.**

AEMO received seven written submissions in the first stage of consultation, from:

- AGL Energy (AGL)
- CWP Renewables – Boco Rock (Boco Rock)
- CWP Renewables – Taralga (Taralga)
- Infigen Energy (Infigen)
- Pacific Hydro
- Musselroe
- Vestas

AEMO also held a meeting with AGL on **21 June 2016**. Consistent with the National Electricity Rules (NER 8.9(e)), AEMO extended the current consultation timeline by 25 days, to accommodate meetings requested by Consulted Persons between the Draft *Issues Paper* submission close date and publication of the Draft Report.

Copies of all written submissions and minutes of the meeting held with AGL have been published on AEMO's website at http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms.

3 Summary of Material Issues

The key material issues raised by Consulted Persons in response to the proposed changes to the ECM Guidelines are summarised in the following table:

NO.	ISSUE	RAISED BY
1.	New ECM Item: Proposed SCADA Local Limit	AGL, Boco Rock, Musselroe, Pacific Hydro, Taralga, Infigen, Vestas
2.	New ECM Item: Dispatch Forecast With Extreme Wind Speed and Direction Cut-out	Musselroe
3.	Existing ECM Item: Changes to definition of SCADA Wind Speed	AGL, Boco Rock, Musselroe, Pacific Hydro, Taralga, Infigen
4.	New ECM Item: Optional Possible Power SCADA item	AGL, Boco Rock, Musselroe, Pacific Hydro, Taralga, Infigen, Vestas
5.	New ECM Item: Maximum Capacity Static Parameter	AGL
6.	New ECM Item: Slope Tracking Direction	AGL
7.	Provision of signals for FCAS	Taralga, Pacific Hydro, AGL

A detailed summary of issues raised by Consulted Persons in submissions and at the meeting with AGL, together with AEMO's responses, is contained in **Appendix B**.

4 Discussion of Material Issues

4.1 New ECM Item: Proposed SCADA Local Limit

4.1.1 Issue summary and submissions

In the *Issues Paper*[1], AEMO proposed to add a new SCADA item, "Local Limit", to the Wind and Solar ECM Guidelines. All new and existing *Semi-Scheduled Generators* will be required to provide this in respect of their *semi-scheduled generating units*.

Overall, responses were supportive of the proposed SCADA Local Limit signal for its improvements to the accuracy of dispatch outcomes and to regulation FCAS contribution factors.

One submission suggested an alternative – of making system changes that allow the bid maximum availability for a semi-scheduled generating unit to apply in NEMDE as a cap on its dispatch.

Specific comments are discussed, where appropriate, in detail below. AEMO also asked a series of consultation questions which are also detailed below.

4.1.1.1 Dispatch Outcomes and Distribution Network Constraints

Do you agree that the requirement for a SCADA Local Limit will improve your dispatch outcomes?

In response to this question, two submissions (AGL, Infigen) noted that their dispatch outcomes would be improved by the SCADA Local Limit signal, while one (Musselroe) stated it supported the inclusion of the SCADA Local Limit, and two (CWPR (Taralga), Pacific Hydro) noted it was beneficial to market outcomes..

Three submissions (CWPR (Boco Rock), CWPR (Taralga), Pacific Hydro) stated that the proposed signal would provide little benefit to them because either their farms do not have connection asset limitations or their limitations are already covered by the existing Turbines Available SCADA signal. However, two of those submissions (CWPR (Taralga), Pacific Hydro) acknowledged that the change was beneficial to market outcomes.

Musselroe's submission did not agree with excluding market-related limits from the definition of SCADA Local Limit, as it would exclude its existing process for managing market-related limitations. Musselroe also considered bidding adjustments an impractical solution as "significant manual intervention" is required.

In response to Musselroe's comment about market-related limits, AEMO has revised the explanatory list of inclusions and exclusions for the SCADA Local Limit. AEMO notes that concerns may legitimately be raised about compliance with Clause 4.9.8(e) in the *Rules* in this situation, however AEMO does not take a view on this.

Musselroe's submission asked for clarification of what to do with reactive power limits managed by AEMO. AEMO's response is that the definition of SCADA Local Limit will be clarified as outlined in Section 4.1.2, to state specifically that limits managed by AEMO through the central dispatch process should be excluded.

Infigen's submission noted that *plant availability* should not be in the SCADA Local Limit as it was already covered by the SCADA Turbines Available. AEMO notes that *plant availability* was included in the definition to cover local limits that are unrelated to connection assets, but agrees that aspects of *plant availability* already fully covered by the SCADA Turbines Available should not need to be also communicated in this signal, and proposes as outlined in Section 4.1.2 to re-word the definition.

Following clarification by phone, Infigen explained that it sometimes imposes a manual cap to limit generation for reasons not related to availability, including controlling ramp-up rates after semi-dispatch cap periods as described in the submission. Infigen considers such limits should be excluded from the SCADA Local Limit, to prevent future semi-dispatch cap values being reduced by these limits, as they do not reflect availability for the next dispatch interval. AEMO has amended the definition of SCADA Local Limit to exclude manual limits that do not give information on availability for the next dispatch interval.

Please quantify for your wind/solar farm(s) the likely impact of the exclusion of *distribution network constraints* not managed by AEMO from the SCADA 'Local Limit' definition.

[1] Published for the first round of this consultation on the webpage for this consultation, at http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms

Five submissions (AGL, CWPR (Boco Rock), CWPR (Taralga), Infigen, Vestas) considered that distribution network limits should be included in the SCADA Local Limit to improve dispatch outcomes, with three submissions noting an impact on their own farms (AGL, CWPR (Boco Rock), CWPR (Taralga)), and three submissions acknowledging that a rule change may be required to implement this (CWPR (Boco Rock), Pacific Hydro, CWPR (Taralga)).

Infigen's submission suggested it would also be useful as a market participant to understand what kind of distribution network limits were active in the region. AEMO has considered this suggestion but considers it outside the scope of the current consultation.

One submission suggested that the proposed limit should include both transmission and distribution network limits. AEMO considers that the central dispatch process (NEMDE) appropriately captures this information at the transmission level.

4.1.1.2 Validation of SCADA Local Limit

Do you agree with the proposed validation of the SCADA Local Limit, and the proposed validation range? If not, how should quality be handled?

Two submissions (AGL, Infigen) noted agreement with the SCADA Local Limit validation criteria.

Three submissions recommended the wording be changed to apply the local limit if it is less than the dispatch UIGF, not the nameplate rating. One submission requested the validation be against Maximum Capacity, not *nameplate rating*. On clarification by phone, Pacific Hydro clarified that they saw no value in validating against *nameplate rating*.

One submission (Infigen) noted that validation of this signal is important as it affects future dispatch levels.

AEMO considers that given the intention of the SCADA Local Limit is to cap the dispatch UIGF, if the SCADA Local Limit is above the calculated dispatch UIGF before capping, it will have no effect, hence there is no practical difference between choosing to apply the SCADA Local Limit value if below dispatch UIGF compared to a higher value such as *nameplate rating*.

AEMO proposes to perform range validation of the SCADA Local Limit value where its quality is "Good" in AEMO's SCADA systems, and as such proposes that values above the higher of Maximum Capacity and *nameplate rating* are tagged as poor quality inputs, given that *plant availability*, a component of the definition, is always limited by the plant's capacity. The higher of Maximum Capacity and *nameplate rating* is proposed to give flexibility in implementation by wind farms, noting that this makes no material difference compared to validating against Maximum Capacity only.

AGL's submission asked for clarification of what constitutes a "good quality" local limit. AEMO's response is that it refers to quality as reported by the SCADA system. A signal is marked as "Good" if the values in AEMO's SCADA system are updating. The quality may be not "Good" due to communications failures, database failures on the path to AEMO, or out of range values.

Further, to avoid the risk of unduly reducing dispatch levels by a stuck SCADA signal not identified by the existing SCADA quality mechanism, AEMO proposes an additional validation step. If the actual output of the farm is above the SCADA Local Limit signal by more than 10% for more than 15 minutes, AWEFS will declare the SCADA Local Limit invalid and not apply it.

The changes proposed are incorporated in Section 4.1.2 of this document.

4.1.1.3 Types of Limits Affecting Generating Unit

What types of limits affect your semi-scheduled generating unit? Who is responsible for determining those limits, how dynamic are they, how often do they occur, and how are they applied?

There was substantial variation between farms in the types of limits faced and how they are managed. Three submissions (CWPR (Boco Rock), CWPR (Taralga), AGL) described limits on their distribution network managed by the Distribution Network Service Providers (DNSPs), two submissions noting limits primarily managed by AEMO (Pacific Hydro, CWPR (Boco Rock)). For AGL's Oaklands Hill farm, the distribution limit applies about 30% of the time. Two submissions (Infigen, AGL) detailed connection asset limitations and DVAR/DSTAT equipment maintenance.

Some limits described are managed manually, others are automated, with a mix of static and dynamic limits described in the submissions. Occurrence was described as a small percent of the time for several farms, up

to 30% of the time for AGL's Oaklands Hill farm, and as "less than 10 times a year, less than an hour to more than a week" in Infigen's submission.

AGL's submission raised a concern with the proposal for an automated SCADA Local Limit, noting the cost may be prohibitive. AEMO is not requiring the SCADA Local Limit to be fully automated, but suggests that to be most reliable and accurate, it should be as automated as reasonably feasible.

4.1.1.4 Costs to Provide

What do you estimate are your upfront and ongoing costs in providing and maintaining a SCADA 'Local Limit'?

The costs described in the submissions include retrofitting the SCADA system and interfacing with the TNSP/DNSP to add extra SCADA points, with likely higher costs for retrofitting existing farms. One submission (CWPR (Boco Rock)) stated they were still investigating their costs.

Two submissions (CWPR (Taralga), Pacific Hydro) did not give estimates, but stated "As a whole, beneficial to market dispatch outcomes", and Infigen's stated "will vary across farms, not expected to be high".

AGL's submission and meeting minutes described a large cost, but this was split across nine sites and across all parts of this ECM change. AGL's costs included costs to send extraSCADA signals to AEMO, integrate with AGL's dispatch system and carry out with the vendor any programming required within the farm's control system. AGL later clarified with AEMO that the control system programming is for the Wind Speed and Possible Power parts of the ECM change.

4.1.1.5 Other Options

Are there other options available to manage the local limit issue not canvassed in this paper?

Two submissions (AGL, Infigen) were made. Both agreed that managing dispatch by applying the SCADA Local Limit as a cap on the UIGF is more practical and efficient than the other options in the paper, with AGL stating that the other options are not feasible. Infigen's submission suggested there may be alternatives to these options, which AEMO interprets from the following comments to be the use of the bidding of Availability in dispatch as discussed here, and asks Infigen to make a submission with other options if this is not the case.

Infigen's submission noted that bidding of Available Capacity was an existing, practical option for managing fixed limits during maintenance events, and suggested the user interface be reviewed. AGL's submission suggested that AEMO should make system changes to enable bid Availability in NEMDE to manage some limits. Several submissions referred to the use of the EMMS Portal provided by AEMO to manage availability.

AEMO has considered these submissions and to clarify the current design, notes:

- The 'Intermittent Generation' part of the EMMS Portal is used to manage availability, which directly limits the Pre-dispatch, Short Term Projected Assessment of System Adequacy (ST PASA) and Medium Term (MT) PASA forecasts but not the dispatch forecast. However, the entered availability does have a minor, indirect impact on dispatch, because a small component of the Pre-dispatch forecast is incorporated into the dispatch forecast.
- Bids of maximum availability currently only apply to the dispatch of scheduled generators. While semi-scheduled generators can submit a bid with maximum availability, that value is not used and its UIGF from AWEFS/ASEFS1 is used instead.

Regarding the two proponents of enabling the Availability bid in NEMDE, AEMO will recommend this also be investigated with the SCADA Local Limit, because it may benefit participants who actively participate in bidding, and may increase the transparency of the SCADA Local Limit. AEMO notes that enabling the Availability bid in NEMDE is not a complete substitute for the SCADA Local Limit as it is not suitable for dynamic limits such as those described in AGL's submission, or for participants such as Musselroe who find manual intervention of bidding impractical, as noted in Section 4.1.1.1. AEMO notes that a rule change will likely be required to achieve this type of change.

4.1.1.6 Related Matters

Are there any other related matters you wish to raise?

Musselroe's submission raised that the proposed solution would not address issues with correct dispatch during extreme wind speed or extreme wind direction changes. AEMO has addressed this in Section 4.2 of this document.

Two submissions (Pacific Hydro, CWPR (Taralga)) suggested adding a new "Distribution Limit SCADA" signal to the ECM Guidelines to allow AEMO to see both distribution and connection asset constraints, and in anticipation of its future use in AWEFS/ASEFS, noting this would firstly require a *Rules* change to allow inclusion of distribution network limits in the UIGF. AEMO does not consider this a viable approach and provides reasons in Section 4.1.2

Two submissions also raised that "Local Limit" was ambiguous, and suggested "Generating System Limit" instead. AEMO's considers that "Generating System Limit" is not appropriate because it does not include limits on connection assets and other network equipment such as transformers. On the ambiguity of the name of the SCADA Local Limit signal, AEMO considers that it is not ambiguous as it defines limits local to the farm, excluding all network constraints.

AGL's submission asked how the SCADA Local Limit would be used in the tuning of AWEFS power curves. AEMO's response is that the SCADA Local Limit will have no effect on the tuning of AWEFS power curves.

AGL's submission also requested that AEMO consider:

- Publishing more data on semi-scheduled plant in its market management systems (MMS)
- Using ramp-rates to relate dispatch and 5-minute Pre-dispatch forecasts

AEMO will consider these separately to this consultation. On the first point, AEMO agrees that increased transparency of semi-scheduled plant data is desirable and will investigate future options to achieve this.

4.1.2 AEMO's assessment

AEMO's assessment is that the submissions generally support provision of a SCADA Local Limit in improving dispatch outcomes.

The proposal closes a current gap in the implementation of AWEFS/ASEFS, whereby farms are not able to efficiently advise some aspects of their availability for dispatch to AEMO. For some existing farms, the implementation of the SCADA Local Limit gives little benefit to dispatch outcomes, so AEMO proposes to describe the signal as "Mandatory, unless otherwise agreed by AEMO" to prevent an unjustified retro-fitting expense.

There was strong support in the submissions for including distribution network limits in the calculation of the UIGF including support for a rule change to achieve this. In Section 3.1.3 in the *Issues Paper*, AEMO suggested two options to improve dispatch accuracy for distribution network limits not currently managed in dispatch by AEMO:

1) AEMO to implement additional constraint equations in NEMDE to represent distribution network constraints impacting on the dispatch of *Semi-Scheduled Generators,* where this is a practical and efficient way to improve dispatch outcomes, noting that this may put additional data requirements on distribution network service providers.
2) A change to the *Rules* to amend the definition of UIGF to allow consideration of network constraints not managed by AEMO.

After re-considering the relevant *Rules,*as detailed below, AEMO considers that option 1 is the most appropriate. AEMO considers that the SCADA Local Limit covers limits on a *Semi-Scheduled Generator*'s assets behind its network connection and should be reflected in AEMO's forecast of their available capacity (or UIGF) under clause 3.7B(a) of the *Rules*. Limits on the network beyond this are the responsibility of Network Service Providers, and reflected by AEMO in network constraints. To improve dispatch accuracy, AEMO intends to explore the implementation of additional constraint equations in NEMDE to represent distribution network constraints impacting on the dispatch of *Semi-Scheduled Generators* in consultation with the Distribution Network Service Providers.

- Clause 4.8.1 of the *Rules* requires Registered Participants (in this case, Distribution Network Service Providers) to advise AEMO of distribution network limits
- The *Rules* defines a *network constraint* as both transmission and distribution network
- Clause 3.8.10(a),(b) of the *Rules* requires that AEMO define and apply *network constraints* to dispatch
- Clause 3.8.1(b)(5) of the *Rules* requires dispatch to be subject to *network constraints*

In light of submissions, AEMO considers the overall costs to implement a new SCADA Local Limit and apply it to dispatch UIGF reasonable compared to the overall benefit of more accurate market dispatch outcomes. The cost to AEMO to implement this change is modest, and AEMO considers that, for new farms, the additional cost will be minimal given the large number of SCADA points already supplied.

AEMO acknowledges that the new SCADA Local Limit would be opaque to market participants and AEMO will investigate future options to increase transparency of semi-scheduled generation operations.

Revised definition of SCADA Local Limit – to be provided by all new and existing *Semi-Scheduled Generators* in respect of their *semi-scheduled generating units*.

SCADA Local Limit – Mandatory, unless otherwise agreed by AEMO

In MW, the SCADA Local Limit is the lower of *plant availability* and of the limitation on capacity of connection assets on the export of energy from the wind/solar farm.

When implemented in AWEFS/ASEFS1, the SCADA Local Limit is used to cap the UIGF for the wind/solar farm in the dispatch timeframe.

The SCADA Local Limit excludes limits on a *transmission network* and *distribution network* (to ensure AEMO's compliance with clause 3.7B(c)(6) of the *Rules*), and other limits managed by AEMO through the central dispatch process.

Limits already communicated in the SCADA Turbines Available signal may be excluded from the SCADA Local Limit.

Manually-applied transient limits of less than 5-minute duration may be excluded from the SCADA Local Limit.

The SCADA Local Limit should not exceed the higher of the *nameplate rating* and the Maximum Capacity of the wind/solar farm.

Revised explanation, from Section 3.1.1 in the *Issues Paper*:

SCADA Local Limit should give regard to:

- Limits on connection assets and network connection plant, including outages.
- Limits on generating plant (plant availability), including outages, unless already communicated in the SCADA Turbines Available signal.

SCADA Local Limit should not give regard to:

- Limits on the transmission network.
- Limits on the distribution network.
- Limits due to the available wind/solar energy.
- Limits due to turbine cut-out from extreme wind speed or direction change.
- The current dispatch level during a semi-dispatch interval.
- Limits managed by AEMO through the central dispatch process.
- Transient limits of less than 5-minute duration, including manual ramping limits after a semi-dispatch period.

Revised implementation of SCADA Local Limit

- Change to the Wind and Solar ECM Guidelines, to mandate the provision of a real-time SCADA 'Local Limit' for existing and future *semi-scheduled generating units* (unless otherwise agreed with AEMO); **and**
- Changes to AWEFS/ASEFS1 to:
  - Sample the SCADA Local Limit as the one-minute average between 2 and 3 minutes into the dispatch interval.
  - Mark the SCADA Local Limit as poor quality if the incoming SCADA quality is not "Good" OR if the value is less than zero OR if the value is above the higher of the *nameplate rating* and the Maximum Capacity of the wind/solar farm.
  - Mark the SCADA Local Limit as poor quality if the SCADA Output MW (with incoming good quality) is more than 10% above the SCADA Local Limit for more than 15 minutes.
  - Limit the Dispatch UIGF to SCADA Local Limit only if the above validation tests pass. "Limit" means to reduce the Dispatch UIGF to SCADA Local Limit if it exceeds SCADA Local Limit.

4.1.3 AEMO's Conclusion

AEMO concludes that the SCADA Local Limit should be defined as proposed in Section 4.1.2 above, as a mandatory provision unless otherwise agreed with AEMO.

Further, AEMO recommends that:

- AEMO to investigate implementing additional constraint equations to represent distribution network constraints impacting on the dispatch of *Semi-Scheduled Generators*.
- AEMO to investigate the costs and benefits of applying the bid Availability for semi-scheduled generators in NEMDE and PASA.
- AEMO to investigate options to increase the transparency of semi-scheduled generation operation in future.

4.2 New ECM Item: Dispatch Forecast with Extreme Wind Speed and Direction Cut-out

4.2.1 Issue Summary and Submissions

Musselroe's submission raised that the proposed solution would not address issues with incorrect dispatch during extreme (high) wind speed or extreme wind direction changes.

Musselroe's submission also raised concerns about what it described as the "AEMO hysteresis limit" at times of extreme wind speed.

4.2.2 AEMO's Assessment

AEMO agrees that the proposed solution does not address issues of incorrect dispatch during extreme wind speed or extreme wind direction changes. Sustained high wind conditions in May 2016 showed AEMO that AWEFS does not accurately model extreme wind cut-out in the dispatch timeframe.

AEMO understands that the "AEMO hysteresis limit" described by Musselroe was the result of blending into the AWEFS dispatch UIGF the pre-dispatch forecast at 7.7% of the final dispatch UIGF. At times of cut-out when the farm is not semi-dispatched, the AWEFS dispatch forecast will be close to the last output, blended at a ratio of 92.3% (dispatch)/7.7% (pre-dispatch) with the latest pre-dispatch forecast. If the pre-dispatch

forecast does not predict cut-out, then this is likely near full power, which means the AWEFS dispatch forecast sits at around 7% of farm capacity while output is near zero.

AWEFS is only able to model high wind-speed cut-out while wind speed is above the threshold configured in the ECM. Recent experience has shown that high wind-speed cut-out is complex to model in real-time because each turbine cuts out individually, and the period of hysteresis before generation comes back on can be several hours.

During periods of semi-dispatch, AWEFS needs to have an accurate forecast of generation based on measured wind speed, which it is not able to do currently with the information available. Since the fix in AWEFS and ASEFS1 on 7 April 2016 to correct problems in detecting downregulation[2], AWEFS will consistently use the higher of actual generation and the wind-speed-based forecast when the farm has a semi-dispatch cap. During semi-dispatch, if the measured wind speed is below the configured threshold but many turbines are in cut-out mode, the dispatch UIGF, used as the farm's availability for dispatch, may be near full power while actual output may be close to zero.

AEMO proposes a new SCADA Turbines Extreme Wind Cut-out signal as a mandatory item in the Wind ECM, to be provided by all new and existing *Semi-Scheduled Generators* in respect of their *semi-scheduled generating units* with one signal per cluster. This is unless farm-level is deemed adequate for a specific farm by agreement with AEMO. Once implemented, AWEFS will use this signal to limit the dispatch UIGF given the number of turbines in extreme wind cut-out mode. This implementation will also address the offset above zero in the dispatch forecast at times of extreme wind cut-out from pre-dispatch forecast blending as discussed above. The pre-dispatch forecast itself will not take into account this new signal. The cost to AEMO to implement this in AWEFS is modest. AEMO proposes that this will be mandatory for all new and existing generators except by agreement with AEMO, where exception would be made for existing generators when cost is shown to outweigh market and system security benefits.

Cut-out of turbines due to low wind speed is not considered an extreme wind condition and should not be included in this signal.

To be provided by all new and existing Semi-Scheduled Generators in respect of their semi-scheduled generating units – Wind only.

SCADA Turbines Extreme Wind Cut-out – Provided by Cluster – Wind only – Mandatory, except by agreement with AEMO

This is the number of turbines counted in the Turbines Available signal that are currently in cut-out mode due to extreme high wind speed or extreme wind direction change.

If agreed with AEMO, this signal may be provided at a farm level.

Other options considered:

1. *Include the effect of extreme wind cut-out in the definition of SCADA Local Limit.*

Under this option, farms would incorporate into the proposed SCADA Local Limit the impact of cut-out turbines on the capacity of the farm. AWEFS would cap the dispatch UIGF to this limit.

AEMO does not consider this option to be viable because:

- The turbines in cut-out mode represent a share of farm unavailable due to extreme weather rather than some local limit on farm output.

2. *Change the Turbines Available definition so turbines in cut-out mode would be counted as unavailable*

Under this option, the existing SCADA Turbines Available value would reduce by the number of turbines in cut-out mode.

AEMO does not consider this option to be viable because:

[2] As discussed at the Pre-Consultation Forum on 23 February 2016 – refer to slides on consultation webpage at http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms.

- Changing this definition would give incorrect tuning of AWEFS models during high wind-speed cut-out, and would reduce the ability of the models used for pre-dispatch and above timeframes to predict high wind-speed cut-out.

3. Implement a more complex model of high wind-speed cut-out in AWEFS

Under this option, a more complex model of high wind-speed cut-out, including the hysteresis, would be implemented in AWEFS.

AEMO does not consider this option to be viable because:

- High wind-speed cut-out applies to individual turbines, so without information on wind speed at each turbine, AWEFS could not accurately model it.
- Modelling the decision to go in and out of cut-out in dispatch would require AWEFS to analyse higher time resolution wind speed data than it currently inputs (AWEFS currently analyses wind speed each minute).
- Extreme wind-direction cut-out would also be difficult to model.

AEMO seeks feedback on these questions relating to the provision and use of a SCADA Turbines Extreme Wind Cut-out signal:

1. **Do you agree with the definition and proposed use of this signal?**
2. **Is your wind farm able to provide this signal?**
3. **What upfront and ongoing costs do you estimate your farm(s) will face to provide this signal?**
4. **Do you consider other options more suitable for managing extreme wind cut-out?**

4.2.3 AEMO's Conclusion

AEMO concludes that there is value in implementing a new SCADA Turbines Extreme Wind Cut-out signal as defined in Section 4.2.2 in Wind ECM Guidelines.

4.3 Existing ECM Item: Changes to Definition of SCADA Wind Speed

4.3.1 Issue Summary and Submissions

In the *Issues Paper*, AEMO proposed changes to the definition in the Wind ECM Guidelines of the farm-level SCADA Wind Speed signal, to clarify that:

- Instantaneous measurements are required, where instantaneous means values updated at least every 10 seconds. If averages only are available, maximum 15-second average update.
- Wind speed may be an average of several representative locations in the wind farm or cluster.

Overall, the submissions agreed that the proposed changes would improve the accuracy of measurements AEMO receives and would improve dispatch outcomes. Several submissions (Musselroe, Taralga, Infigen (some farms)) noted that there would be no change for their wind farms.

AGL's submission noted that for existing wind farms AEMO should take a flexible approach, allowing wind farms to assess their options including a "do-nothing" option.

Two submissions (AGL, Infigen (one farm)) identified costs for some existing wind farms to comply with the proposed change, with one (Infigen) noting "significant work and costs" and that measurements of that granularity are not currently provided. One (CWPR (Boco Rock)) noted it was unable to quantify the costs, while another (Pacific Hydro) noted there would likely be a small capital outlay. Several farms (Musselroe, Taralga, Infigen (some farms)) noted they were already compliant so would have no costs.

The *Issues Paper* asked a specific question about the preference for wind speed measurements from turbine nacelle anemometers over meteorological mast measurements. The submissions are generally in agreement

that while a meteorological-mast sensor is more accurate than a nacelle anemometer, an average of nacelle readings is likely to be more representative for the farm.

Further comments are that:

- Averaging wind speeds across a farm can introduce errors when the wind speed is not uniform, and suggests a Possible Power signal to be more accurate. (Infigen, AGL minutes)
- The impact of wind direction and wake effects may outweigh gains from additional nacelle measurements. (AGL)
- A combination of wind speed and wind direction is suggested to improve accuracy. (CWPR (Taralga))
- The most representative wind-speed measurement is site-dependent, and may include meteorological-mast measurements. (AGL)
- Standards are needed around sampling rate, time averaging and multi-location averaging. (CWPR (Taralga))
- AEMO's preference for nacelle measurements is different to the original preference for meteorological masts, and this needs to be communicated to all wind farms. (Pacific Hydro)
- Participants should comprehensively assess the best way to measure wind-speed, and should re-assess some months into commissioning. (AGL)
- AEMO should be involved in studies during the design and development phase to assess the best configuration of wind speed measurement to generation profile. (AGL)

4.3.2 AEMO's Assessment

AEMO notes support from the submissions on the value of improving the SCADA Wind Speed measurement.

Given the range of costs identified in the submissions for some existing wind farms (between "none", "low" and "significant", with some uncertain), AEMO proposes to change the definition of "instantaneous" in the "Wind Farm SCADA to AEMO" section of the Wind ECM Guidelines, to allow AEMO to approve an exemption from this requirement on a case-by-case basis. AEMO acknowledges that for some existing wind farms, the costs to comply with this specific definition may exceed the overall benefits.

AEMO notes that in the existing ECM Guidelines, the farm-level SCADA Wind Speed is already defined as "instantaneous" but the cluster-level SCADA Wind Speed allows 10-minute averages. As noted in Appendix A of the *Issues Paper*, AEMO proposes a change to cluster-level SCADA Wind Speed to "instantaneous" only, to align with the farm-level SCADA.

Revised Implementation of Wind Farm SCADA to AEMO and SCADA Wind Speed

Wind Farm SCADA to AEMO

Unless otherwise stated, instantaneous measurements are required, unless otherwise approved by AEMO.

Instantaneous means values updated every 4-10 seconds. If averages only are available, a maximum 15-second update to the average is required.

SCADA Wind Speed – Farm level

Measurements from turbine nacelle anemometers are much preferred over measurements from meteorological mast(s).

SCADA Wind Speed – Farm level is a single wind speed measurement, which must be representative of wind conditions across the site for calculation of dispatch UIGF. For large wind farms, an average of several turbine nacelle wind speed measurements may be used to achieve this. Ideally this average is of all turbine nacelles, or of several geographically-distributed meteorological masts.

The measurement is considered representative if, on the advice of the AWEFS vendor, the wind speed measurement is sufficiently stable and there is adequate correlation between the wind speed measurement and the farm's active power output when not downregulated.

AEMO agrees with the submissions that farm-level average wind speeds and the impact of wind direction may reduce accuracy, but considers the current proposal the best option until more detailed work is complete to investigate use of a Possible Power or other signal for more accurate power estimation.

While noting the strong agreement on the value of using an average of nacelles, AEMO agrees that there may be some circumstances where a meteorological-mast measurement is more representative than a set of nacelles, and notes that the definition does not preclude use of meteorological-mast measurements. AEMO will review the connection and commissioning processes for new wind farms to ensure that the preference for an average of nacelles instead of meteorological masts is communicated, and that a suitable plan for assessing and improving wind speed measurements is in place.

AEMO notes that the sampling rate and time averaging are specified in the "Wind Farm SCADA to AEMO" text above. Further detail has been added to the SCADA Wind Speed definition, to address the ideal configuration for averaging, and the meaning of "representative".

AEMO will work with all wind farms to assess the quality and representativeness of their SCADA Wind Speed signal, noting that it directly affects the accuracy of each wind farm's dispatch level during semi-dispatch intervals, and indirectly, outside of semi-dispatch intervals through its impact on the power curve and other model tuning. AEMO will be pleased to work with wind farms to improve this signal accuracy.

4.3.3 AEMO's Conclusion

AEMO concludes that the proposed definition of farm-level SCADA Wind Speed in the Wind ECM should be amended per Section 4.3.2.

AEMO concludes that the proposed definition of "instantaneous" in the "Wind Farm SCADA to AEMO" section of the Wind ECM should be amended as per Section 4.3.2.

4.4 New ECM Item: Optional Possible Power SCADA Signal

4.4.1 Issue Summary and Submissions

In the *Issues Paper*, AEMO proposed adding to ECM Guidelines an **optional** SCADA item "Possible Power" that provides an estimate of the active power that each wind farm can deliver to the network, based only on wind conditions at the site and available wind turbines. AEMO proposed to begin a program to investigate its use in calculating the AWEFS dispatch forecast.

All submissions expressed agreement, noting some clarifications, with the definition of SCADA Possible Power, and several submissions (Musselroe, Infigen, Vestas) supported its use in improving dispatch forecast accuracy. Two submissions (Pacific Hydro, Infigen) noted that it must be clear that it is calculated from available, not currently generating turbines.

Musselroe's submission, on clarification by phone, raised the question of what the SCADA Possible Power should be when high wind-speed cut-out is occurring, as they believed the signal from Musselroe's control system did not reduce during some levels of high wind-speed cut-out, and that costs would be incurred to change the signal to do this.

Several farms (CWPR (Boco Rock), CWPR (Taralga), Infigen (2 farms), AGL, Musselroe) already calculate and/or provide some measure of Possible Power. One farm does not have such a signal (Infigen (Woodlawn)), and for one the signal is not currently active (Pacific Hydro).

On the consultation question of how they estimated Possible Power, several submissions described the estimate as calculated per turbine from instantaneous wind speed and turbine power curve (CWPR (Boco Rock), CWPR (Taralga), Pacific Hydro, Infigen, AGL). There was some variation in what was done with turbines not currently generating or out of service. Some wind farms (Pacific Hydro, Infigen (Woodlawn), AGL (some farms)) use a 10-minute average wind speed, not instantaneous.

On the consultation question of implementation cost, several wind farms estimated the cost would be none or minimal (CWPR (Boco Rock), CWRP (Taralga), Pacific Hydro, Infigen (2 farms)). Moderate upfront cost was estimated for one older wind farm (Infigen (Woodlawn)). Clarification of costs with AGL revealed that substantial costs could be incurred in meeting this definition for their older farms, including potentially needing to update the turbine software.

On the consultation question of quality, validation and update frequency, two submissions (CWPR (Taralga), Pacific Hydro) noted that ideally Possible Power would be instantaneous. Submissions disagreed on the upper limit for Possible Power – one (AGL) suggested Maximum Capacity, two others (Pacific Hydro, CWPR (Boco Rock)) registered capacity, with one suggesting capping the Possible Power at registered capacity (Pacific Hydro).

One submission (CWPR (Taralga)) noted that Possible Power should also account for 'wind sector management' and that losses within the reticulation system are likely not accounted for. On clarification with Taralga Wind Farm, "wind sector management" refers to turbines that pause due to wake effects for specific wind directions.

Additional comments were made by Infigen and AGL on the use of the Possible Power signal within AWEFS. Their suggestions were that dispatch UIGF be determined as the lowest of Registered Capacity (or Maximum Capacity), SCADA Local Limit and the SCADA Possible Power. If SCADA Possible Power was unavailable or bad quality, substitute with the AWEFS-calculated wind-speed-based Potential Power. If Potential Power was unavailable, substitute the actual generation.

One submission (Infigen) suggested a Possible Power based on turbines that are currently generating may also be useful for very short-term forecasting.

Several submissions (Pacific Hydro, Infigen, AGL) commented on the value of a "Forecasted Possible Power" signal to look ahead 8-10 minutes, potentially including remote-sensing technology and consideration of turbine ramp rate limitations due to paused or feathered turbines. One submission (Infigen) said it could give a more realistic production trajectory over the dispatch interval. CWPR's (Taralga)'s submission commented that the Possible Power cannot provide an accurate measure of what the wind farm is capable of producing in the next dispatch interval.

4.4.2 AEMO's Assessment

In considering the detailed submissions provided on this topic, AEMO considers that while there is strong support to provide such a signal, the details of the factors this signal should consider, its validation and use are not sufficiently well-defined for it to be added to the ECM Guidelines at the current time. Many farms are not able to meet the existing specification and AEMO does not see the value in defining a signal, even if optional, in the ECM Guidelines that will be revised later to tighten its specification and accuracy requirements once its use is precisely known.

Further, many limitations of such a signal were advised in the submissions and AEMO wishes to understand the impact of these limitations. AEMO intends to commence further discussion to specifically discuss what information (using currently available and emerging technologies) wind and solar farms would be able to supply to AEMO to give a step-change in dispatch forecast accuracy.

AEMO advises that it will still be able to carry out its investigation into the accuracy of SCADA Possible Power signals already communicated to AEMO via direct access to the SCADA system instead of through AWEFS, and encourages participants to supply these signals to AEMO if this can be done for minimal cost.

AEMO acknowledges the potential value of this signal as defined in the *Issues Paper,* to give a more accurate power estimate than an average of wind speeds for AWEFS to incorporate in its forecasting processes. However, AEMO does not consider that this justifies defining it as a signal in the ECM Guidelines

at this stage, given the support in the submissions for SCADA Possible Power to be used to directly determine the UIGF. AEMO also notes that AWEFS currently uses a dynamically tuned power curve in calculating the UIGF, which may give increased accuracy over static power curves used by wind farm control systems in Possible Power calculations.

AEMO notes the strong support in submissions for direct use of the SCADA Possible Power to determine dispatch UIGF. To be suitable for this purpose, AEMO considers the following SCADA Possible Power definition issues (as noted in the submissions) need to be addressed first:

- Wind direction may also have an impact on accuracy (from Section 4.3 on SCADA Wind Speed) (AGL, CWPR (Taralga)).
- Wind sector management needs to be accounted for (CWPR (Taralga)).
- Losses in the reticulation system need to be accounted for (CWPR (Taralga)).
- What is the impact of high wind-speed cut-out and should it be included (Musselroe).
- Inclusion of the ramp-rate limitations due to paused or feathered turbines (AGL, Pacific Hydro).
- Whether a forecast Possible Power would be more accurate than current Possible Power (Pacific Hydro, Infigen, AGL).
- Whether there is value in a very short-term calculation using turbines currently generating only (Infigen).

4.4.3 AEMO's Conclusion

AEMO concludes that SCADA Possible Power will not be included in the ECM Guidelines until its use and specific requirements are further defined. Participants are encouraged to discuss with AEMO the relevant signal(s) they already provide or can provide to AEMO at minimal cost, for assessment of the signal's comparative performance against existing AWEFS/ASEFS1 forecasts.

AEMO thanks participants for their suggestions on the limitations of this Possible Power signal and how to make use of it in AWEFS and ASEFS1 in calculating the dispatch UIGF. AEMO will use these as a basis for future discussions on improvements to the AWEFS dispatch forecast.

4.5 Maximum Capacity Static Parameter

4.5.1 Issue Summary and Submissions

The *Issues Paper* proposed an additional static parameter for Maximum Capacity so that AWEFS is able to cap its forecasts (dispatch and otherwise) to Maximum Capacity (not *nameplate rating*, as it does currently) in accordance with the *Rules*.

One comment from AGL was received on this section, noting that the AWEFS forecast should be limited only by Maximum Capacity not by *nameplate rating* as it is currently.

4.5.2 AEMO's Assessment

The one submission received from AGL was in support of this proposal. AEMO agrees that AWEFS should limit the AWEFS forecasts only by Maximum Capacity, not *nameplate rating* as done currently, as this better implements clause 3.7B(c)(1) of the *Rules*.

4.5.3 AEMO's Conclusion

The Maximum Capacity static parameter will be added to the ECM Guidelines. AEMO will investigate limiting the AWEFS forecasts only by Maximum Capacity, not by *nameplate rating* as done currently.

4.6 New ECM Item: Slope Tracking Direction – Solar ECM

4.6.1 Issue Summary and Submissions

In the *Issues Paper*, AEMO proposes to add a new item, "Slope Tracking Direction", to the Solar ECM Static Data as a mandatory provision for solar farms using active solar tracking. It is required as the existing Solar ECM Static Data does not capture adequate detail to allow modelling of tracking array equipped solar farms.

AGL's submission commented that their farms do not currently use tracking.

4.6.2 AEMO's Assessment

Given no submissions against this proposal, AEMO's assessment is to implement it as proposed in the *Issues Paper*.

4.6.3 AEMO's Conclusion

To add the new item "Slope Tracking Direction" to the Solar ECM Static Data as proposed in the *Issues Paper*.

4.7 Provision of Signals for FCAS

4.7.1 Issue Summary and Submissions

Submissions by Taralga, Pacific Hydro and AGL commented on potential use of intermittent generation to provide FCAS. At the meeting, AGL commented that this could "best be achieved if the wind farm forecasting system could recognise the farm operating characteristics, i.e. what the physical plant can and cannot do, so that the FCAS co-optimisation can be done correctly and more accurately", and suggested the Possible Power signal and a rate of change signal could achieve this.

Pacific Hydro commented that AEMO should provide a signal to the wind farm to tell the wind farm that it has been dispatched for FCAS.

4.7.2 AEMO's Assessment

AEMO notes that a signal from AEMO to the wind farm does not fall under the ECM Guidelines, but will pass this suggestion to business units in AEMO looking at future FCAS options.

Apart from AGL's reference to Possible Power at the meeting, the three submissions did not provide suggestions on what ECM Guideline changes may be needed to support FCAS for intermittent generation. In response, AEMO does not intend to include signals or static data items to support FCAS in these ECM Guidelines changes, but thanks participants for these suggestions, and will use these as a basis for further discussions on improvements to AWEFS and ASEFS1.

4.7.3 AEMO's Conclusion

AEMO notes the interest of participants in the participation in FCAS of intermittent generation and will include this topic in further discussions on improvements to AWEFS and ASEFS1.

5 Other Matters

Appendix A of the *Issues Paper* lists a number of minor changes to the ECM Guidelines. One comment was received on these minor matters. Musselroe commented that the units from wind direction had been amended from Decimal Degrees Latitude Longitude to degrees true, which is what their wind farm already provides. No other comments were received.

AEMO will adopt the minor changes as proposed in the *Issues Paper*.

6 Draft Determination

Having considered the matters raised in submissions and at the meeting with AGL on 21 June 2016, AEMO's draft determination is to amend the Wind and Solar Energy Conversion Model Guidelines in the form of **Attachment 1**, in accordance with clause 2.2.7(d) of the NER.

Appendix A - Glossary

TERM OR ACRONYM	MEANING
AWEFS	Australian Wind Energy Forecasting System
ASEFS1	Australian Solar Energy Forecasting System Phase 1
FCAS	Frequency Control Ancillary Services
SDC	Semi-dispatch Cap
SCADA	Supervisory Control and Data Acquisition
UIGF	Unconstrained Intermittent Generation Forecast

In this document, *italicised* phrases refer to defined terms in chapter 10 of the National Electricity Rules. A list of commonly used terms and acronyms from the gas and electricity industry can be found on AEMO's website at http://www.aemo.com.au/About-AEMO/Glossary-of-terms.

Appendix B - Summary of Submissions and AEMO Responses

NO.	CONSULTED PERSON	ISSUE	AEMO RESPONSE
1.	AGL	"AGL considers that the proposed improvements to the ECM Guidelines should provide more accurate dispatch expectations on individual intermittent generators, thereby improving overall participant factors associated with the Frequency Control Ancillary Service (FCAS) Regulation markets. Further, the proposed changes have the potential to improve market and economic efficiencies which could lead to significant cost savings as dispatch outcomes will likely be more reflective of the characteristics of intermittent generation capacity."	Noted in 4.1.1
2.	AGL	"AGL agrees that a SCADA Local Limit will improve dispatch outcomes." AGL provided a specific example of a transformer maintenance outage at Macarthur wind farm where: " For the duration of this event, Macarthur would have been identified as being 50MW off-target and a major causer of regulation raise FCAS. If the Local SCADA limit was implemented, the ~205MW limit would be able to inform AWEFS/NEMDE of a more accurate dispatch outcome. "	Noted in 4.1.1.1
3.	AGL meeting	AEMO sought clarification on the historical examples provided by AGL in its submission on the actual operation of AGL control systems. In the case of Macarthur windfarm, the example showed that the set point was set at 200MW for the relevant intervals. However, AGL indicated that it was unclear if the target was set by AEMO as the Semi-dispatch cap. AGL sought clarification that if AEMO had issued the dispatch cap, would the cap be set at 200 MW. AEMO advised that AWEFS was not issuing the limit as the 200MW set point was provided by AGL. It was discussed that either way, the conclusion stated in AGL's submission would remain unchanged.	No response required.
4.	AGL	"As an example, Powercor can/will constrain Oaklands Hill via their control system when a total fire ban is declared in the region. This will limit the output of the wind farm to 42.7MW and is directly reflected at the wind farm set point within the AGL control systems and the local site control systems.	Noted in 4.1.1.1 and response in 4.1.2.

		This limitation must be reflected in AWEFS at the SCADA local limit, otherwise incorrect dispatch targets will continue to be set. “	
5.	AGL meeting	AEMO noted that AGL’s submission to the issue paper included an example of the Available capacity, which was available to AEMO through AGL’s bidding process into the dispatch system. AEMO explained that the “Availability” bid data capture by AEMO’s EMMS was not used by the AWEFS in determining the UIGF. AGL sought AEMO’s view on whether AEMO may plan to change the process whereby AWEFS will use the Available Capacity in setting the semi-dispatch targets. AEMO advised that it will need to consider this further and will provide a response in the upcoming draft report.	Addressed in 4.1.1.5.
6.	CWPR (Boco Rock)	“CWPR does not believe its transformer or connection assets would be constrained to a point where the local limit signal will impact the dispatch level. Should internal feeder/collector groups be offline, this would be reflected within the local limit, however the ‘turbines available’ SCADA signal should already be contributing to this. CWPR believe the SCADA ‘Local Limit’ would be beneficial so long as it incorporated any distribution network constraints, CWPR acknowledge that this would require an amendment to the rules.”	Noted in 4.1.1.1 and response in 4.1.2.
7.	CWPR (Boco Rock)	“The impact of the exclusion of the distribution network constraint from the SCADA ‘Local Limit’ has been demonstrated to be significant for BRWF when considering historical events.” providing an example of a network outage, where “AEMO’s dispatch systems were still providing targets whilst BRWF was de-energised.” “As a result, this contributed to a high CPF (Causer Pays Factor) for the period, ~0.985.”	Noted in 4.1.1.1. On this particular example, AEMO notes that the STPASA limit (as described in the submission) was not set to zero for the whole period, giving a non-zero dispatch forecast, and that for a short time during this period the Turbines Available SCADA was out, giving a large dispatch forecast.
8.	CWPR (Boco Rock)	“Although an amendment to the rule is required to include distribution limits within the SCADA ‘Local Limit’ (Section 3.1.3), it would be prudent to incorporate it. Such a limit would have been advantageous to BRWF during the network outage as represented in Appendix A.”	Noted in 4.1.1.1 and response in 4.1.2.
9.	Musselroe	“During early May 2016 a series of events highlighted scheduling issues at Musselroe Wind Farm which required overriding of the MRWF Active MW set-point SCADA signal and AEMO’s hysteresis limits. It is understood the proposed ECM change may not fully resolve scheduling issues related to market limits and high wind speed / extreme wind direction operations.” Phone clarification: Musselroe explained that extreme wind direction cut-out occurred due to a large change in wind direction and could persist for around 20 minutes.	Addressed in 4.2 on extreme wind cut-out, and market limits addressed in 4.1.1.1 on SCADA Local Limit.
10.	Musselroe	MRWF is supportive of the inclusion of the SCADA local limit.	Noted in 4.1.1.1.
11.	Musselroe	… “seeks further clarification regarding Market related limits excluded from the proposed SCADA Local Limit signal – it is understood the UIGF would not identify the existing method for managing Market related limitations and bidding adjustments is not a practical solution as significant manual intervention is required.”	Addressed in 4.1.1.1.

12.	Musselroe	…"seeks further clarification regarding reactive plant limits managed by AEMO – MRWF request clarification of excluded non-network connected, local reactive plant, the availability of which is required for generation." Phone clarification: Musselroe explained that it has complex reactive plant behind the connection point, variously managed by MRWF, the NSP and AEMO, and that the text in the ECM needs to be more clear about whether such limits should be included or excluded from the Local Limit SCADA. Additionally, at the time of implementation of the Local Limit, MRWF will need to have a technical conversation with AEMO to determine exactly which limits are managed by AEMO through NEMDE so the correct list is included in the Local Limit SCADA signal.	Addressed in 4.1.1.1.
13.	Musselroe	"MRWF operates complex reactive plant with frequent limitations managed locally and by the NSP and AEMO. The proposed alterations to the SCADA system, its impact on NSP and the ongoing compliance costs are not fully understood at this stage."	AEMO hopes the responses in this Draft Report are of assistance and encourages Musselroe to make a further submission if more clarification is required or new information is available.
14.	Pacific Hydro	"As a participant in the NEM Pacific Hydro believe that improvements to the ECM guidelines allows for both an improved dispatch for semi-scheduled generators, and positive outcomes for the NEM."	AEMO thanks the participant for their overall support, but has not applied this directly to any section of the proposals.
15.	Pacific Hydro	"Clements Gap is transmission connected and it is not envisaged that the transformer or connection assets would be constrained to the point that the local limit signal will impact dispatch level. If an internal feeder is offline then this would be reflected in the local limit; however this should already be accounted for with the turbines available / generating points." "Limits that affect Clements Gap are primarily network constraints that are part of the AEMO constraint system."	Noted in 4.1.1.1 and addressed in 4.1.2.
16.	Pacific Hydro	On distribution limits: "For Clements Gap which is not directly subject to distribution constraints, there is no material effect."	Addressed in 4.1.2.
17.	Pacific Hydro	"Distribution limits should be included as an additional signal to AEMO. Implementation in this manner allows AEMO to see both distribution and connection asset constraints. Whilst updates to the ECM are being conducted, it is sensible to add the impact of distribution constraints which are not currently taken into account by AEMO for dispatch. Although a rule amendment is required to incorporate distribution limits (Section 3.1.3), acquiring the signal now is sensible in terms of future outcomes. As such, the term "local limit" would prove to be ambiguous as from its name it is not clear whether it takes into account distribution level constraints." On clarification by phone, the name "Generating System Limit" was suggested, and that "Local Limit" would be less ambiguous if "Distribution Network Limit" was also present.	Rule change noted in 4.1.1.1, other parts addressed in 4.1.1.6 and 4.1.2.
18.	CWPR (Taralga)	"With only a single 132/33kV transformer and dedicated Essential Energy 132kV transmission line connection to TransGrid at Marulan substation, TWF is unlikely to be in a position that it is constrained by 'Local Limits'	Noted in 4.1.1.1 and addressed in 4.1.2.

		which are not reflected by the 'No Turbines Available", 'No Turbines in Operation' and 'Possible Active Power' data points TWF currently sends to AEMO over SCADA."	
19.	CWPR (Taralga)	"TWF has however, on multiple occasions, been constrained by TransGrid while they perform works at the Marulan substation and request a zero set point at TWF. This period of zero production is manually entered into the EMMS Intermittent Generation Portal as all units unavailable, but this is far from ideal and would be much better represented by a distribution constraint in the ECM".	Noted in 4.1.1.1 and addressed in 4.1.2. Use of the EMMS Portal is addressed in 4.1.1.5.
20.	CWPR (Taralga)	"TWF very rarely has active power production limits imposed by AEMO. The more frequent limits that affect TWF have been network constraints from Essential Energy and TransGrid relating to scheduled maintenance on the transmission line and TransGrid substation. These would still not be reflected by the 'Local Limits' proposal, but need to be accounted for by AEMO in any updates to the ECM".	Noted in 4.1.1.1 and addressed in 4.1.2.
21.	CWPR (Taralga)	"The exclusion of DNSP/TNSP constraints from the ECM (be it included in the 'Local Limits', or as a separate parameter) in the ECM will vastly reduce the benefit of updating the model. TWF currently have to use the EMMS intermittent generation portal to show the effects of these constraints, which is not a true reflection of the issue, and not how the system was intended to be used. This would ideally be entered in an automated (SCADA?) system by the DNSP/TNSP requesting the constraint, updating the ECM automatically."	Noted in 4.1.1.1 and addressed in 4.1.2. Use of the EMMS Portal is addressed in 4.1.1.5.
22.	CWPR (Taralga)	"Distribution limits should be included as an additional signal to AEMO. Implementation in this manner allows AEMO to see transmission, distribution and connection asset constraints. Whilst updates to the ECM are being conducted, it is sensible to add the impact of distribution constraints which are not currently taken into account by AEMO for dispatch."	Noted in 4.1.1.5 and addressed in 4.1.2.
23.	CWPR (Taralga)	"Although a rule amendment is required to incorporate distribution limits, acquiring the signal now is sensible in terms of future outcomes. As such, the term "Local Limit" would prove to be ambiguous as from its name it is not clear whether it takes into account distribution level constraints."	Rule amendment noted in 4.1.1.1 and addressed in 4.1.2. Ambiguity of name addressed in 4.1.1.5.
24.	Infigen	"As Infigen Energy's business is the generation of utility scale renewable electricity, we are eager to engage in the process of maintaining a reliable, transparent and flexible electricity market. As a wholesale generator, our core operations in the NEM are focused on the appropriate dispatch of our generation and ensuring market stability and system security is maintained. Infigen supports the ECM proposed changes by AEMO as it identifies significant opportunities for intermittent generation dispatch outcomes and forecasting improvement in the NEM. It should also provide a more reflective performance measurement of semi-scheduled generators for FCAS regulation causer pays factor which is of benefit to the entire market."	Overall benefits of ECM changes noted in 4.1.1.

25.	Infigen	"Infigen Energy believes that the appropriate application of a SCADA Local Limit could improve the dispatch outcomes of the park during certain maintenance procedures and contingency events."	Noted in 4.1.1.1.
26.	Infigen	"Infigen does not believe that plant availability in this data point is necessary or would add any benefit as it is already provided to AEMO through the number of available turbines data points."	Addressed in 4.1.1.1 and 4.1.2.
27.	Infigen	"There are a variety of local limits that affect Infigen's semi-scheduled generating units. Our semi-scheduled wind farms are limited locally by connection assets being unavailable due to maintenance or outages, local network protection runback schemes and manually imposed farm-wide constraints. These constraints can come in the form of static constraints, which set an upper limit for the wind farms based on the transformer or reactive power equipment availability or a dynamic constraint which is managed by the SCADA system. These constraints can be implemented by planned or unplanned outages of the connection assets in the order of less than 10 periods of limitations a year that can last for less than an hour to more than a week. Following a semi-dispatch cap period NEMDE occasionally removes the dispatch cap when it underestimates possible production. This can result in a rapid ramp up from wind farms affected. Infigen may impose a manual cap to better control its wind farms ramp rates in conformance to NEMDE's expectations."	Types of limits noted in 4.1.1.3. Manual cap addressed in 4.1.1.1.
28.	Infigen	"Infigen Energy believes the handling and validation of the SCADA Local Limit is very important as it has the possibility of erroneously reducing the parks maximum availability if not appropriately handled. Infigen also believes more detail regarding the inclusion of the Local Limit in the UIGF calculation process is required before it can make a full assessment of the validation. In particular with regards to the inclusion of manual SCADA caps, that may be short term and how that could reduce future semi-dispatch cap values in the instance of short term local limits." Clarification by phone – Infigen sometimes imposes a manual cap to limit generation for reasons not related to availability, including controlling ramp-rates after semi-dispatch cap periods as described in the submission. Infigen considers such limits should be excluded from the Local Limit SCADA, to prevent future semi-dispatch cap values being reduced by these limits, as they do not reflect availability for the next dispatch interval.	Manual cap addressed in 4.1.1.1. Further detail on implementation and importance of validation addressed in 4.1.2.
29.	Infigen	"The expected impact on Infigen Energy's existing semi-scheduled wind farms is not relevant, but may become an issue for future assets. Infigen is of the opinion where distribution network constraints exist and affect a semi-scheduled generator then it should be reflected in the SCADA Local Limit setpoint for dispatch targets to remain accurate. It would also be useful as a market participant to understand what kind of distribution network constraints are active in the region."	Noted in 4.1.1.1 and addressed in 4.1.1.1 and 4.1.2. On the point of understanding the active distribution network constraints, AEMO does not make the SCADA signals available to other participants and asks Infigen how it sees this information would be conveyed.

30.	Vestas	"Regarding 'Local Limit' – I suggest this value *should* also include limits on the transmission and distribution networks. The Local Limit value should give information on the limits affecting the total wind farm output. This should include all limits applied locally at the wind farm, this could be form the distribution network due to equipment outage, or from a transmission network due to a line outage; these are protective functions that limit the wind farms generation. I believe AEMO should be aware of all restrictions at the wind farm that will be affecting generation, and it should include these via the Local Limit value."	Noted in 4.1.1.1 and addressed in 4.1.2.
31.	AGL	"AGL agrees with the SCADA local limit validation criteria." "Whilst AGL appreciates the need for the validation rules, AGL would like to ensure that the maximum capacity is used throughout the various processes, rather than nameplate or registered capacity, to ensure consistency with other scheduled generation inputs to NEMDE (AGL understand 'Nameplate capacity' is not used anywhere in NEMDE for scheduled generation)."	Agreement noted in 4.1.1.2. AEMO acknowledges that registered capacity / nameplate rating is used throughout AWEFS and ASEFS1 and not Maximum Capacity. In conducting a complete review of AWEFS in the 16/17 financial year, AEMO will look at how to standardise the use of these two values.
32.	AGL	"In terms of the effectiveness of the limit, AGL would like to further understand what would constitute a 'good' SCADA local limit?"	Addressed in 4.1.1.2.
33.	AGL meeting	AGL sought clarification from AEMO on the definition of a "Good Quality" SCADA Local Limit, and on how the SCADA Local Limit would influence AWEFS's power curve tuning. AEMO indicated that it will need to look into this further and will get back to AGL with more information on what would constitute "Good Quality" data and will respond to this query in the draft consultation report. AGL sought clarification on the sort of data that AWEFS would disregard in determining the targets. AEMO advised that in case of the wind speed, AWEFS will not use any data that are considered not reliable for AWEFS to produce a UIGF. AGL suggested that as SCADA at a site is best placed to provide the right information for estimating a forecast of 5 minutes, it seems to make sense that wind farms could potentially provide an estimate of the most likely output for each 5 minutes.	Addressed in 4.1.1.2 and 4.1.1.6.
34.	AGL	"In its consultation paper, AEMO appears to suggest that SCADA local limits need to be automated. However, AGL is concerned that the many possible permutations of local limits may make it unrealistic to cover every scenario, and the cost may also be prohibitive. AGL would appreciate the opportunity to discuss this further with AEMO."	Addressed in 4.1.1.3.

35.	AGL meeting	AEMO sought clarification on AGL's interpretation of the consultation paper regarding the automation of SCADA Local Limit, and the factors that could contribute to the prohibitive cost of implementation. AGL explained using Oaklands as an example that has Voltage run back schemes and Current run back schemes, which automatically set the set-point values for the wind farm and total fire ban limits. The setting of limits is a dynamic process, which could produce a series of set-points that could take a number of turbines out of services (e.g 10 turbines) (which could include DVAR or STATCON being unavailable). AGL indicated that the process of dynamic setting can become complex as there may be many possible scenarios. AEMO was keen to understand if automation of SCADA Local Limit could still be a viable solution given its potential complexity. AGL noted that in most instances, automation of SCADA Local Limit is still a viable solution as the setting of dynamic set-points that limit the output cannot operate in manual mode. However, in situations where a number of turbines are out of service and the potential that the turbines would be out of services for a long period of time (say a day), then a manual approach may still be applied. Hence, it is possible that both automatic and manual operations may be required. AGL indicated that the set point for wind farms is normally set to the plant's maximum capacity. When there is a restriction imposed on the wind farm output by AEMO, the set point would be automatically set to reflect the required MW value and sent to AEMO through the SCADA. However, AEMO pointed out that the set point AGL indicated above is different from the MW set point for local limit and is not the SCADA local limit AEMO is referring to in the consultation paper. AGL indicated that these local limits should be fed into AWEFS as part of the process in determining the semi-dispatch cap. AEMO advised that the local limit allows wind farms to indicate that the dispatch forecast should be capped at the local limit. Hence, the MW set point signal proposed in the consultation paper is to allow wind farms to inform AWEFS that there is a limitation transmitted via SCADA signal.	Addressed in 4.1.1.3.

		AGL sought clarifications on the possible exclusion of distribution network limitations. AGL indicated that potential limits on generation output could be due to a number of possible factors: distribution or transmission network constraints, or internal plant and equipment operation and maintenance. AGL believes all these possible limits should be taken into account; and these limits should be fed through to AWEFS as the local limit and MW set point. AEMO indicated that it will look into the definition of local limits to provide guidance on what contributes to local limit as intended in the consultation paper. AGL sought clarification on what may be the extent of automation that AEMO would consider necessary for the setting of local limits bearing in mind the potential complexities it may bring. AEMO indicated that it is likely to recommend that all SCADA inputs be automated but recognises there are some situations where this needs to be manual.	
36.	AGL	"The current and voltage limits at OHWF are dynamic. To manually set this as a local limit is not practical. Some form of automation of this local limit is required."	AEMO agrees
37.	CWPR (Boco Rock)	"Based on the information available, it is CWPR's belief that the local limit should be applied if it is less than the Dispatch UIGF as opposed to the nameplate rating of the wind farm." Clarified by phone call that this meant the Local Limit should only affect the dispatch UIGF when the Local Limit is below the dispatch UIGF.	Addressed in 4.1.1.2.
38.	Pacific Hydro	"The check for the Local Limit point exceeding the generating systems nameplate rating feels superfluous, as the Local Limit is intended to override the Dispatch UIGF.", also clarified by phone.	Addressed in 4.1.1.2.
39.	CWPR (Taralga)	"Based on the information available, it is CWPR's belief that the 'Local Limit' should be applied if it is less than the dispatch UIGF as opposed to the nameplate rating of the wind farm."	Addressed in 4.1.1.2.
40.	Infigen	"AEMO then proposes that if the data quality is good (all checks pass), the Local Limit will be used to cap the Dispatch UIGF value, which Infigen in is accordance with."	Noted in 4.1.1.2.
41.	AGL	AGL provided a table showing the types of limits and approximate % of time on limit.	Noted in 4.1.1.3 and addressed in 4.1.2.
42.	AGL	AGL provided a screen shot of an outage at Oaklands Hill in 2015.	AEMO notes that it appears this is referring to the use of the Availability bid into the EMMS, which is overridden in NEMDE by the UIGF from AWEFS. Addressed in 4.1.1.5.

43.	CWPR (Boco Rock)	"Majority of limits imposed on BRWF have been the result of AEMO network constraints and less commonly the TNSP/DNSP (Transgrid/Essential Energy) as a result of yard work in the local area outside of BRWF. When instructed to 'idle' by the DNSP, CWPR operators insert the instruction via the SCADA system, implementing a set point cap manually. Should BRWF be required to de-energise, CWPR operators shut down each of the WTG's and proceed to open up the appropriate circuit breakers. This happened a number of times within 2015."	Noted in 4.1.1.3 and addressed in 4.1.2.
44.	AGL	"AGL notes that while it supports the proposed changes and improvements to ECM Guidelines, AEMO should carefully consider the implementation costs of the proposed changes on existing wind farms. Specifically, the implementation program, including its timing, should be subject to each participant's assessment of its cost and benefits, as well as its financial readiness to expend the additional costs."	Noted in 4.1.1.4 and addressed in 4.1.2 for SCADA Local Limit. Noted in 4.3.1 and addressed in 4.3.2 for SCADA Wind Speed. Noted in 4.4.1 and addressed in 4.4.2 for SCADA Possible Power.
45.	AGL	"Total Estimated costs for all data points These changes will require changes to site and AGL Dispatch Centre SCADA systems. The cost of implementation for AGL wind farm and solar sites is approximately upward of $300K, which includes the additional limit information and wind speed data points based on the existing available metmasts. The above costs do not include programming of each site control system. AGL estimates the cost for local programming for each site would be approximately upwards of $300k for AGL sites. The total costs of implementing the proposed changes in ECM is expected to be upwards of $600k for AGL sites.	Noted in 4.1.1.4 and addressed in 4.1.2 for SCADA Local Limit. Noted in 4.3.1 and addressed in 4.3.2 for SCADA Wind Speed. Noted in 4.4.1 and addressed in 4.4.2 for SCADA Possible Power.
46.	AGL meeting	AEMO sought clarification with AGL on how the different parts of the ECM changes contribute to the total cost estimate provided. AGL advised that costs were broken down to initial and on-going costs. The initial cost consists of setting up the SCADA and the system that support the new data requirements. AGL advised that the initial cost for setting up the SCADA should be around $35,000 to $45,000 for each site. This does not include other initial cost consisting of AGL internal system set up and potential costs from vendors of Wind or Solar sites. AGL estimated that it may cost approximately $300,000 to $400,000 to set up the nine AGL sites (which includes 7 wind farms and 2 solar farms) to send extra SCADA signals. In addition, it may cost at least an additional $300,000 to integrate the new signals with the AGL dispatch system.	Noted in 4.1.1.4 and addressed in 4.1.2.

		AGL also advised that a one off change with a vendor may be significant but could not obtain an estimate from the vendors at this stage. However, an indicative cost could be around $50,000 per system. AEMO indicated that it would like to understand the estimated costs for each site.	
47.	CWPR (Boco Rock)	On the Local Limit: "Costs are difficult to quantify at this stage, however CWPR is investigating."	Noted in 4.1.1.4 and addressed in 4.1.2.
48.	Pacific Hydro	"Costs would vary depending on the DNSP/TNSP interface. Retrofit to an existing wind farm would require a larger investment. For example however, at Clements Gap a SCADA local limit signal would not provide much benefit to the market operator. Despite this Pacific Hydro believes that the provision of a local limit signal as a whole is beneficial to market dispatch outcomes."	Noted in 4.1.1.1 and 4.1.1.4, and addressed in 4.1.2.
49.	CWPR (Taralga)	"Retrofitting the existing wind farm SCADA system would incur implementation costs for TWF, and likely the DNSP/TNSP, to add the SCADA points required. Despite this, TWF believes that the provision of a 'Local Limit' signal as a whole is beneficial to market dispatch outcomes.	Noted in 4.1.1.1 and 4.1.1.4, and addressed in 4.1.2.
50.	Infigen	"The upfront cost of implementing this Local Limit will vary across Infigen's wind farms however the ongoing costs are not expected to be high."	Noted in 4.1.1.4 and addressed in 4.1.2.
51.	AGL	"AGL agrees that alternatives no. 1/2/3 as outlined in the Consultation Paper are unacceptable, with alternatives 4 & 5 being too problematic and inconsistent with other SCADA inputs from other generators."	Noted in 4.1.1.5.
52.	AGL	"The example discussed above (Diagram 1) also demonstrates why participants must be able to bid semi-scheduled generator availability to a suitable level. AGL appreciates that this will require a NEMDE change to take the minimum of a UIGF or Bid Availability. However AGL considers it a necessary step to improve current outcomes. AGL considers that it could be accomplished by adding another NEMDE input on the left hand side of Figure 1 in the Consultation documentation (p 10)." "AGL would like to see the addition to NEMDE of the Available Capacity as bid for a wind farm used within the dispatch process (at present, it is not). Participants must have more control over their desired output instead of using price offers or fixed load bids."	Addressed in 4.1.1.5
53.	Infigen	"While Infigen Energy believes there may be other options for managing the local limit, from the alternatives presented the current option is believed to be the most efficient."	Addressed in 4.1.1.5. AEMO requests Infigen to make a further submission if the "other options" is not covered by the bidding of Available Capacity in the dispatch process as discussed in 4.1.1.5.
54.	Infigen	"Infigen Energy sees a potential management strategy available in using the Available Capacity bids already submitted by wind farms in the NEMDE dispatch process. For maintenance events this is a practical management strategy that is already undertaken when a static limit is in place. A review into the user interface of the online portal would further increase the efficiency of making availability bids."	Addressed in 4.1.1.5.

55.	AGL	"AGL would like to clarify and understand further details on how AWEFS vendor ANEMOS will use the SCADA local limit to tune the AWEFS power curves "	Addressed in 4.1.1.6.
56.	AGL	"AGL would like to see more data from semi-scheduled plant published in MMS, akin to AGC local limits being published by AEMO for FCAS providers."	Addressed in 4.1.1.6.
57.	AGL	"AGL would like to explore with AEMO how current time-dependent ramp-rates and plant limits could be applied for semi-scheduled generators to determine a more accurate 8-minute forecast to help improve the accuracy of the 5-minute pre-dispatch. " AGL provided an example showing an apparent gap between the dispatch and 5-minute pre-dispatch forecasts of much more than the plant's ramp-rate.	Addressed in 4.1.1.6. AEMO also notes that in the example shown, the first interval of the 5MPD AWEFS forecast had jumped from 148 MW to around 300 MW as the output went up to 270 MW in the interval before this 300 MW forecast was issued.
58.	AGL meeting	AEMO sought clarifications on page 6 of AGL's submission regarding a graph on pre-dispatch. AEMO pointed out that the graph appeared to show an offset in the timeline, and that the output from the wind farm appeared to rise faster than the registered ramp rate. AEMO explained that AWEFS provided a forecast of 300MW based on the actual generation of around 300 WM during those intervals. AEMO would like AGL to review and provide feedback on this query.	No response required.
59.	Musselroe	"Musselroe Wind Farm has been actively working with AEMO to manage the ongoing Scheduling issues post the 7th April 2016 change applied by AEMO."	AEMO agrees it has been working with Musselroe since April, and responds, as clarified with Musselroe, that the issues have been due mostly to high-wind cut-out and frequency issues in Tasmania, not the change made to AWEFS in April.
60.	Musselroe	… " seeks further clarification regarding overriding of AEMO hysteresis limits 7.7% (12 MW) – details on AEMO's active limit and its effect on the ongoing generation post high wind speed / extreme wind direction recover."	Addressed in 4.2.2 on extreme wind cut-out.
61.	AGL	"AGL agrees that improvements to wind speed calculations will improve the accuracy or timeliness of dispatch forecast. For existing wind farms, AEMO should adopt a flexible approach in implementing changes so that each participant is given the option to assess an alternative design, costs and benefits of sampling the wind speed data, including a "do nothing" decision."	Noted in 4.3.1 and addressed in 4.3.2.
62.	AGL	"AGL would agree that the wind speed calculations should provide the best opportunity to forecast the sites generation profile, be that at a meteorological mast level, grouped clusters or individual nacelles: blanket demands for nacelles will not necessarily be the most effective arrangement but will certainly add up-front costs to participants. "	Noted in 4.3.1 and addressed in 4.3.2.
63.	AGL	"AGL appreciate that the work to understand cluster/layout and wind speed link is somewhat costly at first for a participant, but considers that the benefits are worthwhile and that they will inform what is the best configuration of wind speed measurement to generation profile. This study	AEMO notes this and will consider reviewing commissioning procedures, as addressed in 4.3.2.

		should be carried during the design and development phase of building the wind farm asset in consultation with AEMO. AGL recognise in the first instance (i.e. during commissioning or the months after commissioning), an initial wind speed measurement is required and that meteorological masts will most likely be the best available source. This may result in AWEFS effectively modelling a far simpler wind speed/turbines available/generation model than would otherwise be the case. As the wind farm settles into operation, say within 6 months, this would be a good opportunity to reassess how the farm is operating compared to AWEFS forecast and review a more desirable wind speed indicator for the various clusters or groupings. “	
64.	AGL	In terms of forecast significance, AGL note that wake effects impact each site to varying degrees as the wind changes direction, so unless AWEFS is mapping individual wind direction vectors to generation output impacts as well, any additional benefit gained from more wind speed measurements at the nacelle may not provide the intended forecast accuracy.	Noted in 4.3.1 and addressed in 4.3.2.
65.	AGL meeting	AGL commented that the use of wind speed and possible power from every single wind turbine across all sites to determine the “most likely output” from wind farm could become expensive, and it depends on how far the alternatives may be applied. AGL indicated that in the case of wind speed, one of the concepts in AEMO’s Issues paper was trying to find the right levels of aggregated power (ie cluster level) instead of the power generated by every turbine based on wind speed, as the later approach could lead to a high volume of data points. AGL suggested the idea of having the wind farm nominating a reasonable level of data points and sought AEMO’s view if this is a concept that might work more effectively. AGL further indicated that AWEFS’s possible power could be adopted to replace the use of average wind speed to improve the accuracy of forecasting the output. AEMO advised that wind farms are typically set up with a few clusters of turbines. AEMO advised that this ECM Consultation proposes to explicitly state that wind farms can provide an average wind speed for each site, which is an improvement to the current approach of providing a single measurement of wind spend. AGL sought to clarify if possible power provided by the wind farm should be used rather than AWEFS forecasting the possible output base on average wind speed. AGL believed this is likely to provide more accurate forecast.	Noted in 4.3.1 and addressed in 4.3.2.

		AEMO noted AGL's suggestion to use possible power provided by each wind farm as an alternative to AWEFS computing the potential output based on average wind speed. AEMO also advised the use of possible power as an alternative had been suggested in the consultation paper as an "optional signal". AEMO indicated that further analysis is needed on possible power before a decision can be made. Additionally, AGL indicated that if AWEFS had an estimate of power curve, it would provide an effective way to determine the potential output from the wind farm. AEMO advised that AWEFS does have an estimate of power curve for each wind farm as a starting point, which is then adjusted for different wind conditions to derive the forecast. AEMO advised that it is currently collating information from all participants and wind speed based approach to forecasting power is being assessed. As possible power was suggested as an optional approach, AEMO needs to work out what information it will be providing in its next draft report.	
66.	CWPR (Boco Rock)	On the Wind Speed: "CWPR agrees the proposed changes would improve its dispatch outcomes."	Noted in 4.3.1.
67.	CWPR (Boco Rock)	On the Wind Speed: "CWPR is unable to quantify the costs at this stage, however an investigation is underway to determine this."	Noted in 4.3.1 and addressed in 4.3.2.
68.	CWPR (Boco Rock)	"BRWF acknowledges and has observed reliable data obtained from the nacelle mounted anemometers in contrast to the operational met masts. CWPR's experience has determined 1st class instruments mounted on met masts are considerably more accurate than a nacelle mounted anemometer even after the application of a transfer function. However, when considering the site topography and the span of the BRWF, a single met mast point is incapable of accurately estimating the generation across the entire wind farm irrespective of the anemometers measurement accuracy. With consideration to the aforementioned statements, CWPR believes that providing a single averaged instantaneous reading, derived from averaging all nacelle mounted anemometers, would be more representative of the site and result in increased accuracy in dispatch targets."	Noted in 4.3.1 and addressed in 4.3.2.
69.	Musselroe	"MRWF is supportive of the proposed changes to the SCADA Wind Speed and agrees data from the sites turbine anemometers is more representative than that of the Met mast(s). The proposed ECM SCADA Wind Speed and Direction changes are not estimated to impact MRWF. MRWF currently provides instantaneous wind speed values updated at 5 second intervals from all turbines as an aggregate to AEMO, along with wind direction at the same data frequency, provided from 1 of 8 representative nacelles."	Noted in 4.3.1 and addressed in 4.3.2.
70.	Pacific Hydro	Do you agree that the proposed changes to SCADA Wind Speed will improve your dispatch outcomes? "Yes".	Noted in 4.3.1 and addressed in 4.3.2.

71.	Pacific Hydro	On the costs of SCADA Wind Speed: "Pacific Hydro estimates the ongoing cost to be low, with a small initial capital outlay."	Noted in 4.3.1 and addressed in 4.3.2.
72.	Pacific Hydro	"Experience shows that a class 1 anemometer mounted on a mast is able to determine the wind speed within 2 % accuracy. A well setup (transfer function) nacelle anemometer rarely reaches accuracy levels below 4 % more often in the range of > 5 %. Generally data coverage and reliability is higher in a Nacelle based system than in a met mast, and is guaranteed."	Noted in 4.3.1 and addressed in 4.3.2.
73.	Pacific Hydro	"We note that the preference for turbine nacelle anemometers differs from the original preference which was for meteorological mast measurements – this needs to be communicated to all wind farms providing wind speed data."	Addressed in 4.3.2.
74.	CWPR (Taralga)	"The TWF SCADA system currently submits Wind Speed measurements from both Met Masts and from three clusters of Wind Turbines (with each cluster comprised of a different model of turbine) at two second sample rates so this is likely to have little impact on our dispatch outcomes. There are not likely to be any changes needed at TWF."	Noted in 4.3.1 and addressed in 4.3.2.
75.	CWPR (Taralga)	"Experience shows that a class 1 anemometer mounted on a mast is able to determine the wind speed to a higher level of accuracy than the ultrasonic wind sensors on a turbine nacelle. However, generally data coverage and reliability is higher in a nacelle based system than in a met mast, and is guaranteed."	Noted in 4.3.1 and addressed in 4.3.2.
76.	CWPR (Taralga)	"It may be beneficial to use a combination of wind speed and direction to calculate possible power (if not supplied directly from wind farm SCADA) as the topography and turbine layout may result in different levels of generation at the same wind speed, based on incident wind direction."	Noted in 4.3.1 and addressed in 4.3.2.
77.	CWPR (Taralga)	On Wind Speed SCADA: "There should also be standards surrounding the sampling rate, time averaging and multi-location averaging used". Clarification by phone: Taralga agreed that what was in the Issues Paper for the definition of "Instantaneous" covered these, and that this should also be explained to AEMO's SCADA people involved in commissioning. On "multi-location averaging", Taralga said that ideally the wind farm's potential power signal would be used, and that suitable configurations for average wind speed such as an average wind speed of each turbine, or of multiple met-masts, should be listed. Further, Taralga noted that wind direction has a substantial effect that would not be captured by the wind speed at the turbines.	Noted in 4.3.1 and addressed in 4.3.2.
78.	Infigen	"Infigen believes that, depending on the configuration, nacelle based averages may be more accurate. Infigen does believe that overall the changes will improve the accuracy of the measurements AEMO receives."	Noted in 4.3.1 and addressed in 4.3.2.
79.	Infigen	"Some of Infigen's wind farms already produce wind speeds that conform with this definition and the other wind farms do not currently produce wind speeds at the appropriate granularity which will require significant work and costs to update."	Noted in 4.3.1 and addressed in 4.3.2.

		Clarification by phone: the "granularity" refers to the sampling rate.	
80.	Infigen	"Lake Bonney currently samples 5 second instantaneous turbine wind speeds and takes an average over at least three of these samples (15 seconds) and updates this every 5 seconds. For Lake Bonney it is believed that nacelle based wind speeds are more accurate than met mast based wind speeds. Woodlawn wind farm currently provides met mast data to AEMO however it is agreed that nacelle based wind speeds would provide a more accurate estimate for future forecasts."	Noted in 4.3.1 and addressed in 4.3.2.
81.	Infigen	"Note that averaging wind speeds can introduce error to the possible energy calculation when wind speed is not uniform across the site and a SCADA Possible Power value is likely to represent a more accurate estimation than using the average wind speed of several turbines."	Noted in 4.3.1 and addressed in 4.3.2.
82.	AGL	Do you agree with the definition of SCADA Possible Power? "Yes, although AGL would prefer two distinct types: Possible Power for Turbines Generating and Possible Power for Turbines Available. "	Noted in 4.4.1 and addressed in 4.4.2.
83.	AGL	"AGL believes Vestas sites Possible Power is calculated at the nacelle level for all available turbines and aggregated. AGL will confirm this arrangement with Vestas. For Suzlon sites, Possible power is calculated at the nacelle level for all turbines and aggregated. Turbines that are out of service are included in the aggregation. It is based on a 10 minute average turbine wind speed. "	Noted in 4.4.1 and addressed in 4.4.2.
84.	AGL meeting	AGL commented that the use of wind speed and possible power from every single wind turbine across all sites to determine the "most likely output" from wind farm could become expensive, and it depends on how far the alternatives may be applied. AGL indicated that in the case of wind speed, one of the concepts in AEMO's Issues paper was trying to find the right levels of aggregated power (ie cluster level) instead of the power generated by every turbine based on wind speed, as the later approach could lead to a high volume of data points. AGL suggested the idea of having the wind farm nominating a reasonable level of data points and sought AEMO's view if this is a concept that might work more effectively. AGL further indicated that AWEFS's possible power could be adopted to replace the use of average wind speed to improve the accuracy of forecasting the output. AEMO advised that wind farms are typically set up with a few clusters of turbines. AEMO advised that this ECM Consultation proposes to explicitly state that wind farms can provide an average wind speed for each site, which is an	Noted in 4.4.1 and addressed in 4.4.2. Comment on FCAS noted in 4.7.1.

		improvement to the current approach of providing a single measurement of wind spend. AGL sought to clarify if possible power provided by the wind farm should be used rather than AWEFS forecasting the possible output base on average wind speed. AGL believed this is likely to provide more accurate forecast. AEMO noted AGL's suggestion to use possible power provided by each wind farm as an alternative to AWEFS computing the potential output based on average wind speed. AEMO also advised the use of possible power as an alternative had been suggested in the consultation paper as an "optional signal". AEMO indicated that further analysis is needed on possible power before a decision can be made. Additionally, AGL indicated that if AWEFS had an estimate of power curve, it would provide an effective way to determine the potential output from the wind farm. AEMO advised that AWEFS does have an estimate of power curve for each wind farm as a starting point, which is then adjusted for different wind conditions to derive the forecast. AEMO advised that it is currently collating information from all participants and wind speed based approach to forecasting power is being assessed. As possible power was suggested as an optional approach, AEMO needs to work out what information it will be providing in its next draft report. AEMO sought clarifications on the two types of Possible Power suggested by AGL – Possible Power for Turbines Generating and Possible Power for Turbines Available. AEMO is also keen to clarify whether the Suzlon turbines include either of these, given that the calculation includes turbines out of service. AGL explained that an example for Turbines Available is that if 10 turbines that are on "Pause", it is available for generation but will require at least 90 - 240 seconds before the first generation can be sent out. Therefore, if AEMO were to consider generation forecast for longer period, possible power would be higher as both types of Possible Power will need to be included, compared to when the forecast is for the next 0 to 5 minutes when only Possible Power Generating is available. AGL suggested that both concepts should be considered: Option 1 is to reduce possible power to a 3 to 8 minute period; and Option 2 is to use a rate of change to produce the Possible Power in that time. AGL suggested that either option 1 or 2 should be adopted because "possible power available" as it is currently understood or defined may not accurately reflect the actual power capability of wind farms.	

		AGL further commented that Figure 1 shown in its submission to the Consultation paper provided a good reference to the discussion on possible power, which explained the correct sequence to determine the actual capability of the wind farm in the dispatch timeframe. AGL suggested the use of "dynamic rate of change" as an input to AWEFS may also significantly improve the accuracy of forecast. AGL further explained that Possible Power Available (denoted as PPa) is power that would be available from turbines in pause mode. However, the paused turbines will need time to ramp to the target possible power. AGL indicated that this does not affect the level of possible power from the generating turbines, but will affect the possible power forecast in 7 to 8 minutes time. AGL further indicated if the correct possible power calculations are adopted, it may be possible for wind farms to develop the capability to provide FCAS in the future.	
85.	AGL	"AGL suggests that the UIGF output from AWEFS should be based on the Maximum Plant Capacity or Local Limit or Possible Power whichever is the lowest value. Note: The above approach assumes data quality for all items is GOOD. A possible example: If the data quality for "Possible Power" is BAD then replace this with "Wind speed based power (power curve)". If the data quality for both "Possible Power" and "Wind speed based power (power curve)" are BAD then replace this with previous dispatch interval "Actual Generation" from the wind farm effectively providing a persistence forecast. "	Noted in 4.4.1 and addressed in 4.4.2.
86.	AGL	"Additionally, AGL would like to explore the concept of a possible power projection or forecast for 8-10 minutes ahead (to assist the wind farms in providing a better forecast of where it is likely to be in the coming 5-10 minutes)."	Noted in 4.4.1 and addressed in 4.4.2.
87.	AGL	"AGL would like to discuss the implications of turbine blade feathering and whether this needs to be incorporated into AWEFS so that the true nature of all windfarms internal operational limitations are clearly understood and modelled within AWEFS."	Noted in 4.4.1 and addressed in 4.4.2.
88.	AGL meeting	AGL indicated that it had provided to AEMO a briefing paper as part of AGL's discussion with AEMO on its report on Scheduling Error. The AGL briefing paper submitted to AEMO discussed about those intervals that were identified with Scheduling Error and highlighted the impact the errors would have on potential dispatched outputs. The briefing paper discussed the significance of ramp rate with respect to AEMO setting the targets and the wind farm responding to AEMO targets.	Reference to turbine blade feathering noted in 4.4.1. Remaining comments are outside the scope of this consultation.

		AGL suggested that if the rate of change concept is merged with the blade trapezium concept, the target setting would be more sensitive to the operation of wind turbines and their capacity to follow and meet the targets that recognised the plant 's operating parameters. This includes "feathering of turbine blades" that enable the turbines to generate at a faster rate. The generation output rate would change when wind farms output falls to or below the blade-feathering % of individual turbines capacity, based on different OEM designs. AGL pointed out that the briefing paper also suggested that even though "Pitching" of wind turbines was not a major focus of the ECM Guidelines Consultation, it is an important element of plant operation to consider as it provides an important insight into how and what plant can and cannot do. AGL commented that the wind turbine pitching technology for newer turbines can provide different pitching actions differently to older ones which could impact on the forecast produced by AWEFS. AGL suggested that such a difference in pitching actions could be captured as the "Rate of change" to reflect different pitching levels for different turbines.	
89.	CWPR (Boco Rock)	"CWPR agrees with the definition of SCADA possible power."	Noted in 4.4.1 and addressed in 4.4.2.
90.	CWPR (Boco Rock)	"GE's wind controller system at BRWF currently produces a possible power output in real time (MW). It is believe the estimate is calculated from the instantaneous nacelle anemometer reading and the power curve of the turbine. Turbines that are not communicating or not generating are not believed to be contributing to the possible power. BRWF is waiting on confirmation of the exact calculation the system performs."	Noted in 4.4.1 and addressed in 4.4.2.
91.	CWPR (Boco Rock)	"There are numerous approaches which could be adopted to ensure the quality of data for the 'Possible Power' data point, this would need to be discussed in greater detail should this point be utilised in AWEFS. However, at a general level the number should be greater than zero, whilst remaining less than or equal to the registered capacity. With respect to frequency, should possible power become an included data point for AWEFS, CWPR believes this should be provided to AEMO at a high resolution if not instantaneous."	Noted in 4.4.1 and addressed in 4.4.2.
92.	Musselroe	"MRWF is supportive of the proposed changes to the SCADA Possible Power as it currently provides Possible Power data to AEMO. It is understood that SCADA changes may be required to meet the new AEMO definition. The costs to amend the SCADA point are not fully understood at this stage." Clarification by phone: On the Possible Power SCADA changes – during high-wind-speed cut-out, MRWF's existing Possible Power does not automatically account for the pausing of turbines, but there is a higher threshold above which it does account for pausing of turbines. The definition of Possible Power in the Issues Paper does not include any mention of behaviour around high-wind-speed cut-out.	Noted in 4.4.1 and addressed in 4.4.2.

93.	Musselroe	"MRWF would encourage AEMO to explore utilising the wind farm's possible power capabilities, which being calculated from real-time data at every turbine could further enhance the existing AWEFS forecasting."	Noted in 4.4.1 and addressed in 4.4.2.
94.	Pacific Hydro	"Pacific Hydro agrees with the current definition of SCADA Possible power. It is an important distinction to use available turbines rather than generating turbines."	Noted in 4.4.1 and addressed in 4.4.2.
95.	Pacific Hydro	"The control system of the wind farm is capable of providing what "the power output could actually be if a set-point is released". It is not currently activated. The estimate is calculated from the nacelle anemometer 10 minute average wind speed and the power curve of the turbine. Turbines that do not have the ability to generate are not included. Turbines that are not communicating with the main park controller are also not included in the calculation."	Noted in 4.4.1 and addressed in 4.4.2.
96.	Pacific Hydro	On Possible Power: "Implementation costs would still exist despite the fact that the calculation is already performed. A software upgrade on the wind turbines and power park controller would be required in order to provide this signal. Cost is likely to be less than $10,000. Provision of a possible power estimate based on a smaller average period of 30 seconds rather than ten minutes may be possible and is subject to an investigation by the manufacturer."	Noted in 4.4.1 and addressed in 4.4.2.
97.	Pacific Hydro	"Possible power should be greater than zero, and less than or equal to registered capacity (not maximum capacity). Maximum capacity is addressed in Section 3.4 of the ECM consultation, and addresses the issues where UIGF exceeds maximum power. If possible power is to be used in AWEFS predictions or analysis, then values greater than the registered capacity should be interpreted as registered capacity. The update frequency of this tag should ideally be instantaneous to reflect the availability of generators at any particular point in time."	Noted in 4.4.1 and addressed in 4.4.2.
98.	Pacific Hydro	"It should be noted that whilst a possible power estimate can give an estimate of wind farm curtailment, it cannot provide an accurate measure of what the wind farm is capable of producing in the next dispatch interval. Due to an inherent lag in starting turbines, the expected ramp rate may not be achieved if turbines are not generating. By providing a forward forecast of turbine availability or possible power in future dispatch interval timeframes, it would be possible to provide improved dispatch outcomes. It is suggested that the relevance of an optional tag future possible power is investigated to allow a wind farm operator to predict the wind farm output based on turbines available or wind speed estimations from remote sensing devices such as LIDAR or SODAR. This would also improve the frequency control of the NEM as the dispatch could be predicted with much greater accuracy."	Noted in 4.4.1 and addressed in 4.4.2.
99.	CWPR (Taralga)	"TWF agrees with the current definition of SCADA Possible Power".	Noted in 4.4.1 and addressed in 4.4.2.

100	CWPR (Taralga)	"The TWF SCADA system currently submits 'Possible Active Power' via TransGrid."	Noted in 4.4.1 and addressed in 4.4.2.
101	CWPR (Taralga)	"The estimate is calculated from the nacelle anemometer wind speed and the power curve of the turbine. Turbines that do not have the ability to generate are not included. Turbines that are not communicating with the main park controller are also not included in the calculation."	Noted in 4.4.1 and addressed in 4.4.2.
102	CWPR (Taralga)	"The wind turbine/SCADA suppliers seem to have good models for estimating 'Possible Power' in their latest development, but it is likely to be difficult to implement on older wind farms."	AEMO agrees, as discussed in 4.4.2.
103	CWPR (Taralga)	"The update frequency of this tag should ideally be instantaneous to reflect the availability of generators at any particular point in time."	Noted in 4.4.1 and addressed in 4.4.2.
104	CWPR (Taralga)	"The calculations should account for any 'wind sector management' applied to individual turbines." Clarification by phone: 'wind sector management' is where some turbines pause due to wake effects for some wind directions. You noted that turbine manufacturers could be asked what their control systems can calculate for possible power.	Noted in 4.4.1 and addressed in 4.4.2.
105	CWPR (Taralga)	"The 'Possible Power' estimates are likely to be calculated at an individual turbine level, so won't account for any losses in the wind farm reticulation system."	Noted in 4.4.1 and addressed in 4.4.2.
106	CWPR (Taralga)	"Whilst a 'Possible Power' can give an estimate of wind farm curtailment, it cannot provide an accurate measure of what the wind farm is capable of producing in the next dispatch interval."	Noted in 4.4.1 and addressed in 4.4.2.
107	Infigen	"Infigen agrees with the definition of possible power assuming that the definition of 'available turbines' includes turbines paused due to network constraints or connection asset constraints but otherwise available to generate. Otherwise it is believed this could significantly reduce estimates of Possible Power and would be an incomplete measure of current Possible Power."	Noted in 4.4.1 and addressed in 4.4.2.
108	Infigen	"Infigen suggests further analysis into the use of two distinct data points for Possible Power: 'available turbines' and 'turbines generating'. 'Available turbines' would produce a possible power estimate for optimising dispatch decisions. 'Turbines generating' would produce a possible power estimate that would correlate to real park production and may be used under certain circumstances for short-term forecast."	Noted in 4.4.1 and addressed in 4.4.2.
109	Infigen	"Infigen Energy currently calculates instantaneous farm possible power by measuring wind speed and estimating power for both turbines generating (i.e. excluding paused turbines) and turbines available (i.e. including paused but ready to run turbines) for Lake Bonney 2 and 3. Infigen Energy believes the appropriate estimate of Possible Production should use turbines available and is known as the "Future Possible Power" data point at Lake Bonney."	Noted in 4.4.1 and addressed in 4.4.2.
110	Infigen	Woodlawn SCADA currently calculates an "Estimate Output" based on the number of turbines with communications and a 10 minute average of wind	Noted in 4.4.1 and addressed in 4.4.2.

		speed for the wind farm. Infigen does not believe this estimate would provide an accurate estimate of possible production as it does not exclude turbines that are stopped or paused due to an alarm or fault.	
111	Infigen	Infigen Energy believes this amendment will necessitate a moderate amount of work and costs to update our existing set of transmitted SCADA data streams at Woodlawn to include the proposed Possible Power, with negligible ongoing cost.	Noted in 4.4.1 and addressed in 4.4.2.
112	Infigen	"Infigen Energy is of the view that AWEFS should generate the UIGF value based on the lowest value of Registered Capacity, Possible Power or Local Limit. If the SCADA Possible Power data quality isn't good, wind speed based possible power should be used."	Noted in 4.4.1 and addressed in 4.4.2.
113	Infigen	"Infigen Energy also see a material benefit in exploring the calculation of a forecasted Possible Power figure looking 5-10 minutes ahead of time. This would assist in providing a more realistic production trajectory over the dispatch interval."	Noted in 4.4.1 and addressed in 4.4.2.
114	Vestas	"Regarding 'Possible Power' – I agree that this value should originate from the turbine using the wind condition and the turbine power curve. It will bring better accuracy to the AWEFS as it will be a better representation of the possible power that could be generated if no limit was applied to the wind farm."	Noted in 4.4.1 and addressed in 4.4.2.
115	AGL	"AWEFS should only be statically limited by registration value Max Capacity, as opposed to the Registered or Nameplate Capacity (and thus more akin to what occurs in Scheduled Generators which do not use nameplate/registered for anything)."	Noted in 4.5.1 and addressed in 4.5.2.
116	AGL	"AGL do not currently has solar tracking capability. However, AGL would like to be involved with discussions on how this will be implemented for future solar farms."	Noted in 4.6.1.
117	AGL	"In a broader context, some of the proposed ECM changes could lead to developments that will potentially enable intermittent generators to provide some form of FCAS in the future, as witnessed in Europe."	Noted in 4.7.1 and addressed in 4.7.2.
118	AGL meeting	AEMO sought clarification on which of the proposed changes discussed by AGL may relate to potential FCAS in future. AGL indicated that if AEMO choose to implement the concepts of possible power and the rate of change, the two functions can be linked to allow for wind farms to offer FCAS in the market. AGL suggested an example would be where a wind farm chooses to offer to the market a 10MW of raised capability. AGL commented that this could best be achieved if the wind farm forecasting system could recognise what the farm operating characteristics, ie what the physical plant can and cannot do, so that the FCAS co-optimisation can be done correctly and more accurately. A possible scenario could occur in say South Australia, when FCAS is priced at $300 MWh, the wind farms may then be co-optimised from the energy market and offer	Noted in 4.7.1 and addressed in 4.7.2.

		10MW into the FCAS market. AGL commented that it believed the MASS (Market Ancillary Service Specification) is not designed for this sort of offer at the moment.	
119	Pacific Hydro	"Thought should also be given on the future integration of wind farms into the ancillary services market. If a generating unit is to submit an offer for lower services and is not dispatched, a signal should be provided to enable or disable lower services as required. This would help the market to move towards a higher renewables penetration system." Phone clarification: "On how an FCAS lower signal would operate – as a signal from AEMO to the plant to tell the wind farm if they have been dispatched for raise or lower services."	Noted in 4.7.1 and addressed in 4.7.2.
120	CWPR (Taralga)	"It is also worth noting that with the correct turbine/inverter/storage technologies, operating strategies and control systems, including those proposed here, it may be possible in the near future for intermittent generators to be used for Frequency Control and Ancillary Services."	Noted in 4.7.1 and addressed in 4.7.2.
121	Musselroe	"The ECM proposal seeks amending the wind direction units from Decimal Degrees Latitude/Longitude, MRWF currently provides wind direction units as degrees true."	Addressed in section 5.
122	AGL meeting	AGL enquired if the proposed changes for ECM may include ASEFS1 for solar plants. AEMO advised the ECM Guidelines changes also apply to Solar where indicated.	No response required
123			

Attachment 1 – Draft Wind Energy Conversion Model Guidelines and Solar Energy Conversion Model Guidelines

See spreadsheets Energy_Conversion_Model_Guidelines_Wind_20160802.xlsx and Energy_Conversion_Model_Guidelines_Solar_20160802.xlsx as published on the consultation website at http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms.