WIND AND SOLAR ENERGY CONVERSION MODEL GUIDELINES CONSULTATION

FINAL REPORT AND DETERMINATION

Published: December 2016

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

NOTICE OF FINAL DETERMINATION – **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: 09 December 2016

This notice informs Semi-Scheduled Generators and any party having an interest in the Wind and Solar Energy Conversion Model (ECM) Guidelines (**Consulted Persons**) that AEMO has completed its consultation on the Amendments to the Wind ECM Guidelines and the Solar ECM Guidelines.

This consultation was conducted in accordance with the rules consultation requirements detailed in rule 8.9 of the National Electricity Rules (the *Rules*).

Determination and Publication

AEMO's final determination is to make the Wind Energy Conversion Model Guidelines and the Solar Energy Conversion Model Guidelines in the form published on the AEMO website, in accordance with clause 2.2.7(d) of the *Rules*. The Guidelines are published on AEMO's website at:

http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms

EXECUTIVE SUMMARY

The publication of this Final Report and Determination (Final Report) concludes 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 (*"Rules"*).

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

The *Issues Paper* for this consultation proposed a new Supervisory Control and Data Acquisition (SCADA) signal "Local Limit" to address this, along with an optional "Possible Power" SCADA signal, and amendments to the definition of the "Wind Speed" SCADA signal, and other minor amendments.[1] This consultation process did not consider Western Australia.

During the course of the consultation, a number of material issues were raised. Due to strong participant feedback in the second stage of consultation on the "Possible Power" SCADA signal, AEMO has conducted, with the agreement of stakeholders, a third stage of consultation.

The material issues addressed in this Final Report and Determination include:

- Concern about the implementation cost and low value of the proposed SCADA Turbines Extreme Wind Cut-out signal.
- Changes to the definition of the proposed SCADA Estimated Power signal.

After considering the submissions received in all stages of consultation, AEMO determines:

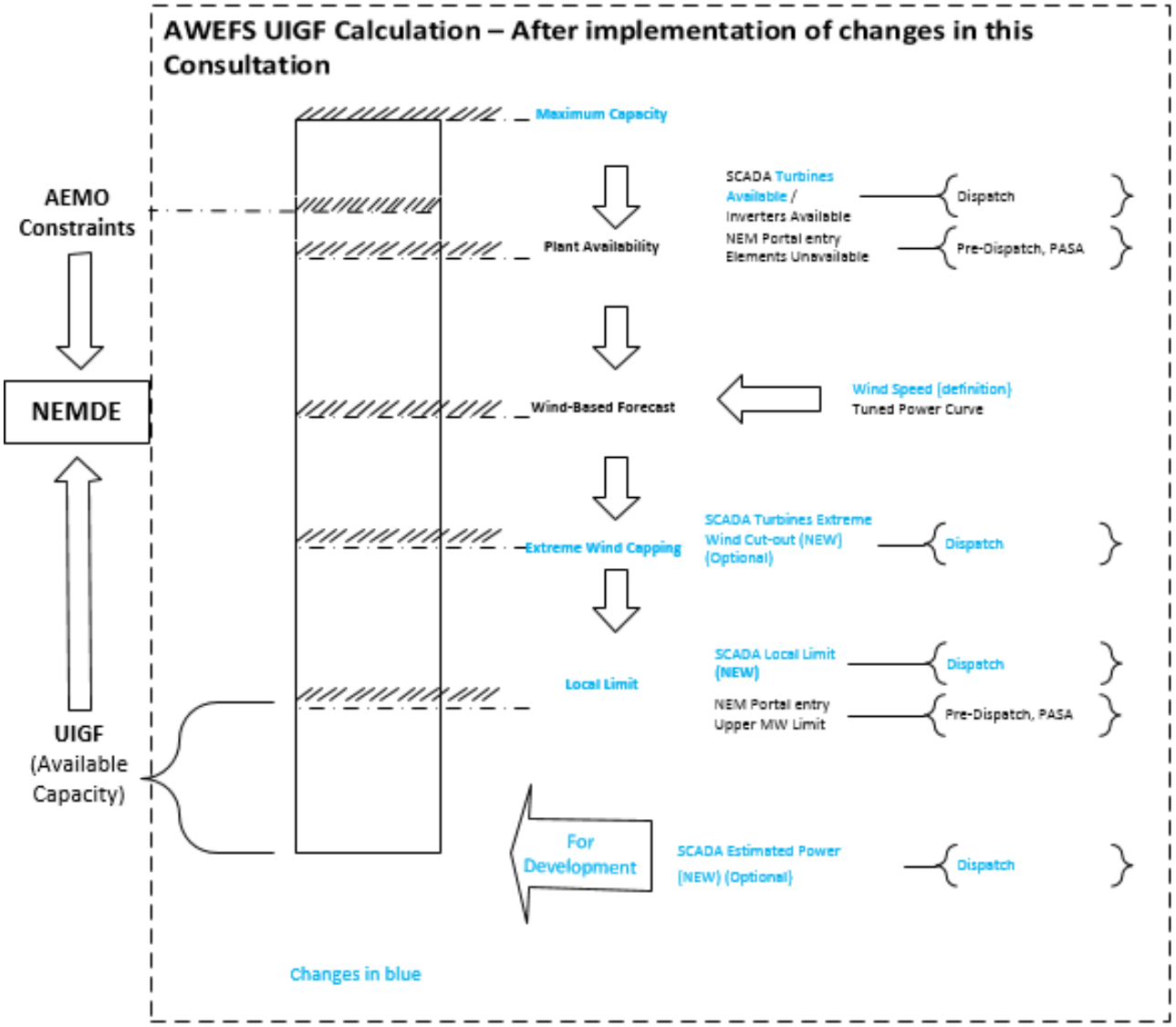
- To add the proposed SCADA Local Limit item to the Wind and Solar ECM as a mandatory provision for all new and existing *Semi-Scheduled Generators* except by agreement with AEMO, and make changes to AWEFS/ASEFS to apply that limit as a cap on the *unconstrained intermittent generation forecast* (UIGF) used in 5-minute dispatch.
- To implement the proposed ECM changes to the SCADA Wind Speed item and the required sampling rate of the SCADA signals, on the basis that exemption from this requirement for existing wind farms will be considered by AEMO on a case by case basis .
- To add a new SCADA Turbines Extreme Wind Cut-out item to the Wind ECM as an optional provision with corresponding changes to AWEFS, and to note that depending on the outcomes of the development of the SCADA Estimated Power signal and of a review of the SCADA Turbines Available signal, AEMO may seek to make this signal mandatory at a future date.
- To adopt a minor amendment to the existing definition of SCADA Turbines Available to more accurately handle high-temperature cut-out.
- To note further work following this consultation on a review of the precise definition of the SCADA Turbines Available signal, and associated signals that may be of value in future.
- To amend the proposed SCADA Estimated Power signal definition, and commence work with *Semi-Scheduled Generators* on assessing the accuracy of candidate signals, and on scoping of implementation pathways.

The diagram on the following page gives a visual summary of the changes to the UIGF calculation.

After completion of this consultation, AEMO will be conducting a detailed review of AWEFS, and to a lesser degree ASEFS, across all forecast timeframes. AEMO will engage regularly with stakeholders during this process.

AEMO's final determination is to make the Wind Energy Conversion Model Guidelines and Solar Energy Conversion Model Guidelines in the form published with this Final Report and Determination.

[1] Refer to http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms for the *Issues Paper*.


AWEFS UIGF Calculation – After implementation of changes in this Consultation
Maximum Capacity
AEMO Constraints
Plant Availability
SCADA Turbines Available / Inverters Available
Dispatch
NEM Portal entry Elements Unavailable
Pre-Dispatch, PASA
NEMDE
Wind-Based Forecast
Wind Speed (definition)
Tuned Power Curve
Extreme Wind Capping
SCADA Turbines Extreme Wind Cut-out (NEW) (Optional)
Dispatch
SCADA Local Limit (NEW)
Dispatch
Local Limit
NEM Portal entry Upper MW Limit
Pre-Dispatch, PASA
UIGF (Available Capacity)
For Development
SCADA Estimated Power (NEW) (Optional)
Dispatch
Changes in blue

Contents

1 Stakeholder Consultation Process

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

This Final Report is published in accordance with clause 8.9(k).

There is a link to all submissions received during the third stage of consultation at **Appendix B**. Issues raised in submissions are summarised in Table 1, and discussed in Section 4.

The ECM Guidelines are published on AEMO's website at:

http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms

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 *Rules*.

2 Background

2.1 National Electricity Rules 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 NEM *Semi-Scheduled Generators* at times when output is constrained by a local limit currently not reflected in the AWEFS forecast.

During discussions on other matters, AEMO raised this issue with several NEM *Semi-Scheduled Generators* and identified a potential solution, which would require NEM *Semi-Scheduled Generators* to provide a new SCADA signal to AEMO with information that identifies limits to the export of the *plant*. During these discussions and internal review, further improvements to the dispatch forecast were also proposed. These included investigating the capture 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 located across a farm.

AEMO held a Pre-Consultation Forum on 23 February 2016 which was attended by the majority of NEM *Semi-Scheduled Generators*.

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 clause 8.9(f) of the Rules, AEMO extended the current consultation timeline by 25 days, to accommodate meetings requested by Consulted Persons between the submissions 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.

2.4 Second stage consultation

On **2 August 2016**, AEMO issued a Notice of Second Stage Consultation along with the Draft Report and Determination and draft ECM Guidelines. This information is also available on AEMO's website at: http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms.

The Draft ECM Guidelines proposed:

- A new SCADA Local Limit signal, with updated definition and implementation in response to the first stage submissions.
- Updated definition of the existing SCADA Wind Speed, in response to the first stage submissions.
- Addition of a new SCADA signal Extreme-Wind Cut-out, proposed only in the second round.
- The omission of the proposed optional Possible Power signal to allow more comprehensive consultation to occur.
- Adoption of other minor changes proposed in the Issues Paper.[2]

In the second stage of consultation, AEMO received seven written submissions, from:

- AGL Energy (AGL)
- CWP Renewables (CWPR (Boco Rock)) – this submission was received late.
- Infigen Energy (Infigen)
- Pacific Hydro
- Clean Energy Council (CEC)
- Australian Energy Regulator (AER)
- Musselroe – part of this submission was confidential.

AEMO held the following meetings with stakeholders:

- Face-to-face meeting with AGL, Pacific Hydro, and Infigen Energy on 8 September 2016 to clarify details in their submissions.
- One confidential meeting.
- Face-to-face and teleconference meeting on 26 September 2016, attended by the majority of Semi-Scheduled Generators.

[2] Refer to http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms for the *Issues Paper*.

Copies of all written submissions (excluding any confidential information) 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, along with minutes from the two non-confidential meetings.

2.5 Third stage consultation

On **14 October 2016**, AEMO issued a Notice of Third Stage Consultation along with the Second Draft Report and Determination and second draft ECM Guidelines. This information is also available on AEMO's website at: http://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms.

The Second Draft ECM Guidelines proposed, in revision of the Draft ECM Guidelines:

- Minor amendments to the SCADA Local Limit signal definition and Wind Farm SCADA to AEMO definition.
- A minor amendment to the definition of SCADA Turbines Available to more accurately handle high-temperature cut-out.
- A definition for an optional SCADA Estimated Power signal that is the wind or solar farm's forecast of its generation at the end of the next dispatch interval, based on technical factors behind the connection point.

In the third stage of consultation, AEMO received seven written submissions, from:

- AGL Energy (AGL)
- Infigen Energy (Infigen)
- Pacific Hydro
- Clean Energy Council (CEC)
- Australian Energy Regulator (AER)
- Woolnorth Wind (Musselroe)
- Joint industry response – from Pacific Hydro, AGL, Infigen, Woolnorth, Tilt Renewables, Acciona, Suzlon, Vestas, Siemens, Goldwind, Senvion, GE, FirstSolar, Hardsoftware, Ingeteam, CEC, Greenview Strategic Consulting.

3 Summary of material issues

The key material issues raised by Consulted Persons in response to the proposed changes to the ECM Guidelines in the Second Draft Report and Determination are summarised in the following table, covering the third stage of consultation.

NO.	ISSUE	RAISED BY
1.	New ECM Item: Proposed SCADA Local Limit	Musselroe, Infigen, AER
2.	Existing ECM Item: Changes to definition of SCADA Wind Speed	Musselroe, Infigen, Pacific Hydro
3.	New ECM Item: Dispatch Forecast With Extreme Wind Speed and Direction Cut-out	AGL, Infigen, Pacific Hydro
4.	Existing ECM Item: Change to SCADA Turbines Available Definition	Musselroe, Infigen
5.	New ECM Item: Optional SCADA Estimated Power item	Musselroe, AGL, Infigen, Pacific Hydro, CEC, Joint Industry Response, AER
6.	Management of "by agreement with AEMO" items	Musselroe
7.	Participation in FCAS	Musselroe, AGL, Joint Industry Response
8.	Transparency and Bidding of Availability	Musselroe, Pacific Hydro, AER

A detailed summary of issues raised by Consulted Persons in submissions to the second stage of consultation, together with AEMO's responses, is contained in **Appendix B**.

4 Discussion of material issues

This section summarises the material issues AEMO identified following receipt of third stage submissions. It also provides AEMO's assessment of the issues and how AEMO proposes to address them.

4.1 New ECM item: Proposed SCADA Local Limit

4.1.1 Issue summary and submissions

In their third stage submissions, **Infigen** and **Musselroe** supported the definition of SCADA Local Limit, including the requirement that the limits should be technical.The **AER** acknowledged the addition of "technical" to the definition in response to their second stage submission.

4.1.2 AEMO's assessment

No further changes are required to the definition of this item.

The Draft Report and Determination for this Consultation stated that the SCADA Local Limit would be flagged as bad quality if the value is above the higher of Maximum Capacity and *nameplate rating*. During specification of the detailed implementation of this item in AWEFS and ASEFS, AEMO has identified that to prevent spurious triggering of a bad quality input flag, the SCADA Local Limit will be flagged as bad if the value is more than 10% above the higher of Maximum Capacity and *nameplate rating*.

4.1.3 AEMO's conclusion

AEMO determines that the SCADA Local Limit should be defined as in Section 4.1.3 of the Second Draft Report and Determination and repeated here.

Definition of SCADA Local Limit – to be provided by all new and existing NEM *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 for a wind/solar farm is the lower of its *plant availability* and all technical limits on the capacity of its connection assets to export energy.

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 may exclude other limits managed by AEMO through the central dispatch process.

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

Manually-applied transient limits not intended to apply at the end of the next dispatch interval 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.

Further, as concluded in the Second Draft Report and Determination, AEMO concludes that:

- AEMO will investigate implementing additional constraint equations to represent *distribution network constraints* impacting on the dispatch of *Semi-Scheduled Generators*, seeking information from *Distribution Network Service Providers*.
- AEMO will work with *Semi-Scheduled Generators* to ensure as far as possible that all relevant *transmission* and *distribution network* constraints are managed adequately by AEMO.

4.2 Existing ECM item: Changes to definition of SCADA Wind Speed

4.2.1 Issue summary and submissions

Musselroe, **Infigen** and **Pacific Hydro** noted agreement with the definition in the Second Draft Report and Determination.

4.2.2 AEMO's assessment

No further changes are required to this item.

4.2.3 AEMO's conclusion

AEMO determines that the Wind Farm SCADA to AEMO and SCADA Wind Speed components of the Wind ECM Guidelines be amended as in Section 4.3.3 of the Second Draft Report and Determination, repeated below.

Definition 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, with 4 seconds or faster preferred. 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.

As noted in the Draft Report and Determination, 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.

4.3 New ECM item: Dispatch forecast with extreme wind speed and direction cut-out

4.3.1 Issue Summary and Submissions

In the Draft Determination and Report, AEMO proposed a new item SCADA Turbines Extreme Wind Cut-out. The Second Draft Determination and Report provided further explanation of its value to improving dispatch accuracy, and acknowledged comments in submissions that the signal may be expensive to implement for some farms, and that the proposed SCADA Estimated Power signal would provide more complete information than a specific signal just for extreme wind. AEMO also proposed to review, following this consultation, the definition of the SCADA Turbines Available signal and/or new related signals to give better dispatch accuracy during all cut-out events. Section 4.4 covers this in more detail. AEMO also proposed to review the forecasting of extreme wind cut-out events before they occur across forecasting timeframes.

In the third stage of submissions, **AGL**, **Infigen**, and **Pacific Hydro** stated that SCADA Estimated Power would better reflect the impact of wind turbine cut-out due to extreme wind, and that there is little or no benefit from providing a separate SCADA Turbines Extreme Wind Cut-out signal.

4.3.2 AEMO's assessment

AEMO acknowledges the view of some participants that this signal may have little value to dispatch accuracy if a suitable SCADA Estimated Power signal is implemented. However, the cost to AEMO to implement this signal is small and, as detailed below, AEMO believes it could offer a net benefit for some wind farms in the interim period while work progresses on evaluating the SCADA Estimated Power signal. AEMO determines to add the SCADA Turbines Extreme Wind Cut-out signal to the ECM Guidelines, but only as optional rather than mandatory provision.

AEMO considers that the review of the definition of the SCADA Turbines Available signal and the potential addition of related signals (as discussed in Section 4.4 of this report), would ultimately deliver a better forecast because a broader range of site-specific conditions and other turbine cut-out events could be accounted for, and the implementation could be less complex for some wind farms.

AEMO will continue to work with stakeholders on the implementation of the SCADA Estimated Power signal and will pursue potential improvements to the existing SCADA Turbines Available signal and/or the addition of related signals on turbine availability. At the conclusion of this work, AEMO would seek to make mandatory at least one of SCADA Estimated Power, SCADA Turbines Extreme Wind Cut-out, updated SCADA Turbines Available or new signal(s) related to turbine availability, to improve the accuracy of the AWEFS dispatch forecast in extreme wind situations.

AEMO also notes that anticipated work to improve the prediction of high-wind cut-out in forecast timeframes may benefit from specific information on high-wind cut-out as opposed to other causes of cut-out events. Given the feedback from some participants on the difficulty of isolating high-wind cut-out events, AEMO does not have sufficient reason to require this information now, but may work with participants in future to obtain the necessary information once the need is better defined.

AEMO's assessment is to add the SCADA Turbines Extreme Wind Cut-out signal as an optional provision, with the following benefits identified:

- The signal would give improved dispatch accuracy for wind farms that choose to implement it (prior to implementation of SCADA Estimated Power), and would reduce the need for NEM control room action for system security purposes during some events of high-wind cut-out.
- The signal would complement the existing SCADA Turbines Available signal and provides a means to validate the SCADA Estimated Power signal during high-wind cut-out events.
- The signal would provide specific information on high-wind cut-out events for anticipated use in improving the forecasting of high-wind cut-out before it occurs.

4.3.3 AEMO's conclusion

AEMO determines to add the item SCADA Turbines Extreme Wind Cut-out signal to the Wind ECM Guidelines as an optional provision, as defined in Section 4.2.3 of the Second Draft Report and Determination and repeated below.

Optional provision by 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 – Optional

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. If agreed with AEMO, extreme wind direction change may be excluded.

In addition, AEMO intends to investigate improvements to the forecasting of high-wind cut-out for the dispatch and longer forecast timeframes.

4.4 Existing ECM item: Change to SCADA Turbines Available definition

4.4.1 Issue summary and submissions

The Second Draft Report and Determination proposed a small amendment to the definition of SCADA Turbines Available to more correctly handle high-temperature cut-out in accordance with the design of AWEFS.

In addition, AEMO proposed to investigate a potential redefinition of the SCADA Turbines Available signal, given the complexity around the conditions such as ambient condition cut-out that make a turbine genuinely able to run, as opposed to just "available". AEMO also raised the idea of a "Future Turbines Available" or similar signal to indicate which turbines would likely be able to run in the next dispatch interval, or a "Share of farm available" signal.

AEMO proposed to investigate following this consultation, in discussion with stakeholders and the vendor of AWEFS, the options and implications across all AWEFS forecasting timeframes of such an approach. AEMO noted that this approach may be valuable to wind farms that do not see value in a full "Estimated Power" signal, and that such signals could also improve the accuracy of the AWEFS-calculated forecast for all farms, which would improve AEMO's ability to validate an "Estimated Power" signal.

Musselroe's submission notes that the focus on ambient temperatures will be complicated, and prefers that "Future Turbines Available" be reflected in SCADA Estimated Power. **Infigen**'s submission noted agreement with AEMO's amendment, and supported a further review of SCADA Turbines Available.

The **Joint industry response** noted that not all OEMs agreed it was possible to provide a SCADA Estimated Power signal, and some OEMs queried if instead AWEFS/ASEFS should be provided with more SCADA signals to process.

4.4.2 AEMO's assessment

AEMO appreciates the concern that the focus on ambient temperatures could be complicated. AEMO's response is that the proposed change to allow turbines paused due to ambient temperature to be included if agreed with AEMO, would avoid undue retro-fitting and expense in changing the SCADA Turbines Available signal.

In response to the **Joint industry response**, AEMO sees a review of the SCADA Turbines Available signal, and potential associated signals, as offering an option for improving dispatch accuracy for wind farms unable to implement a SCADA Estimated Power signal.

4.4.3 AEMO's conclusion

The existing SCADA Turbines Available will be redefined as in Section 4.2.2 of the Second Draft Report and Determination and repeated below. AEMO also intends to further investigate following this consultation process a potential redefinition of the SCADA Turbines Available signal and/or the addition of a "Future Turbines Available" or other signal to improve the dispatch forecast accuracy of AWEFS.

SCADA Turbines Available – Provided by Cluster – Wind only

Number of turbines available for generation. This definition is the summation of:

- Turbines operating
- Turbines available to operate, but not operating due to ambient wind conditions (very low / high wind speeds, extreme direction change)
- Turbines available to operate, but paused due to down regulation.

This definition excludes all the following cases:

- Turbines under maintenance or repair
- Turbines with a fault or damage
- Turbines not yet built
- Transmission/distribution network not available.

If agreed with AEMO, turbines paused due to ambient temperature may be counted as available in this signal.

4.5 New ECM item: Optional SCADA Estimated Power signal

4.5.1 Issue summary and submissions

In the Second Draft Report and Determination, AEMO proposed a new optional SCADA Estimated Power signal, following a meeting with the majority of *Semi-Scheduled Generators* on **26 September 2016**. At the meeting there was strong support for a precise simple definition to be made for wind and solar farms in advance of work to assess the accuracy and potential implementation of this signal.

The **AER**'s submission states that the **AER** supports the further work AEMO and other participants have undertaken in relation to the inclusion of the 'SCADA Estimated Power' parameter as a potential replacement of the AWEFS dispatch forecast, and that the AER considers that the comprehensive inputs from across a wind farm should ensure that the SCADA Estimated Power accurately represents the wind farm's performance, and that the data should be well scrutinised and compared to the outputs from AWEFS.

In the second draft report, AEMO asked a series of specific questions.

Do you agree with the name "Estimated Power"?

All who responded agreed that Estimated Power was a suitable name.

Is one signal enough? Is there need for a second signal such as a dynamic rate of change?

Musselroe, **AGL**, **Infigen** and the **CEC** agreed that a single signal was enough, with **Musselroe**, **Infigen**, **AGL,** the **CEC**, and **Pacific Hydro** noting that a dynamic rate of change signal was not of value. **Pacific Hydro** said that an additional DI+2 signal may prove beneficial for pre-dispatch and dispatch outcomes at extra cost, with clarification provided that the benefit was expected to be mostly for pre-dispatch. AEMO notes this suggestion for future discussion as work on SCADA Estimated Power progresses. **Pacific Hydro** also noted that a wind farm is not always capable of maintaining a linear ramp rate. AEMO notes this, but responds that this is outside the scope of this consultation, which considers the dispatch forecast for the end of the dispatch interval.

Do you have concerns about interaction between the "Estimated Power" value and the existing bid of ramp rate?

Musselroe, **Infigen**, and **Pacific Hydro** had no issue with NEMDE continuing to apply the bid ramp rate separately to the implied ramp rate in the SCADA Estimated Power signal. **Musselroe** noted that NEMDE should operate in a similar manner for scheduled and semi-scheduled generation, where NEMDE is responsible for determining the dispatch level from the availability. However, **AGL**'s view was that the bid ramp rate should not be necessary as ramp rates are implicit in the SCADA Estimated Power and are more accurate.

AEMO's response is that as there are no concerns identified by submissions about the interaction between Estimated Power and bid ramp rate, no changes are indicated, and it would be up to *Semi-Scheduled Generators* to consider any interaction between the two.

Do you agree with the level of detail in the definition?

All submissions that commented agreed that the definition ensured understanding of the purpose but allowed freedom in the implementation.

The **AER**'s submission supported the specification of 'subject only to technical factors' in the definition.

AGL and the **CEC** noted that it would be better to replace 'forecast' with 'estimate', to make it clear that forecasting of wind is not a requirement (**CEC**) and that the estimate can be based on robust physical principles (**AGL**). The **Joint industry response** indicated that it is highly improbable that forecast wind speed and wind direction would be included.

Should limits on connection assets be included or excluded from this definition?

The specific question on whether limits on connection assets should be included gave differing views.

Musselroe, **AGL**, and **Infigen** proposed that they be excluded, seeing the SCADA Estimated Power as the estimated output of the generation equipment, with the SCADA Local Limit covering the effect of the connection assets. **Musselroe** indicated that this could be important when considering hybrid systems.

AGL's submission proposed that SCADA Estimated Power be 'at the connection point', while **Musselroe**'s submission proposed it be 'at the sampling point'.

Pacific Hydro and the **CEC** agreed with AEMO's proposal that limits on connection assets should be included to give an equivalent signal to the AWEFS/ASEFS UIGF. The **CEC** proposed an alternative way of defining what asset limits are reflected in SCADA Estimated Power, by excluding limits represented by AEMO and NSP constraints.

Pacific Hydro clarified in a subsequent email to its submission that the term "connection assets" may be misleading as there may be connection assets that are within the network and not behind the connection point, and that it needed to be clear that SCADA Estimated Power included only effects behind the connection point. In response, AEMO considers that the proposed definition of SCADA Estimated Power already excludes limits on output from assets outside the connection point by its exclusion of distribution and transmission network constraints.

Other comments

AGL, **Infigen** and the **AER** supported the need for validation of SCADA Estimated Power, with **Infigen** requesting more detail on how an adequate level of accuracy would be determined, and whether it would be for the initial adequacy assessment or an ongoing data quality test. The **CEC**'s submission stated that AEMO should not have the discretion to reject estimates provided by participants as market forces through the causer-pays process would incentivise accuracy of the signal, with the participant, not AEMO bearing the risk.

The **Joint industry response** identified concern about the degree of accuracy required and suggested that a globally consistent standard be developed. The submission also noted that the method of making the estimates would improve over time, with some variables such as wind sector management not currently included, and predicting the state of variables in 5 minutes' time was not currently done.

4.5.2 AEMO's assessment

Location of SCADA Estimated Power

In response to the comments on 'at the connection point' and 'at the sampling point', AEMO considers that the intention of the SCADA Estimated Power signal is to provide an estimate of the active power in MW of the Generator as measured by the existing SCADA Active Power signal, corresponding to the quantity dispatched. While for many *Semi-Scheduled Generators* this is at its *connection point*, this is not true for all.

AEMO determines to amend the SCADA Estimated Power definition to add "This should align with the measurement point of the SCADA Active Power signal."

Forecast or estimate?

In response to comments that "forecast" may lead to confusion and the expectation that a wind forecast must be incorporated, AEMO agrees to change "forecast" to "estimate". AEMO notes that wind farms may wish in future to include a wind forecast in their calculation of SCADA Estimated Power to increase its accuracy, but this is not mandated by this definition.

Connection assets included or excluded?

On the question of whether connection asset limits should be included or excluded from SCADA Estimated Power, AEMO's view is that this is effectively an implementation decision given that the results is the lower of SCADA Estimated Power and SCADA Local Limit, and until the implementation details, both by the Generators and AEMO are determined, a flexible definition is most appropriate. A flexible definition also gives scope for configuring hybrid systems as needed when these arise. In response to the **CEC's** comment that the definition should say what is excluded not what is included, AEMO considers that "generation and connection assets" is sufficiently wide to describe the equipment behind the connection point that affects production. While AEMO acknowledges the comments on the duplication of the information in the SCADA Local Limit signal, AEMO does not want to define the split between SCADA Local Limit and SCADA Estimated Power at this early stage of development of the signal implementation by OEMs. AEMO sees that even with an all-inclusive SCADA Estimated Power that the SCADA Local Limit signal has value in its own right in informing the AWEFS forecast used for validation of the SCADA Estimated Power.

AEMO determines to amend the SCADA Estimated Power definition to add the phrase "Limits already communicated through the SCADA Local Limit signal may be excluded".

How is accuracy of SCADA Estimated Power determined?

In response to **Infigen**'s request for more detail on how accuracy would be determined, AEMO notes that AWEFS provides a baseline accuracy and that sufficient accuracy would be an improvement over this in ordinary operation and in specific situations such as cut-out events. AEMO intends to carry out at least an initial assessment of accuracy for each wind farm and ongoing validation of the SCADA data. In response to the **CEC**'s assertion that AEMO should not have the discretion to reject estimates provided by participants and that market forces should drive accuracy, AEMO agrees that there are market incentives for accuracy, but notes that the signals provided effectively feed directly into the dispatch system from SCADA, and that AEMO is responsible for ensuring the integrity of the dispatch system, which includes the need to perform some level of validation on the input data from SCADA. This validation may involve comparison with the

outputs of AWEFS, as suggested by the **AER**. The validation process will be developed in discussion with stakeholders as the implementation details are worked through.

In response to the **Joint industry response**, AEMO agrees that a global standard for a SCADA Estimated Power-type signal could give a more effective means for reliable implementation and consistent accuracy. AEMO understands that the accuracy and complexity of the implementation will evolve, but suggests that the lack of modelling currently of wind sector management in candidate SCADA Estimated Power calculations, as indicated in the **Joint industry response**, would have a material impact to many of the more complex farms and suggests its implementation be investigated early on.

4.5.3 AEMO's conclusion

AEMO determines the optional SCADA Estimated Power signal will be added to the Wind and Solar ECM Guidelines as defined below.

Optional provision by new and existing Semi-Scheduled Generators in respect of their semi-scheduled generating units – Wind and Solar

SCADA Estimated Power

SCADA Estimated Power is the Generator's estimate in MW of active power at the end of the next dispatch interval, subject only to technical factors affecting operation of its generation and connection assets. This should align with the measurement point of the SCADA Active Power signal.

Limits already communicated through the SCADA Local Limit signal may be excluded.

SCADA Estimated Power should be calculated assuming that no *distribution* or *transmission network* constraints apply to the next dispatch interval, and may assume that other limits managed by AEMO through the central dispatch process do not apply to the next dispatch interval.

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

Implementation of this parameter is dependent on AEMO being satisfied that its accuracy and implementation concerns are addressed. AEMO will then issue a market notice to this effect and post it on its website.

After implementation, AEMO will retain discretion to reject SCADA Estimated Power data that does not pass its initial and ongoing validation and accuracy assessment.

4.6 Management of "by agreement with AEMO" items

4.6.1 Issue summary and submissions

Several items in the ECM Guidelines include the qualifier "by agreement with AEMO".

Musselroe's submission commented that while this was useful for existing operators, it could give ambiguity as new wind farms register, as there will not be historical data for consideration, relevant for the SCADA Turbines Extreme Wind Cut-out signal.

4.6.2 AEMO's assessment

AEMO agrees that the primary reason for the "by agreement with AEMO" statements is to prevent unjustified retro-fitting expense. AEMO notes there is a need to assess new farms without access to historical SCADA data. On the specific topic of SCADA Turbines Extreme Wind Cut-out, AEMO notes that it is optional in this final determination.

4.6.3 AEMO's conclusion

AEMO will publish a document providing guidance on the issues that AEMO would consider under a "by agreement with AEMO" qualifier, ensuring that lack of historical SCADA data does not prevent a fair assessment for new farms.

4.7 Participation in FCAS

4.7.1 Issue summary and submissions

In response to submissions expressing interest in participation in FCAS markets, in the Second Draft Report and Determination AEMO noted upcoming reviews of Causer Pays and the Market Ancillary Services Specification.

In the third round of submissions, **Musselroe** strongly welcomed these reviews. **AGL** and the **Joint industry response** noted that SCADA Estimated Power has the potential to enable participation by wind and solar farms in the FCAS market.

4.7.2 AEMO's assessment

AEMO notes the interest in participation by *Semi-Scheduled Generators* in FCAS markets.

4.7.3 AEMO's conclusion

On 28 October AEMO initiated a consultation on the Causer Pays Procedure to address specific issues AEMO needs to address following the conclusion of a dispute. The dispute determination requires these changes to be implemented by 3 March 2017, to meet this timeframe AEMO is focussing the consultation on the issues raised in the dispute only.

To address broader stakeholder concerns AEMO intends to now conduct the broader consultation on the causer pays procedure, commencing with the publication of an Issues Paper on 2 December 2016.

AEMO will commence a consultation on the MASS, with a planned start date in January 2017. As part of the consultation AEMO will consider the compatibility of the MASS with technologies not traditionally associated with providing FCAS, including wind power.

4.8 Transparency and bidding of availability

4.8.1 Issue summary and submissions

In the first and second stage of submissions several submissions noted support for increased transparency of Semi-Scheduled Generator operations and for the addition of the ability for Semi-Scheduled Generators to bid their availability directly, similar to Scheduled Generators.

AEMO concluded that while outside the scope of this determination, AEMO intends to investigate measures to increase the transparency of *Semi-Scheduled Generator* operations, specifically the possibility of *Semi-Scheduled Generators* bidding their availability for Dispatch and Predispatch through NEMDE as well as potential improvements to the useability of the EMMS Portal for Intermittent Generation for PASA.

In the third stage of submissions, the **AER** and **Pacific Hydro** expressed support for these investigations, with **Pacific Hydro** encouraging consideration of automated availability bidding via SCADA.

Musselroe suggested that when the AEMO control room needs to revert the AWEFS forecast to a persistence forecast that this should be flagged to the affected participant in the MMS or SCADA.

Musselroe also asked that AEMO publish all AWEFS/ASEFS input data to improve participant understanding and market transparency.

4.8.2 AEMO's assessment

AEMO notes the support for the investigations into the bidding of availability and the useability of the EMMS Portal for Intermittent Generation.

AEMO understands that it could be beneficial for the participant to be automatically notified when the AWEFS forecast is reverted to a persistence forecast and intends to investigate this further.

On the publishing of input data to AWEFS/ASEFS (which AEMO understands to mean SCADA inputs), AEMO intends to investigate the value of publishing this data in terms of market transparency, noting that this data is currently protected information.

4.8.3 AEMO's conclusion

While outside the scope of this determination, AEMO intends to investigate measures to increase the transparency and efficiency of *Semi-Scheduled Generator* operations in the market, specifically the possibility of *Semi-Scheduled Generators* bidding their availability for Dispatch and Predispatch through NEMDE as well as potential improvements to the useability of the EMMS Portal for Intermittent Generation for PASA.

AEMO will investigate improving the notification of the event where the AWEFS dispatch forecast is reverted to a persistence forecast, and will investigate the value and feasibility of publishing SCADA inputs to AWEFS/ASEFS in terms of market transparency.

5 Other matters

AEMO will adopt all amendments to the ECM Guidelines not further discussed in this report as published in the Second Draft Determination and Report.

Appendix A - Glossary

TERM OR ACRONYM	MEANING
AEMO	Australian Energy Market Operator ABN 94 072 010 327
AWEFS	Australian Wind Energy Forecasting System
ASEFS1	Australian Solar Energy Forecasting System Phase 1
FCAS	Frequency Control Ancillary Services
MMS	AEMO's Market Management System
OEM	Original Equipment Manufacturer
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.	AER	"We support the further work AEMO and market participants have undertaken to identify improvements to the accuracy of Australian Wind Energy Forecasting System (AWEFS) forecasts, outputs of which are used in the calculation to determine dispatch targets. We support the further work AEMO and other participants have undertaken in relation to the inclusion of the 'SCADA Estimated Power' parameter as a potential replacement of the AWEFS dispatch forecast."	Support noted.
2.	AER	"We acknowledge AEMO's response to our submission on the First Draft Report and Determination, including: • adding the word "technical" to the first sentence of the SCADA Local Limit definition, in response to the AER's submission that it should be a technical parameter • indicating AEMO's intention to investigate the possibility of Semi-Scheduled Generators bidding their availability for Dispatch and Predipatch through NEMDE as well as potential improvements to the useability of the EMMS Portal for Intermittent Generation for PASA, thereby providing transparent commercial information to the market."	Noted in S4.1.1 Addressed in S4.8.2
3.	AER	"We consider that the comprehensive inputs from across the wind farm should ensure that the SCADA Estimated Power parameter accurately represents the wind farm's performance."	Noted in S4.5.1
4.	AER	"As per the 'SCADA Local Limit' definition, we consider that this should be a technical parameter only."	Noted in S4.5.1
5.	AER	"To this end we note AEMO's inclusion in the definition of SCADA Estimated Power that it is 'subject only to technical factors affecting operation of its generation and connection assets'."	Addressed in S4.5.3
6.	AER	"We agree that the submitted data should be well scrutinised and compared to the outputs from AWEFS."	Addressed in S4.5.2
7.	AGL	"AGL supports AEMO's third stage consultation in recognition of substantial discussions on various issues raised in second stage consultation, particularly on the determination not to include Optional Possible Power in the the revision of ECM. AGL acknowledges that there were key issues relating to Possible Power that might not have been apparent during AEMO's deliberation of second stage consultation. AGL understands that further information and clarifications provided to AEMO since had suggested the inclusion of "Estimated Power" in the ECM should be re-considered."	Support noted

8.	AGL	"AGL supports the inclusion of Estimated Power in the ECM for the following reasons: • It has the potential to improve the accuracy in setting the dispatch targets that will closely align with near-real time operating conditions at the wind and solar farms; • Higher accuracy in estimates is essential in minimising the risk of scheduling and FCAS errors resulting in a more efficient dispatch and market outcome; • Over time, it has the potential to enable the wind and solar farms to participate in FCAS market."	First two dot points have been addressed in previous reports. Addressed in S4.7.2
9.	AGL	"AGL would support the name "Estimated Power". AGL understands that there are other current names used specifically by various operators or manufacturers for different purposes, which may encompass elements relevant to Estimate Power. It is important that the new signal name must not share with any existing names to ensure clarity and precise interpretation by all participants."	Noted in S4.5.1
10.	AGL	"In addition, the intention of the signal is to essentially provide AEMO the most likely output a wind or solar plant can produce based on the near-real time available information from the operation at the site. That is, it is not strictly a forecast in the usual meaning of the word, but an estimate of the physical and operational ability of the plant to send out generation to the grid. Such an estimate is already provided by a schedule generator as dispatch "availability" based on relatively predictable fuel source and energy conversion production process."	Addressed in S4.5.2
11.	AGL	"AGL considers the limit that may be imposed by the connection asset (by definition, behind the connection point) should be separated from Estimated Power. The limit imposed by Connection Asset would be provided to AEMO through the proposed "Local Limit" in this consultation. This distinction is important as Estimated Power represents what the plant (ie the turbines, the control systems, electrical equipment and devices etc) can deliver to the connection point via the electrical equipment (connection assets) that connects the plant to the connection point. In other words, conceptually, the plant is the generation equipment and the connection assets is the 2 transmission equipment that deliver the plant's estimated output to the connection point. The Estimated Power is an estimate of the output from the generation equipment."	Addressed in S4.5.2
12.	AGL	"AGL would support the one signal approach. As discussed in item 2 above, the Estimated Power allows AEMO to know with reasonable certainty what the generation plant can produce at the end of the 5 minute dispatch interval. By combining this estimate and the Local Limit SCADA signal (which represents limits that may be imposed by the balance of the entire wind farm facilities up to the connection point/interface with the grid), AEMO will be able to decide what the dispatch targets should be, taking into account any other limits external to the wind that may be imposed by the networks and market."	Addressed in S4.5.1
13.	AGL	"AGL is of the view that if the Estimated Power is adopted, it should not be necessary to use the the ramp rate to determine the ramp up or down of power over the 5 minute dispatch interval. The intention is that when the Estimated Power is determined, it will take into account various states of each turbine so that any potential increase or decrease of output that would be known to the control system. These changes woud take into account all the units that are capable of producing power and the time it will take each turbine to produce those power (that is, those generating and paused). The power control system would have access to data for each turbine on known delays, brake program, re-set or start up times etc that will impact on the rate at which a turbine will be able to generate the power. AGL consider that this in-depth knowledge of the behaviour of turbine would be more robust and reliable in estimating the potential power output than a single ramp rate applied across the entire cluster of turbines at the site."	Addressed in S4.5.1

14.	AGL	"AGL considers the following changes to be necessary: a. Replace "forecast" with "estimate". While "forecast" could be taken to be a form of "estimate", AGL is concerned that it can be associated with a predictive quality that may be associated with a high degree of statistical variability. AGL considers that Estimated Power would be computed through established wind, electrical and mechanical engineering principles grounded on mathematical algorithms of how much electricity each turbine and group of turbines is able to produce and be transmitted to the connection point. This calculation process produces a physical quantity that can be executed with a reasonable level of accuracy over a short duration subject to a given scope of variables. AGL considers "estimate" to be a better representation of the quantity than "forecast" as the quantity can be calculated based on robust physical principles.	Addressed in S4.5.2
15.	AGL	"Remove "connection assets". Please refer to AGL's response to item 2. As a way of further explanation, connection assets usually consist of private transmission line(s) and transformer(s)/switch yard(s) that serve to transmit the electricity from the generation plant to a jointly defined interface with the grid that constitutes the connection point.	Addressed in S4.5.2
16.	AGL	"Insert "at the connection point" after "active power". This is important as the "connection point" is a critical point of reference in AEMO settlement, metering regulations, connection agreement with the networks, and the AEMO power system and security modelling. It is also important in delineating factors that the generator would consider in calculating the Estimated Power and those that are that are in the domain of the networks.	Addressed in S4.5.2
17.	AGL	"Proposed changes to the first paragraph of the definition is thus: SCADA Estimated Power is the Generator's estimate in MW of active power at the connection point at the end of the next dispatch interval, subject to only technical factors affecting operation of its generation."	Addressed via two points above.
18.	AGL	AGL welcomes AEMO's approach in implementation that involves validation on the accuracy of Estimated Power and exploring the possible issues and solutions to ensure an effective set up and usage of Estimated Power as intended.	Support noted
19.	AGL	AGL supports the notion that if Estimated Power is provided that specifically takes into account the effect of extreme wind cut out conditions, it is unlikely that the Extreme Wind Cut Out count as requested in this consultation would add any further value. AGL notes that while it may be possible in a long run to expand and include prediction of the wind conditions over the next 5 minutes, it would initially be focussed on the instantaneous wind condition (speed and direction), which could include the extreme wind cut out factors.	Addressed in S4.3.2
20.	CEC	"We welcome AEMO's proposed changes as set out in the consultation paper. The main focus of this submission is on matters in relation to the proposed "SCADA Estimated Power" and the definition of this parameter."	Support noted
21.	CEC	"Firstly, we question AEMO's perception of the accuracy of this approach. On one hand the existing reliance on AWEFS has introduced systemic errors that imposes increased unavoidable costs onto wind farms. On the other the introduction of the new "SCADA Estimated Power" signal provides these participants with a means to manage their risks by reducing the impact of such errors. These participants have an incentive to improve over AWEFS, and would be penalised by higher causer-pays charges where they do otherwise. Our view is that improvements in dispatch accuracy would be aligned to the efficient decisions of these participants therefore AEMO's concerns about accuracy are not significant."	Addressed in S4.5.2
22.	CEC	"Given this we also disagree that AEMO should be provided with the discretion to reject estimates provided by participants. AEMO has the capacity to demonstrate to a participant that it could be receiving lower causer pays charges, but the risk and costs associated with inaccuracy lies with the participant, not AEMO."	Addressed in S4.5.2

23.	CEC	"Placing an upper limitation on the data to the maximum of the nameplate rating and the maximum capacity is also redundant as a result of the above"	The limitation is for identification of erroneous SCADA operation. Existing EMMS processes would reject any value above Maximum Capacity.
24.	CEC	"Market forces should drive accuracy in these estimates. Participants that are not confident that they can deliver a better outcome will have the option to rely on AWEFS as an alternative."	Addressed in S4.5.2.
25.	CEC	"Secondly, we have concerns about the reference to "SCADA Estimated Power" being a forecast. The definition should be careful to not confuse wind forecasting with the other parameters affecting the estimated generation. Referring to this data as a forecast could be read to imply that a wind farm operator would need to implement its own wind energy forecasting system. This creates unnecessary confusion."	Addressed in S4.5.2
26.	CEC	"Thirdly, given that there are many potential influences on a generator's output behind the connection point it may be best to restrict specific aspects of the definition to the factors that it excludes."	Addressed in S4.5.2
27.	CEC	"Given the above our discussions with members had identified a preferred definition: "SCADA Estimated Power" is the estimated output of a semi-scheduled plant's active power in MW to be delivered from its connection point at the end of the next dispatch interval, excluding constraints imposed by AEMO, a DNSP or a TNSP."	Addressed in S4.5.2 Definition in S4.5.3
28.	CEC	"As clear from the proposed definition "SCADA Estimated Power" should be permitted to incorporate any factor behind the generator's connection point affecting production at the end of the next dispatch interval. This would naturally include connection, or any other assets that may be coming into or out of service in the coming dispatch interval."	Addressed in S4.5.2
29.	CEC	"Also, the data point is an estimate of production in the coming period. Ramp rates and dynamic changes over the dispatch interval are therefore implicit so including this as a separate data point may be unnecessary."	Noted in S4.5.1
30.	Infigen	"Infigen Energy supports the implementation of the SCADA Local Limit and changes to the definition of SCADA Wind Speed – Farm Level definition."	Support noted
31.	Infigen	"Infigen Energy agrees that the SCADA Local Limit should only reflect technical limitations on the park and as such agrees with the introduction of this to the definition of the SCADA Local Limit."	Noted in S4.1.1
32.	Infigen	"Infigen Energy believes that this [SCADA signal: Turbines Extreme Wind Cut-out] adds undue burden to wind farm generators by requiring the creation of a data point that will offer little benefit. The information captured by this point looks at the turbine status for two very particular event codes and doesn't look at the event codes for other ambient condition stops and would only provide information once the high wind stops occur."	Addressed in S4.3.2
33.	Infigen	"This signal comes with a proposed change to the definition of SCADA Turbines Available. The combination of this change with the SCADA Turbines in Extreme Wind Cut-out would mean this information was sent to AEMO through two different signals. Infigen believes this requirement is unnecessary and the update of SCADA Available Turbines in conjunction with a tested and validated SCADA Estimated Power signal would provide a more efficient and accurate dispatch. Infigen Energy believes the definition of Available Turbines should be reviewed, but agrees with the amended version."	Addressed in S4.3.2. Support for review of Available Turbines noted in S4.4.1.

34.	Infigen	"Infigen has no issue with the name Estimated Power and believes it adequately reflects the definition of the set point. Infigen Energy agrees with the level of detail in this definition. The definition gives a clear description of the expectation of the data point without defining exactly how it should be calculated (as this may vary from participant to participant). Individual turbine level data and information would be captured within the SCADA Estimated Power which would provide a much more accurate power estimation than a value derived from average site wind speed used in AWEFS, for example."	Support noted in S4.5.1
35.	Infigen	"Infigen Energy believes that the SCADA Estimated Power signal should be a representative estimate of what the wind turbines will be able to produce in the next dispatch interval and as such should not include limits on the connection assets, as this is separate to the turbines capability and will already be reflected within the SCADA Local Limit."	Addressed in S4.5.2
36.	Infigen	"The two data signals should remain separate as they provide different information and the UIGF will be based on the lower of the two."	Addressed in S4.5.2
37.	Infigen	"One signal is enough, there is no need for a second signal if the Estimated Power signal is working effectively. A dynamic rate of change signal may only reduce the accuracy of the dispatch forecast."	Noted in S4.5.1
38.	Infigen	"The "Estimated Power" value should take into account the wind farms actual ability to achieve the setpoint at the end of the dispatch interval, in other words, should theoretically take into account the technical ramp rate of the park at any given time and in changing conditions. We expect that the "Estimated Power" would interact with bid ramp rate in the same way UIGF does. Infigen Energy has no concern with the interaction between the "Estimated Power" value and the exisiting ramp rate bid."	Noted in S4.5.1
39.	Infigen	"The "Estimate Power" signal's purpose is to provide an accurate estimate to AEMO, to complement the estimate obtained by AWEFS and therefore be fed into NEMDE for dispatch determination. AWEFS is not a dispatch engine, nor does Estimate Power propose to replace the dispatch target."	Noted in S4.5.1 as no concern with interaction between ramp-rates.
40.	Infigen	"Infigen Energy would query what level of accuracy is adequate and how this would be determined. AEMO state that it would retain the ability to reject data that does not pass its initial and ongoing validation and accuracy assessment. Infigen request clarification regarding whether this pertains to the initial adequacy assessment? Or would the data point be subject to a "data quality" test, potentially similar to the data test outlined in earlier consultation stages for the SCADA Local Limit?"	Addressed in S4.5.2
41.	Infigen	"Infigen Energy believes it would be important to ensure that the accuracy of the SCADA Estimated Power signal is maintained over time however requests further clarification from AEMO regarding this point."	Addressed in S4.5.2
42.	Infigen	"Infigen Energy is largely supportive of the amendments make in the third stage of consultation."	Support noted.
43.	Infigen	"Infigen does not agree with the implementation of the SCADA Extreme Wind Cut Out signal as this and more information can be more efficiently captured with the proposed SCADA Estimated Power and the possible revision to the Turbines Available data point."	Addressed in S4.3.2
44.	Infigen	"Infigen views the addition of another signal regarding solely wind related turbine stops as an unneccessy requirement."	Addressed in S4.3.2
45.	Infigen	"Infigen Energy fully supports the development of the SCADA Estimated Power signal."	Support noted.
46.	Infigen	"Infigen acknowledges that this may be a many staged process requiring review and validation steps and is eager to continue to work with AEMO, industry participants and OEMs on this data point."	Support for future work noted

47.	Musselroe	Further to our comments in Stage 1 and 2, we do not intend to re-visit the following areas as these matters appear satisfactorily settled: • SCADA Local Limits; • Maximum Capacity Limits; and • Wind speed source definitions	Noted
48.	Musselroe	We support the comments and modifications noted by AEMO (and others) in respect of the following issues: • The AER's comments on use of SCADA data for technical limits and bidding information for commercial changes; • Strongly welcome AEMO review of CPF and reviewing inclusion of wind into MASS; • That AEMO will investigate bidding of availability to further improve the accuracy of dispatch and pre-dispatch; • That AEMO will work to ensure all appropriate transmission and distribution level constraints and run-back schemes are applied in NEMDE as required (particularly on the Norwood to Scottsdale line for MRWF); and The agreement by AEMO to further understand the benefits of estimated power.	Support noted
49.	Musselroe	Additional semi-scheduled information needs to be published: At present, when issues are identified with AWEFS in the control room and AWEFS is turned off (i.e. persistence forecasting is used), this should be flagged in MMS data or communicated to the participant via SCADA data. Similarly, while UIGF continues to be used in dispatch, all the input data used by AWEFS/ASEFS should be published and publicly accessible. This improves understanding for the participant and market transparency.	Addressed in S4.8.2
50.	Musselroe	Use of the term 'By agreement with AEMO': There appears to be several areas where the term 'by agreement with AEMO' is used, and whilst recognising this is useful to assist existing operators where changes may be made to arrangements, it will likely result in ambiguity as new wind farms register in the NEM in the coming years. For instance, the optionality of providing an extreme wind cut-out signal will have no historical basis for AEMO consideration, hence will just be required of new entrants, thereby effectively removing any optionality and due consideration.	Addressed in S4.6.2
51.	Musselroe	[Agree with the name 'Estimated Power'?] "Yes. Although the industry typically uses terms such as Possible Power and Capable Power, these are SCADA reserved terms and reflect live conditions. The intention of this new term, in the short-medium term, is to reflect the capability of the plant is likely to be at the end of the next dispatch interval, approx. 6-7 minutes into the future. Therefore, perhaps additional wording can be used such as "..forecast in MW of active power at the sampled point and used to estimate the next dispatch interval subject only to ..". We consider this term could also be used across scheduled generation to help improve dispatch security, hence see the term and definition as technology agnostic."	Noted in S4.5.1 Addressed in S4.5.2 and S4.5.3
52.	Musselroe	[Should limits on connection assets be included or excluded?] "Excluded. The market operates on a gross pool arrangement whereby dispatch is optimised at the generator terminals, with revenue based on net metering. As additional hybrid generation solutions with batteries begin to be implemented, it is important to understand what is happening 'behind' the point of connection. Where additional connection assets are impacting dispatch, they will either need to be considered through network constraint equations, bid parameters, local limit or expected power."	Addressed in S4.5.2

53.	Musselroe	[Is there a need for a second signal such as a dynamic rate of change?] "Given most scheduled generation send the plants dynamic rate of change, we see some merit in considering this value, especially since the rate of change can be very significant across large wind farms and especially once control set points are occurring around turbine minimum generation levels (for MRWF, approx. 25% WTG capacity). We see this as important for the determination of the dispatch target, as opposed to Availability as noted in item 4) below. To that end, application of the minimum rate of change for the farm of either the dynamic value or bid ramp rate seems appropriate." [Referring to Figures 1 and 2 in the Musselroe Submission] However, as is shown in the following diagrams, the very nature of the expected power value being proposed, even as a pure SCADA value without consideration for where the plant will be at the end of the next dispatch interval, includes dynamic consideration of rates of change. Therefore, we do not consider the dynamic ramp rate will add any additional benefit compared with the implementation of the expected power."	Addressed in S4.5.1
54.	Musselroe	[Referring to Figures 1 and 2 in the Musselroe Submission Form] "Figure 1 (low wind) and Figure 2 (high wind) show close approximations of expected power as defined in this consultation, for two days where light and moderate wind conditions were experienced. The data in these Figures are 1 second data matched with 5-minute market data on days that have been identified as highlighting interesting results. Using the preliminary definitions from the consultation paper, we have replicated the value that would be snapped by NEMDE if the Expected Power was being sent to AEMO approx. two minutes before the commencement of the dispatch intervals – this is shown on the graphs as 'EP(Mod)@datasnap'. The blue arrows indicate significant differences between UIGF, Expected Power and EP(Mod)@datasnap. Figure 2 also highlights a period where a local limit (CBAC) was present (but no SDC), during high wind conditions with movement in operating turbines. It can be seen that the Expected Power values were clearly indicating unconstrained generation values. In both Figures, the differential between the UIGF and the actual generation is significant and would be contributing to increased regulation requirements across the region."	AEMO thanks Musselroe for this illustration and will continue to work with Musselroe on the development of the Estimated Power signal.
55.	Musselroe	[Interaction between the "Estimated Power" value and bid ramp rate?] "Yes, Estimated Power adequately conveys the ramp capability inclusive of rate of change and we contend if sampling is improved along with bidding this should satisfactorily cover all requirements. Given the estimated power will effectively be the Availability of the wind/solar plant, and the bid ramp rate should only affect the dispatch target, we see no issue with the interaction between the two."	Addressed in S4.5.1
56.	Musselroe	"A scheduled generator, at present and appropriately, can bid a unit out of service by bidding the available MW's to 0MW from as high as 750MW (for example) in one dispatch interval, yet maintain the integrity of the rate of change limits through its dispatch targets with NEMDE managing dispatch accordingly. Unless we are mistaken, NEMDE does not recognise the difference between semi-scheduled generation and scheduled generation, hence NEMDE should operate in a similar manner."	Addressed in S4.5.1
57.	Musselroe	[Do you agree with the level of detail in the definition?] "The definition is prescriptive enough to ensure understanding and yet retains the ability for the OEM to produce a number to suit their control system setup. Further to point 1 above, if the only references to wind and solar were removed and replaced with 'generating system', this definition could be applied to scheduled generation, which we suggest makes this a reasonable definition. The use of this concept across all generation types may assist with enhanced dispatch accuracy, especially during plant run-ups/run-downs, where dispatch non-conformances appear anecdotally to occur more regularly than during steady operations."	Noted in S4.5.1. AEMO thanks Musselroe for the comment on all generation types, and has noted this, but notes it is out of scope for this consultation.

58.	Musselroe	"The focus on ambient temperatures, while understandable, will be complicated, as it is generally the individual equipment operating temperatures of varying values, as influenced by ambient temperature changes, that will determine whether limits will be reached."	Addressed in S4.4.2
59.	Musselroe	"Whilst we understand AEMO's intention to investigate future turbines available, we would encourage consultation with the OEM's and participants to explore a forecast MW value."	Noted in S4.4.1. AEMO is exploring a forecast MW value and addresses in S4.4.2 a reason for a future turbines available signal.
60.	Musselroe	"Again, the expected power value (and forecast mechanism that is yet to be developed) would take all climatic factors into consideration."	AEMO agrees
61.	Pac Hydro	"In Pacific Hydro's second stage submission it was highlighted that the proposed "Estimated Power" signal would provide better information than an extreme wind speed cut-out signal. Pacific Hydro's opinion has not changed."	Addressed in S4.3.2
62.	Pac Hydro	"Pacific Hydro welcomes AEMO's position that a sampling frequency for wind speed less than or equal to ten seconds is acceptable."	Addressed in S4.2.2
63.	Pac Hydro	"Estimated power appears to sufficiently capture the nature of the signal. Pacific Hydro believes that the current definition for estimated power as opposed to an overly restrictive definition allows scope for future improvement of the signal without the requirement for further ECM consultations. The current definition gives adequate degrees of freedom to implement estimates that account for the differences between turbine manufacturers. By explicitly defining the estimated power value as the active power at the end of the next dispatch interval, it removes any doubt from implementations as to what the signal should take into account."	Addressed in S4.5.2
64.	Pac Hydro	"Connection asset limitations are implicitly included in the Estimated Power definition. Pacific Hydro believes this is the correct approach, as the intent of the signal is to provide an estimation of active power output at the end of the next dispatch interval."	Addressed in S4.5.2
65.	Pac Hydro	"It is not clear how a dynamic rate of change signal will be sufficient to describe the non-linearities involved in ramping wind generators. A wind turbine that is presently synchronising to the grid may achieve full power output within a dispatch interval, but will not achieve this linearly across a five minute dispatch interval."	Addressed in S4.5.1
66.	Pac Hydro	"Pacific Hydro believes that a second signal indicating unconstrained power similar to a UIGF, or an Estimated Power signal for a pre-dispatch interval (DI+2 as opposed to DI+1) may prove beneficial to dispatch and pre-dispatch outcomes. If a DI+2 solution were pursued over a wind farm provided "UIGF" better dispatch outcomes may result, but it would be a more expensive solution."	Addressed in S4.5.1
67.	Pac Hydro	"As outlined in 3, a wind farm is not always capable of maintaining a linear ramp rate."	Addressed in S4.5.1
68.	Pac Hydro	"Additionally, the definition of estimated power includes the maximum ramp rate of the turbines within its definition. By definition the estimated power signal accounts for the predicted available power at the end of the next dispatch interval, and thus ramp rate."	Noted in S4.5.1
69.	Pac Hydro	"Pacific Hydro does not have any concerns about the interaction between the proposed Estimated Power signal and the existing bid of ramp rate. A second signal would help improve visibility of wind farm behaviour."	Addressed in S4.5.1
70.	Pac Hydro	"Any improvements to the usability of the EMMS portal or bidding systems are encouraged."	Addressed in S4.8.2
71.	Pac Hydro	"Thought should be given as to automated availability bidding via SCADA as wind farm availability depends significantly on environmental conditions and maintenance."	Addressed in S4.8.2

72.	Joint Industry	"All the Operators support the option of sending a new SCADA signal to AEMO that will provide "an estimated active power output of the Plant at the connection point at the end of a 5-minute dispatch interval" (EP)"	Support noted
73.	Joint Industry	"Majority of the OEMs are of the view that it is possible to provide EP."	Noted
74.	Joint Industry	"OEMs' main concern centers on the degree of accuracy of EP and the allocation of risks associated with this estimate."	Noted. AEMO notes continuing engagement with stakeholders on the topic of accuracy.
75.	Joint Industry	"This discussion is considered as preliminary, more details on how EP can be and should be calculated will need to be explored, discussed and clarified further between the OEMs and the Operators."	Noted
76.	Joint Industry	"Some OEMs suggest that it could be feasible to use the current capability of the Plants (with or without modifications) to provide EP depending on what an "acceptable" estimate is."	Noted
77.	Joint Industry	"There is a general understanding that the provision of EP should be optional to give the Operators and OEMs some time to work through the details and arrangements."	The SCADA Estimated Power item is optional in the ECM Guidelines.
78.	Joint Industry	"It was noted that AEMO was keen for the industry to provide further guidance on the definition of EP as part of its deliberation on the inclusion of a new optional signal in the current Energy Conversion Model (ECM) consultation."	AEMO thanks the industry for your input.
79.	Joint Industry	"Operators expressed their support for the inclusion of EP in the ECM as follows: Improvements in the setting of dispatch targets will minimise their exposure to trading losses due to causer pay factor contributions, scheduling errors, avoided lost production and renewable energy certificates (RECs);"	Noted
80.	Joint Industry	"Maturing of wind farm technology and operation offers the opportunity to operate the Plants closer to the mode of other types of generation technology;"	Noted
81.	Joint Industry	"Provides an opportunity for Plants to participate in the provision of FCAS in the future;"	Noted in S4.7.1
82.	Joint Industry	"Offers a starting point for on-going improvement in the method of estimates over time as more and more Plants gain experience and feedback from the initial trials; and"	Noted. AEMO will continue to work with industry as this capability develops.
83.	Joint Industry	"Optional approach would allow operators/OEMs to choose when they are ready to commence pre-production trial period with AEMO to compare relative accuracies and establish suitable commercial arrangements for providing the new SCADA signal."	AEMO agrees.
84.	Joint Industry	"Some OEMs were generally comfortable with the idea of providing EP. However, they understandably expressed various concerns and sought clarifications, further considerations and consultations, which will take time."	Noted.

85.	Joint Industry	"Issues and questions raised and discussed by OEMs, Operators and industry representatives include: What would be the extent of variables or factors to be included in the estimates that could impact on the accuracy of EP? That is, "how far do we go"? An example would be whether the estimates would include the forecast of wind conditions, which would significantly increase the risk and complexity in providing such a calculation. One possible way of providing clarity and consistency, as an OEM suggested, is to confine the boundary of variables for EP to "operational look-ahead' of the wind turbines, taking account of the present and foreseeable changes in the operational states of the wind turbines. [Operators expressed the views that the initial stage of providing EP should be based on pragmatic considerations of what the current Plants capability could achieve and if it provides better estimates than those currently provided by AWEFS/ASEFS. Operators consider an effective approach to EP would be to start by focussing on variables that are within the control of the plant operation and control system. The Operators expect AEMO to provide a period of trial and investigations to validate the relative accuracies of the estimates before proceeding to dispatch production.]"	AEMO will engage with industry to ensure a feasible implementation approach and anticipates an increase in accuracy into the future with refinement of the implementations.
86.	Joint Industry	"Some OEMs indicate that currently the Plants are able to take into account some variables that can have significant impact on the EP including individual turbine status that are aggregated at the connection point as instantaneous power. [Footnote: This is variously termed "possible power", "expected power", "available power" and "capable power" by different OEMs which include turbines generating, turbines paused, may include high wind speed cut out, known delays, brake program, auto-reset, start up times etc.] One OEM suggests that instantaneous power would be pretty close to EP. However, the OEMs pointed out that this estimate does not specifically take into account possible changes to the conditions of the related variables over the following few minutes within the next 5-minute dispatch interval. Additionally, the OEMs also noted that the current estimate does not include other known factors that could have impact on the accuracy of the estimate, including externalities beyond the Plant operation and control system [Footnote: Factors like windfarm noise restrictions, wind sector management, wind turbulence are not included in current instantaneous power estimates]. [Operators expressed the views that the existing instantaneous power could be a proxy to EP as a start and may reasonably cover the necessary operating conditions at the Plants. Operators are cognisant of the fact that the refinement to include other possible factors and changes over the next few minutes could further improve accuracy. The Operators acknowledge that it would take some time to determine which of these possible refinements, if any, may be necessary to achieve an acceptable accuracy for the EP [Footnote: It is highly improbable that some externalities should be included in EP like the prediction of wind speed and wind direction conditions.]. The Operators consider that for some Plants, some of the current estimates are more than likely to provide greater granularities in local variables than AWEFS, and hence potentially more accurate estimates.]"	AEMO will engage with industry to ensure a feasible implementation approach and anticipates an increase in accuracy into the future with refinement of the implementations. Comment on Wind Sector Management noted in S4.5.2. Comment on forecasting of wind speed noted in S4.5.1 and addressed in S4.5.2.

87.	Joint Industry	"Some OEMs query if AWEFS/ASEFS (EFS) should be the tool to cover the EP and if an alternative would be for the Plants to provide all the required SCADA signals for AWEFS to process. [Operators expressed the views that AEMO is actively working on improving the accuracy of the current EFS including local limit, highly quality wind data and contemplating high wind cut out of turbines. Operators indicate that AEMO is required under the Rules to provide EFS as the forecasting tool and will continue to do so going forward. Operators consider that it is appropriate for EFS to provide longer time horizon forecast like MTPASA and STPASA. Operators consider that it is impractical for EFS to be the tool for a 5 minutes dispatch-able estimate without major changes, and that it would be better done at the Plant level. It would be too onerous and SCADA intensive for EFS to process and cover current and possible future variables. In addition, other scheduled generators are already providing similar "availability" estimates directly to AEMO in the dispatch time frame."	Noted in S4.4.1 and addressed in S4.4.2.
88.	Joint Industry	"Some OEMs are concerned about how the risk associated with providing EP would be allocated. A related query is how the required accuracy of the EP may potentially be regulated. As suggested by an OEM, in a long run, a globally consistent standard could possibility developed by the International Electrotechnical Commission (IEC). [Operators expressed the view that generally, the registered market participants would be responsible to AEMO and the Australian Energy Regulator (AER) on providing the EP to the market system and taking on the consequential risk associated with the provision of such market data. Operators indicated that this is no different from current arrangements between AEMO, OEMs and Operators in providing a range of Plant data. Operators indicated that each Operator would have different commercial drivers in deciding to provide EP. Operators consider that each Operator would have discussion down the track with OEMs on possible impact of providing EP SCADA signal through contractual negotiations."	Standard addressed in S4.5.2.
89.	Joint Industry	"Some OEMs indicated that EP is not a feature that is already available in other countries although some are moving towards shorter time forecast in Europe. As subsidiaries in Australia, some of the OEMs indicated that they will need to involve their parent companies overseas on whether and how a EP can be provided. [Operators expressed their view that they appreciate that not every OEM has, or will have, the capability of providing EP. Operators indicated that the lack of a robust EP is however materially impacting on the operation and commercial outcome for Operators, which is exacerbated and amplified by significant and increasing penetration of asynchronous Plants in the National Electricity Market. Operators suggested that the provision of EP would need to start somewhere, and as an optional signal, would allow AEMO and Operators to work with some OEMs who are able or willing to provide the signal.]"	Noted

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

See spreadsheets Energy_Conversion_Model_Guidelines_Wind_20161209.xlsx and Energy_Conversion_Model_Guidelines_Solar_20161209.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.