



Guide to Data Requirements for AWEFS and ASEFS

December 2018

Supplementary material to the Solar and Wind Energy Conversion Models

Important notice

PURPOSE

AEMO has prepared this document to provide information about the *Energy Conversion Model* data requirements for the Australian Wind Energy Forecasting System (AWEFS) and the Australian Solar Energy Forecasting System (ASEFS), as at the date of publication.

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VERSION CONTROL

Version	Release date	Changes
1.0	31/10/2018	Initial release
2.0	21/12/2018	Updated measurement point for Wind Direction SCADA signal following publication of the updated ECM Guidelines

Executive summary

This document details the intermittent generation (including wind and solar) data that AEMO requires to prepare the Australian Wind Energy Forecasting System (AWEFS) and the Australian Solar Energy Forecasting System (ASEFS) for new or existing wind and solar farms, respectively.

It supplements AEMO's *Energy Conversion Model (ECM)* Guidelines, which can be found on the AEMO website.

Under National Electricity Rules (NER) rule 3.7B(a)¹, AEMO is required to prepare forecasts of the available capacity of semi-scheduled generators to schedule sufficient generation in the Dispatch process. AEMO is also required to prepare an *Unconstrained Intermittent Generation Forecast (UIGF)*² to be used in PASA processes for reserve assessment purposes.

To meet these requirements:

- AWEFS was designed to produce wind generation forecasts for all semi-scheduled and non-scheduled wind farms for all market system processes (Dispatch, 5MPD, Pre-dispatch, Short term PASA, and Medium Term PASA).
- ASEFS was designed to produce solar generation forecasts for all semi-scheduled and significant non-scheduled solar farms for all market system processes.

¹ Refer to Appendix A1, Rules relating to AWEFS/ ASEFS modelling requirements.

² *Unconstrained Intermittent Generation Forecast (UIGF)* is the forecast generation output of individual semi-scheduled generating units (wind/ solar farms) without considering network limitations, economical decisions or the dispatch optimisation process.

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1. Data supply requirements

1.1 Intermittent generator and cluster standing data

All semi-scheduled generators (see National Electricity Rules (NER) clause 2.2.7(c)(2)) and some intermittent non-scheduled generators (NER clause 2.2.3(c)), connecting to the National Electricity Market (NEM) are required to submit³ to AEMO an ECM consisting of the intermittent generator details and attributes. The static data and dynamic measurements provided as part of the ECM assist AEMO in developing forecasting models for intermittent generators.

ECM validation is a mandatory step for all intermittent semi-scheduled generators (and some non-scheduled generators) before Registration in the NEM is approved by AEMO.

The following guidelines may assist in ensuring a satisfactory and timely validation of the ECM:

1. All data items identified as 'mandatory' need to be completed/provided. Incomplete data will result in delays with validation and approval.
2. The 'Cluster Definition Guideline'⁴ needs to be considered while grouping clusters.
3. The ECM should contain a separate 'ECM Cluster' tab for each cluster.

ECM validation is a time-consuming process, taking four to six weeks from the time of submission to AEMO. To avoid delays, AEMO recommends that the first draft of the ECM be submitted to AEMO at least three months before applying for Registration.

1.2 Wind farm SCADA to AEMO

Table 1 and Table 2 below list the remote monitoring (SCADA) parameters required for modelling wind farms in AWEFS. Table 1 outlines the farm level data requirements, while Table 2 outlines the cluster level requirements. Note that if the wind farm being modelled in AWEFS consists of only one cluster, then the information requested in Table 2 is redundant.

All SCADA data described in the following tables are expected to be instantaneous measures, unless otherwise agreed by AEMO. Instantaneous means the values are updated every 4 to 10 seconds, with 4 seconds or faster preferred. If only averages are available, a maximum 15 second update is required.

³ Energy Conversion Models can be submitted for validation via Op.forecasting@aemo.com.au.

⁴ 'Cluster Definition Guidelines' are provided in the solar ECM (introduction tab) and wind ECM (cluster definition guideline tab).

Table 1 SCADA parameters for modelling wind farms in AWEFS: Farm level

Signal	Unit	Measured from	Mandatory	Preferred deadband*	Decimal places
Wind Farm Active Power	MW	Dispatch Point**	Yes	0.01 MW	>=2
Control System Set-Point	MW	Dispatch Point**	Yes***	0.01 MW	>=2
Local Limit	MW	Dispatch Point**	Yes	0.01 MW	>=2
Possible Power	MW	Dispatch Point**	Optional	0.01 MW	>=2
Number of Wind Turbines Available for Generation	No.	Wind farm control system	Yes	1	0
Number of Wind Turbines Operating/ Actively Generating	No.	Wind farm control system	Yes	1	0
Wind Turbines Extreme Wind Cut-Out	No.	Wind farm control system	No	1	0
Wind Speed	m/s	Average of anemometers of all Turbine Nacelles	Yes	0.1 m/s	>=1
Wind Direction	° (degrees)	Average of anemometers of all Turbine Nacelles – average requires proper directional averaging (x-y decomposition)	Yes	1°	>=0
Ambient Temperature	°C	Weather sensor or met-mast.	Yes	0.1°C	>=1
Barometric Pressure	hPa	Weather sensor or met-mast.	No	1 hPa	>=0

* Minimum required deadband settings can be found in Table 3 of http://aemo.com.au/-/media/Files/Electricity/NEM/Network_Connections/Transmission-and-Distribution/AEMO-Standard-for-Power-System-Data-Communications.pdf.

** These signals must be referenced to the agreed dispatch point. All signals with ‘***’ must be referenced to the same location.

*** Following consultation in 2013: <http://www.aemo.com.au/Consultations/National-Electricity-Market/Open/Amendment-to-the-Energy-Conversion-Model-Guidelines>.

Table 2 SCADA parameters for modelling wind farms in AWEFS: cluster level*

Signal	Unit	Measured from	Mandatory	Preferred deadband	Decimal places
Cluster Active Power	MW	Wind farm control system	Yes	0.01 MW	>=2
Cluster Number of Wind Turbines Available for Generation	No.	Wind farm control system	Yes	1	0
Cluster Number of Wind Turbines Operating/ Actively Generating	No.	Wind farm control system	Yes	1	0

Signal	Unit	Measured from	Mandatory	Preferred deadband	Decimal places
Cluster Wind Turbines Extreme Wind Cut-Out	No.	Wind farm control system	No	1	0
Cluster Wind Speed	m/s	Average of anemometers of all Turbine Nacelles in this cluster	Yes	0.1 m/s	>=1
Cluster Wind Direction	° (degrees)	Average of anemometers of all Turbine Nacelles – average requires proper directional averaging (x-y decomposition)**	Yes	1°	>=0

*Note that if the wind farm being modelled in AWEFS consists of only one cluster, then cluster-level signals are not required.

** Example: https://en.wikipedia.org/wiki/Mean_of_circular_quantities.

1.3 Solar farm SCADA to AEMO

Table 3 and Table 4 below list the SCADA parameters required for modelling solar farms in ASEFS. Table 3 outlines the farm level data requirements, while Table 4 outlines the cluster level requirements. The cluster level requirements, in Table 4, should be provided for each cluster that comprises the solar farm.

All SCADA data described in the following tables are expected to be instantaneous measures, unless otherwise agreed by AEMO. Instantaneous means the values are updated every 4 to 10 seconds, with 4 seconds or faster preferred. If only averages are available, a maximum 15 second update is required.

Table 3 SCADA parameters for modelling solar farms in ASEFS: Farm level

Signal	Unit	Measured from	Mandatory	Preferred deadband	Decimal places
Solar Farm Active Power	MW	Dispatch point*	Yes	0.01 MW	>=2
Control System Set-Point	MW	Dispatch point*	Yes	0.01 MW	>=2
Local Limit	MW	Dispatch point*	Yes	0.01 MW	>=2
Possible Power	MW	Dispatch point*	No	0.01 MW	>=2
Wind Speed	m/s	Weather station or met-mast. To be representative of whole farm.	Yes	0.1 m/s	>=1
Wind Direction	° (degrees)	Weather station or met-mast. To be representative of whole farm.	Yes	1°	>=0
Ambient Temperature	°C	Weather sensor or met-mast. To be representative of whole farm.	Yes	0.1°C	>=1
Relative humidity	%	Weather sensor or met-mast. To be representative of whole farm.	Yes	0.1%	>=1

*These signals must be referenced to the agreed dispatch point. All signals with '**' must be referenced to the same location.

Table 4 SCADA parameters for modelling solar farms in ASEFS: cluster level

Signal	Unit	Measured from	Mandatory	Preferred deadband	Decimal places
Global horizontal irradiance	W/m ²	ISO first class pyranometer	Yes	1	>=0
Global inclined irradiance	W/m ²	ISO first class pyranometer	Yes	1	>=0
Direct normal irradiance	W/m ²	ISO first class pyranometer	Yes (CPV & CST only)	1	>=0
Module surface temperature	°C	Module temperature sensor. Should be an average of all modules in cluster.	Yes (PV & CPV only)	0.1°C	>=1
Module receiver surface temperature	°C	Module temperature sensor. Should be an average of all receivers in cluster	Yes (CST only)	0.1°C	>=1
Number of inverters available	No.	Solar farm control system	Yes	1	0
Reduction through soiling	%	Solar farm control system	Yes (CST only)	1	>=0
Actual tracking slope angle	° (degrees)	Solar farm control/tracking system	Yes (Solar farms with slope tracking technology)	0.1°	>=1
Actual tracking azimuth angle	° (degrees)	Solar farm control/tracking system	Yes (Solar farms with azimuth tracking technology)	0.1°	>=1
Tracking share of modules/ concentrators not on track	%	Solar farm control/tracking system	Yes (Solar farms with tracking technology)	0.1%	>=1
Trackers online	No.	Solar farm control/tracking system	No (Solar farms with tracking technology)	1	0

2. Cluster definition

A cluster is a group of intermittent generating units; there may be more than one cluster in an intermittent generator. When defining the number of clusters in an intermittent generating unit, the following guidelines should be noted.

Table 5 Cluster definition guidelines

Technology	Definition
Wind	<p>To define a "cluster" the ensemble of the following constraints should be satisfied:</p> <ul style="list-style-type: none"> • No more than 7 km x 7 km (with some degree of flexibility). • Only identical turbines are included in a cluster (turbines supplied by same manufacturer, having the same model, hub height and characteristic power curve). <p>The factors that are expected to affect the definition of such clusters are:</p> <ul style="list-style-type: none"> • Important changes in the terrain complexity throughout the area covered by the wind farm. • Changes in the meteorology due to the size of the area covered (presence of local patterns). • Physical separation of parts of the wind farm (considerable distance between groups of wind turbines). • Different timing in the development/commissioning of parts of the wind farm. • Different types of wind turbines in the wind farm (model, hub height). • More than one connection point to the grid.
Solar PV technology	<p>A cluster is defined as a subset of the Facility with:</p> <ul style="list-style-type: none"> • The same inverter type (manufacturer, model and rating). • The same module material (PolySi or CdTd or ...). • The same total module DC power connected to each inverter. Tolerance: +/- 2.5% from average. • The same fixed slope and azimuth angles of modules, if fixed. • The same tracking algorithm and ranges, if tracking. • Geographically close location of all modules (within an area up to 5km x 5km)
Solar CPV technology	<p>A cluster is defined as a subset of the Facility with:</p> <ul style="list-style-type: none"> • The same module type (manufacturer, model and material). • The same inverter type (manufacturer, model and rating). • The same number of modules connected to each inverter. • The same tracking algorithm and ranges. • The same concentrator attributes. • Geographically close location of all modules.
Solar CST technology	<p>A cluster is defined as a subset of the facility with:</p> <ul style="list-style-type: none"> • The same actual turbine(s). • The same tracking algorithm and ranges. • The same concentrator attributes. • Geographically close location of all modules.

3. Submitting data via the AEMO Portal

The AEMO Portal is used by intermittent generators to change their availability information (Upper MW Limit and Elements Unavailable) before the start of the relevant trading date (that is, prior to the start of the respective Pre-dispatch, STPASA, and MTPASA run), according to rule 3.7B(b).

Availability profiles can be updated as frequently as the change occurs, but not retrospectively for historical intervals. During commissioning, farms should update their availability profiles in both Pre-Production and Production environments in the MMS portal. Following commissioning completion, only the Production environment is required to be updated.

For information on accessing and using the AEMO Portal, please see the About Intermittent Generation document available on the AEMO website⁵ or via the help menu in the MMS portal⁶.

To facilitate intermittent generation forecast accuracy, the availability interface allows participants' operational staff to input the following information for intermittent generating units on a half-hourly resolution (for Pre-dispatch and STPASA timeframes) and a daily resolution (for MTPASA). Submissions of Upper MW Limit and Elements Unavailable have a minor effect on the Dispatch and 5-minute Pre-dispatch timeframe. Instead, the SCADA Local Limit, SCADA Control System Set-Point, and SCADA Turbines/Inverters Available should be used in these timeframes.

Upper MW Limit

The Upper MW Limit submission relates to the whole facility.

This input indicates when a facility is down regulated, as a MW limit is applied in the intermittent generator's control system, to limit its MW output to below maximum capacity. This MW limit is a result of planned and unplanned maintenance and should not include any transmission network or distribution network limitations according to rule 3.7B(c)(6).

The default value of -1 indicates that there is no availability limit in place.

Elements Unavailable

The Elements Unavailable value is required on a per cluster basis.

This input indicates the number of elements (turbines or inverters) within each cluster that are unavailable for generation (due, for example, to maintenance, turbines not being built, or the inability to generate because transmission or distribution networks are unavailable). Only enter the total number of unavailable elements in each cluster.

⁵ Available at http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/Solar-and-Wind/Guide-to-Intermittent-Generation.pdf.

⁶ Available at <https://portal.prod.nemnet.net.au> (production) and <https://portal.preprod.nemnet.net.au> (pre-production).

4. FAQs

Q1 What value should I provide for the SCADA signal to AEMO?

You should provide a range of possible values that fall within the valid range of the parameter, satisfying the deadband requirements specified in tables 1-4.

Q2 My intermittent generator contains 2 DUIDs. How many ECMs do I have to submit?

You should submit one ECM for each DUID in the facility being registered.

Q3 How many clusters should my farm have?

Refer to the 'Cluster Definition Guideline' tab in the ECM.

Q4 Is the ECM the same as the SCADA signals list sent to AEMO?

The ECM and SCADA signals list are separate items that must be submitted as part of the registration process for semi-scheduled intermittent generators. The ECM defines the SCADA signals required for intermittent generators to be used in AEMO's forecasting systems. These SCADA signals defined in the ECM should be included in an applicant's SCADA signals list following AEMO approving the ECM.

Q5 How long does it take for AEMO to develop the AWEFS/ASEFS forecasting model?

It takes AEMO three weeks to implement a forecasting model. This three-week process is scheduled after all ECM SCADA signals become 'good' quality and are working as expected.

Q6 When should I begin to update my farm's availability in the MMS Portal?

You should update the Energy Availability and MTPASA Availability in the Intermittent Generation section in the MMS portal following registration approval and IT access provision. Both Pre-Production and Production environments should be updated and reflect each other during the commissioning stage (hold point testing), otherwise only the Production environment is required.

Q7 How often should I update or submit my farm's availability in the MMS portal?

The MW Upper Limit and Elements Unavailable should reflect what is currently occurring at the farm, as seen in the farm's SCADA values, or what is planned to occur at the farm in the future (such as planned maintenance). The most recent submission for a trading day is brought forward each trading day until another submission is made. Therefore, submissions are not required to be repeated each day and are only required when there has been a change in the farm's availability. For this reason, it is important to submit changes both before and after any events affecting availability.

5. Further information

Further information on the ECM, AWEFS and ASEFS can be found on the AEMO website or via the following links:

1. Application forms and supporting documentation for new generators: <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Participant-information/New-participants/Application-forms-and-supporting-documentation>.
2. 2016 Consultation for amendments to the Energy Conversion Model: <https://www.aemo.com.au/Stakeholder-Consultation/Consultations/Energy-Conversion-Model-Guidelines-Consultation---Wind-and-Solar-Farms>.
3. 2018 Abridged consultation on amendments to the Energy Conversion Model Guidelines: <http://aemo.com.au/Stakeholder-Consultation/Consultations/2018-Abridged-consultation-on-amendments-to-the-energy-conversion-model-guidelines>
4. AWEFS and ASEFS working group: <https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/Other-meetings/AWEFS-and-ASEFS-Working-Group>.
5. Solar and wind energy forecasting: <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Solar-and-wind-energy-forecasting>.
6. Market Participant 5-Minute Self-Forecast: <https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/Other-meetings/Market-Participant-5-Minute-Self-Forecast>.
7. Vendor presentation on AWEFS: https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Working_Groups/Other_Meetings/AWEFS-ASEFS/AWEFS_AWEFS_Vendor_Discussion_Corrected.pdf.
8. How semi-scheduled generators operate in dispatch: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Power_System_Ops/Procedures/SO_OP_3705---Dispatch.pdf.

A1. Rules relating to AWEFS/ASEFS modelling requirements

This table details various rule requirements relevant to wind and solar farm proponents, to enable AEMO to model an intermittent generator in AWEFS or ASEFS.

Table 6 Rules related to modelling intermittent generators in AWEFS/ASEFS

Rule clause	Requirement
2.2.7 (c)	AEMO must approve a request for classification as a semi-scheduled generating unit if it is satisfied that the output of the generating unit is intermittent and that the person: <ol style="list-style-type: none"> (1) Has submitted data in accordance with schedule 3.1; (2) has submitted an energy conversion model which contains the information described in the guidelines referred to in paragraph (d); (3) has adequate communications and telemetry to support the issuing of dispatch instructions and the audit of responses.
2.2.3(c)	If, in relation to an application under paragraph (b), in AEMO's opinion it is necessary for any reason (including <i>power system security</i>) for the relevant <i>Generator</i> to comply with some of the obligations of a <i>Scheduled Generator</i> or <i>Semi-Scheduled Generator</i> for that <i>generating unit</i> , AEMO may approve the classification on such terms and conditions as AEMO considers reasonably necessary.
3.7B (a)	AEMO must prepare a forecast of the available capacity of each semi-scheduled generating unit (to be known as an unconstrained intermittent generation forecast) in accordance with this rule 3.7B for the purposes of: <ol style="list-style-type: none"> (4) the projected assessment of system adequacy process; (5) dispatch; and (6) pre-dispatch.
3.7B (b)	A <i>Semi-Scheduled Generator</i> must: <ol style="list-style-type: none"> (1) submit to AEMO, in accordance with the <i>timetable</i>, the <i>plant availability</i> for each <i>semi-scheduled generating unit</i> for the purpose of paragraph (a) as soon as the <i>Semi-Scheduled Generator</i> becomes aware that the <i>plant availability</i> of the unit is at least 6MW below or above the <i>nameplate rating</i> of the unit; and (2) where the <i>Semi-Scheduled Generator</i> has submitted <i>plant availability</i> in accordance with subparagraph (1), notify AEMO in accordance with the <i>timetable</i> as soon as the <i>Semi-Scheduled Generator</i> becomes aware of any changes to the <i>plant availability</i> of that <i>semi-scheduled generating unit</i> until such time as the <i>plant availability</i> of that <i>semi-scheduled generating unit</i> is no longer at least 6MW below or above the <i>nameplate rating</i> of the unit.

Rule clause	Requirement
S5.2.6.1(b)	<p>The remote monitoring quantities referred to under paragraph (a) that AEMO may request include:</p> <p>...</p> <p>(2) in respect of a generating unit with a nameplate rating of 30 MW or more, current, voltage, active power and reactive power in respect of generating unit stators or power conversion systems (as applicable);</p> <p>...</p> <p>(5) in respect of a semi-scheduled generating system, all data specified as mandatory in the relevant energy conversion model applicable to that type of semi-scheduled generating system;</p>
S5.2.6.1(d)	<p>The quantities referred to under paragraph (c) that AEMO may request include:</p> <p>(1) the active power output of the generating unit or generating system (as applicable);</p> <p>...</p> <p>(3) if a semi-scheduled generating system, all data specified as mandatory in the relevant energy conversion model applicable to that type of semi-scheduled generating system.</p>

Glossary

This document uses many terms that have meanings defined in the National Electricity Rules (NER). The NER meanings are adopted unless otherwise specified.

Term	Definition
5MPD	5-minute Pre-dispatch
ASEFS	Australian Solar Energy Forecasting System
AWEFS	Australian Wind Energy Forecasting System
ECM	Energy Conversion Model
MMS	Market Management System
MTPASA	Medium Term Project Assessment of System Adequacy
SCADA	Supervisory Control and Data Acquisition
STPASA	Short Term Project Assessment of System Adequacy
UIGF	Unconstrained Intermittent Generation Forecast