AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

Summary of proposed changes to the Wind and Solar Energy Conversion Model Guidelines

November 2018

2018 Abridged consultation on amendments to the Energy Conversion Model Guidelines

Important notice

PURPOSE

This publication has been prepared by AEMO to propose updates to the existing Wind and Solar *Energy Conversion Model* Guidelines.

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VERSION CONTROL

Version	Release date	Changes
1.0	01/11/2018	Initial Publication

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1. Introduction

1.1 Matters under consultation

AEMO is proposing changes to the Wind and Solar Energy Conversation Model Guidelines ('the ECM Guidelines') and consulting with Semi-Scheduled Generators on the changes as required by clause 2.2.7(d) of the National Electricity Rules ('Rules').

Since early 2017, a significant number of Semi-Scheduled Generators have applied and registered in the National Electricity Market (NEM), particularly in 2018. With these registration applications, each Generator was required to submit an *Energy Conversion Model* ('ECM'). Following ECM submission, AEMO and the vendor for the Australian Wind Energy Forecasting System ('AWEFS') and Australian Solar Energy Forecasting System ('ASEFS') would review the ECM and provide feedback to participants to make the necessary changes to gain ECM approval. This back-and-forth process took some time before ECM approval.

AEMO has identified elements of the ECM review process which cause the review to take longer than required, including:

- The amount of information requested for the farm and cluster level.
- The current ECM Guidelines causing participants to incorrectly fill in the ECM the first time.

AEMO is proposing changes to the ECM Guidelines, outlined in this paper, to transform them into a more coherent and cohesive set of documents. This is expected to improve the efficiency of the application process.

All changes are summarised in Section 2, 'Proposed Amended Energy Conversion Model Guidelines, November 2018'.

AEMO is seeking feedback on the proposed ECM changes raised in this paper.

1.2 References

- AWEFS and ASEFS Working Group: https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/Other-meetings/AWEFS-and-ASEFS-Working-Group
- Solar and Wind Energy Forecasting: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Solar-and-wind-energy-forecasting
- Current Solar ECM: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Dispatch/Policy_and_Process/Energy_Conversion_Model_Guidelines_Solar.xlsx
- Current Wind ECM: https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Dispatch/Policy_and_Process/2016/Energy_Conversion_Model_Guidelines_Wind_20161209.xlsx

2. Proposed Amended Energy Conversion Model Guidelines, November 2018

The following two sections outline the proposed changes to both the Wind and Solar ECM Guidelines:

- Section 2.1 outlines the proposed changes to the Wind ECM Guidelines.
- Section 2.2 outlines the proposed changes to the Solar ECM Guidelines.

Each table within these sections represents proposed changes to existing tabs and proposed addition of new tabs in the ECM Guidelines. Each table is comprised of multiple data parameters and presents proposed changes either through modification, addition or removal of the parameter.

Each data parameter has an assigned ID number to assist in referencing other proposed changes throughout the ECM Guidelines. The *Original* column represents information about the parameter in the current ECM Guidelines and the *New* column represents the definition of the parameter in the proposed ECM Guidelines. The *Comments* column provides the rationale of the proposed changes.

The proposed changes in the ECM Guidelines are intended to:

1. Provide consistency across both Wind and Solar ECMs.
2. Simplify the ECM approval process and therefore, expedite the ECM approval time.

A high-level summary of the proposed changes are as follows:

- Cosmetic updates to page layout.
- Correcting valid range errors.
- Removing fields that are no longer used by AEMO.
- Adding fields to supplement existing fields in the ECM and provide additional clarity.
- Aligning the formatting of the Wind and Solar ECMs to be consistent with each other (such as formatting and naming of tabs, structure layout, and order of data parameters)
- Updating the description of data parameters to provide clarity and provide consistency with the information outlined in the Generator Performance Standard and Registration application

2.1 Proposed changes to Wind ECM Guidelines

Table 1 'AEMO-use Only' tab (new tab)

Added this new tab for AEMO-approved fields for registration purposes. Contents to be filled out by AEMO. This is also consistent with the proposed Solar ECM.

ID#	Data Parameter	Original	New	Comment
1	DUID	N/A	New parameter: DUID	Approved DUID.
2	Wind Farm Maximum Capacity (MW)	N/A	New parameter: Wind Farm Maximum Capacity (MW)	Confirmed Maximum Capacity.
3	Cluster ID(s)	N/A	New parameter: Cluster ID(s)	Approved Cluster ID(s).
4	Cluster Maximum Capacity (MW)	N/A	New parameter: Cluster Maximum Capacity (MW)	Calculated Maximum Capacity.

Table 2 'Submission Guideline' tab

Additional information has been added in this tab to provide additional clarity on the submission guidelines. Multiple new headers have been added to provide the additional information and to be consistent with the proposed Solar ECM.

ID#	Data Parameter	Original	New	Comment
5	N/A	Header: • ECM Data template submission guideline	Header(s): • ECM Data template submission guideline • How to use this document • Who needs to submit an ECM • Document Structure • Facility hierarchy • Additional Information	Added multiple headers to include additional information on ECM submission guidelines. Consistent with proposed Solar ECM.

Table 3 'Cluster Definition Guideline' tab

This tab includes minor text changes and the addition of a new header. The new header states cluster level SCADA signals are not required if the farm is proposed to have only one cluster, where only farm level SCADA signals are required.

ID#	Data Parameter	Original	New	Comment
6	N/A	A "cluster" corresponds to a group of wind turbines of *similar* type in the wind farm and within a reasonable geographic area.	A "cluster" corresponds to a group of wind turbines of *identical* type in the wind farm and within a reasonable geographic area	Replaced 'similar' to 'identical' for consistency with cluster description.
7	N/A	To define a "cluster" the ensemble of the following constraints should be *roughly* satisfied.	To define a "cluster" the ensemble of the following constraints should be satisfied.	Removed 'roughly' as the cluster description already includes a degree of flexibility of cluster design.
8	N/A	N/A	New header: Additional Information Wind farms with only one cluster do not require cluster level SCADA signals. Only farm level SCADA signals are required.	New heading added stating cluster SCADA section in the 'ECM Wind Farm Cluster' tab does not need to be completed if the wind farm consists of only one cluster.

Table 4 'ECM Wind Farm' tab (formerly *ECM Data Template*)

This tab's name has been updated to provide clarity on what type of information is required in this tab (farm level).

ID#	Data Parameter	Original	New	Comment
9	N/A	Column: Data Type Column: Required	Column: Data Parameter Column: Mandatory	Column name changed from 'data type' to 'data parameter'. Column name changed from 'Required' to 'Mandatory' to be consistent with Rule S5.2.6.1(d)(3).
10	N/A	N/A	New column: Data Type	Added new column 'data type' stating unit type for each data parameter.

ID#	Data Parameter	Original	New	Comment
11	N/A	N/A	New column: Valid Range	Added new column 'valid range' stating valid range for each data parameter.
12	Farm Level	N/A	New parameter: Data Type: Parameters that apply to the wind farm. Value: Specify one distinct value per cell. If variants or a range exists, specify the most relevant value.	Added row to provide clarity on completing data parameter fields.
13	Power Station name	Data Parameter: Name Description: Name of the wind farm. To be same as specified in the Registration process.	Data Parameter: Power Station name Description: Name of the wind farm. To be same as specified in the 'Application for Registration as a Generator in the NEM' document, section C.	Changed data parameter 'name' to 'Power station name' and description for clarity and consistency with registration application.
14	DUID	Item deleted.	N/A	AEMO approves DUID for the wind farm. AEMO states approved DUID in the 'AEMO-use Only' tab (ID #1).
15	Region	Description: Name of the Region where the wind farm is installed. Needs to be the same as specified in the Registration process.	Description: Name of NEM region of the facility. To be same as specified in the 'Application for Registration as a Generator in the NEM' document.	Description updated for clarity.
16	Status of the wind farm	Item deleted.	N/A	Unnecessary information.
17	From which date is or will the wind farm be fully operational?	Item deleted.	N/A	Unnecessary information.
18	From which date will the wind farm be first	Item deleted.	N/A	Unnecessary information.

ID#	Data Parameter	Original	New	Comment
	connected to the grid or energised?			
19	Nameplate Rating	Description: The total installed capacity of the Wind Farm (MW). This equals turbine nameplate rating x total number of turbines installed. This Item corresponds to "Nameplate Rating" in Sections C and I.5 of "Application for Registration as a Generator in the NEM."	Description: The total installed capacity of the Wind Farm (MW) as outlined in the Performance Standard. This equals the sum of the nameplate rating of all turbines installed. This Item corresponds to "Nameplate Rating of Generating System" in Section C of the "Application for Registration as a Generator in the NEM" document.	Description updated for clarity and consistency with the information outlined in the Generator Performance Standard and Registration application form.
20	Maximum Capacity	Description: Maximum generation to which the semi-scheduled generating unit may be dispatched. This definition can be found in sections C, I.4 and I.5 of "Application for Registration as a Generator in the NEM".	Description: Maximum generation to which the semi-scheduled generating unit may be dispatched as outlined in the Performance Standard, rounded down to the nearest whole MW. This definition can be found in section C of the "Application for Registration as a Generator in the NEM" document. The Maximum Capacity value must reference the same measurement point as the SCADA Wind Farm Active Power signal.	Description updated for clarity and consistency with the information outlined in the Generator Performance Standard and Registration application form.
21	Geographical coordinates (UTM WGS-84)	Item deleted.	N/A	Geographical coordinates in latitude and longitude is already provided (ID #23, #24).
22	Geographical coordinates	Item deleted.	N/A	Due to the addition of the two items below, geographical coordinates have been deleted (ID #23, #24).

ID#	Data Parameter	Original	New	Comment
23	Facility Latitude	N/A	New parameter: Description: Defined at the centre of the collector area.	New mandatory parameter to replace 'geographical coordinates' (ID #22).
24	Facility Longitude	N/A	New parameter: Description: Defined at the centre of the collector area.	New mandatory parameter to replace 'geographical coordinates' (ID #22).
25	Facility Map	Data Parameter: Wind farm geometry Description: Given as a map with marked wind turbines position (high resolution image/ PDF file)	Data Parameter: Facility Map Description: Given as a map with marked wind turbines position (high resolution image/ PDF file). Please submit as separate pdf.	Changed data parameter 'wind farm geometry' to 'facility map' and updated description for clarity.
26	Orography information	Item deleted.	N/A	Unnecessary information.
27	Mesoscale roughness coefficient	Item deleted.	N/A	Unnecessary information.
28	Roughness of surrounding area	Item deleted.	N/A	Unnecessary information.
29	Met mast measuring height	Item deleted.	N/A	Met-masts are no longer mandatory as turbine nacelle measurements take precedence.
30	Met mast Geographical coordinates	Item deleted.	N/A	Met-masts are no longer mandatory as turbine nacelle measurements take precedence.
31	Number of Clusters	N/A	New parameter: Description: Number of clusters of the facility, for cross-checking	New mandatory item for cross-checking.

ID#	Data Parameter	Original	New	Comment
32	NSP MW Control Schemes in Operation	N/A	N/A	Parameter item relocated from Cluster tab (ID #65).
33	Any other restrictions	N/A	N/A	Parameter item relocated from Cluster tab (ID #66).
34	Wind Farm SCADA to AEMO	N/A	New column: Provision	Added new column 'provision' with 'yes/no' located underneath. Participant to specify in comments if a particular SCADA signal will be provided.
35	Wind Farm Active Power	Description: Total wind farm active power.	Description: Total wind farm active power. The SCADA Wind Farm Active Power measurement must reference the agreed point of dispatch.	This parameter must reference the agreed point of dispatch. This is to ensure the forecasting model is developed with respect to the same dispatch point location.
36	Control System Set-Point	Data Parameter: Wind Farm Control System Set Point.	Data Parameter: Control System Set Point. Description [addition]: SCADA MW Set-Point must reference the same measurement point as the SCADA Active Power signal.	Parameter name shortened as this item is in the Wind Farm SCADA section. Only one control set-point exists. In addition to the already existing definition, the control set-point requires regulation of output at the agreed point of dispatch i.e. where the Active Power is measured.
37	Local Limit	Required: Yes, unless otherwise agreed by AEMO	Mandatory: Yes. Description [addition]: SCADA Local Limit must reference the same measurement point as the SCADA Active Power signal.	Now a mandatory item as it significantly improves dispatch targets in AWEFS. In addition to the already existing definition, the Local Limit needs to also reference the agreed point of dispatch i.e. where the Active Power is measured.

ID#	Data Parameter	Original	New	Comment
38	Estimated Power	Item deleted.	N/A	This parameter is deleted as it's being replaced by the Market Participant 5min self-forecast (MP5F) option.
39	Possible Power	N/A	New parameter: Description: SCADA Possible Power is the Generator's estimate in MW of current unconstrained intermittent generation, subject only to technical factors affecting operation of its generation and connection assets. SCADA Possible Power is used to assess the performance of unconstrained intermittent generation forecasts. SCADA Possible Power must be calculated assuming that no transmission or distribution network constraints currently apply, and may assume that other limits managed by AEMO through the central dispatch process do not apply. SCADA Possible Power must reflect any Local Limits at the wind farm, unless agreed with AEMO. The SCADA Possible Power must not exceed the Maximum Capacity of the wind farm. SCADA Possible Power must reference the same measurement point as the SCADA Active Power signal.	New optional item that will be used to assess the performance of potential power output of the wind farms participating in MP5F during semi-dispatch cap intervals.
40	Number of Wind Turbines Available for Generation	N/A	Description [addition]: This definition excludes all the following cases:	In addition to the already existing definition, the Turbines Available signal should also exclude these scenarios to prevent over-dispatch.

ID#	Data Parameter	Original	New	Comment
			• Turbines still being commissioned and not released for operation. • Turbines that cannot operate because connection to *network* is still being commissioned.	
41	Number of Wind Turbines Operating / Actively Generating	Data Parameter: Number of wind turbines actively generating	Data Parameter: Number of wind turbines operating/ actively generating	Updated parameter name for clarity.
42	Wind Turbines Extreme Wind Cut-out	N/A	New parameter: Description: 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.	New optional item included on a wind farm-level for wind farms containing one cluster. This item already exists on a cluster-level basis.
43	Wind Speed	Description: 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	Description: 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. This is an average of all turbine nacelle wind speed measurements. 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	Average wind speed calculation significantly improves the accuracy of the unconstrained forecast compared to single point measurements via met-masts or anemometers.

ID#	Data Parameter	Original	New	Comment
		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.	the wind speed measurement and the farm's active power output when not downregulated.	
44	Wind Direction	Description: Wind direction measurements from turbine nacelle anemometers much preferred over measurements from meteorological mast(s). Wind direction from selected single representative nacelle (no averaging for direction).	Description: SCADA Wind direction – Farm level is a single wind direction measurement which must be an average of all turbine measurements. This requires proper directional averaging (x-y decomposition). Example: https://en.wikipedia.org/ wiki/ Mean_of_circular_quantities	Directional average wind direction calculation improves the accuracy of the unconstrained forecast compared to single point measurements via met-masts or anemometers.
45	Ambient Temperature	Data Parameter: Temperature data	Data Parameter: Ambient Temperature	Changed data parameter 'temperature data' to 'ambient temperature' to provide clarity that this item is ambient temperature rather than turbine temperature.
46	Barometric Pressure	Data Parameter: Pressure of humidity data	Data Parameter: Barometric Pressure	Changed data parameter 'pressure of humidity data' to 'barometric pressure'. Barometric Pressure remains optional.
47	SCADA data available from this wind farm	Item deleted.	N/A	Unnecessary information.

ID#	Data Parameter	Original	New	Comment
48	Provide historical SCADA measurements since the beginning of operation of the wind farm	Item deleted.	N/A	Unnecessary information.

Table 5 'ECM Wind Farm Cluster' tab (formerly *ECM Data Template Cluster*)

This tab's name has been updated to provide clarity on what type of information is required in this tab i.e. cluster level. This is now consistent with the farm level tab.

ID#	Data Parameter	Original	New	Comment
49	N/A	Column: Data Type Column: Required	Column: Data Parameter Column: Mandatory	Column name changed from 'data type' to 'data parameter'. Column name changed from 'Required' to 'Mandatory' to be consistent with Rule S5.2.6.1(d)(3).
50	N/A	N/A	New column: Data Type	Added new column 'data type' stating unit type for each data parameter.
51	N/A	N/A	New column: Valid Range	Added new column 'valid range' stating valid range for each data parameter.
52	Cluster Level	N/A	New parameter: Value: Specify one distinct value per cell. If variants or a range exists, specify the most relevant value.	Added row to provide clarity on completing cluster data parameter fields.
53	Cluster Reference	Data Parameter: ID of this Wind Turbines Cluster Description: Unique ID of the cluster of wind turbines in the farm to be provided	Data Parameter: Cluster Reference Description: Unique reference for this cluster. Note, following ECM submission,	Changed data parameter 'ID of this Wind Turbines Cluster' to 'Cluster Reference' for participant's reference. AEMO will allocate Cluster IDs to participant following ECM approval.

ID#	Data Parameter	Original	New	Comment
		by the participant. Maximum 10 characters allowed. Example – SYDWND_CL1. Cluster ID to be same as specified in the Registration process.	AEMO will allocate a unique cluster identification to each of your clusters.	
54	Turbine Manufacturer & Model ID	Data Parameter: Type of Turbines in the Cluster	Data Parameter: Turbine Manufacturer & Model ID	Changed data parameter 'Type of Turbines in the Cluster' to 'Turbine Manufacturer & Model ID' for clarity.
55	Directional power curves	Item deleted.	N/A	Unnecessary information.
56	Manufacturer's thrust coefficient vs wind speed characteristic curve	Item deleted.	N/A	Unnecessary information.
57	Maximum Power	Item deleted.	N/A	Turbine maximum power no longer required as turbine nameplate rating is sufficient.
58	Turbine Temperature Rating	Data Parameter: Operation in ambient temperature range	Data Parameter: Turbine Temperature Rating	Changed data parameter 'Operation in ambient temperature range' to 'Turbine Temperature Rating' for clarity.
59	Cut-out Speed - other measurements	Item deleted.	N/A	Unnecessary information.
60	Restart after cut-out Wind Speed - other measurements	Item deleted.	N/A	Unnecessary information.
61	Imposed noise level restrictions	Required: No	Mandatory: Yes. If any.	Provide information if available.

ID#	Data Parameter	Original	New	Comment
62	Manufacturers' power vs wind speed characteristic curve as a function of noise level	Required: No	Mandatory: Yes. If applicable.	Provide information if available.
63	Legal start night time	Required: No	Mandatory: Yes. If applicable.	Provide information if available.
64	Legal ending night time	Required: No	Mandatory: Yes. If applicable.	Provide information if available.
65	NSP MW Control Schemes in operation	Item deleted.	N/A	Due to relocating this parameter to the ECM Wind Farm tab (ID #32), it has therefore been deleted.
66	Any other restrictions	Item deleted.	N/A	Due to relocating this parameter to the ECM Wind Farm tab (ID #33), it has therefore been deleted.
67	Cluster SCADA	Data Parameter: Cluster SCADA	Data Parameter: Cluster SCADA (Not required for wind farms with only one cluster) New column: Provision.	Data parameter update to reaffirm cluster level SCADA signals not required if wind farm consists of only one cluster. Added new column 'provision' with 'yes/no' located underneath. Participant to specify in comments if the particular SCADA signal will be provided.
68	Cluster Active Power	Description: Total cluster active power	Description: Total cluster active power. This measurement must reference the generator terminals in this cluster.	For multiple cluster wind farms, this must reference the generator terminals in each cluster.
69	Cluster Number of Wind Turbines	Data Parameter: Number of wind turbines available for generation data	Data Parameter: Cluster Number of Wind Turbines Available for Generation	Updated parameter name for clarity and constancy with Solar ECM.

ID#	Data Parameter	Original	New	Comment
	Available for Generation		Description [addition]: This definition excludes all the following cases: - Turbines still being commissioned and not released for operation. - Turbines that cannot operate because connection to *network* is still being commissioned	In addition to the already existing definition, the Cluster Turbines Available signal should also exclude these scenarios to prevent over-dispatch. This is now consistent with farm level turbines available definition.
70	Cluster Number of Wind Turbines Operating / Actively Generating	Data Parameter: Number of wind turbines actively generating	Data Parameter: Cluster Number of Wind Turbines Operating / Actively Generating	Updated parameter name for clarity and consistency with farm level turbines operating name.
71	Cluster Turbines Extreme Wind Cut-out	Data Parameter: Turbines Extreme Wind Cut-out	Data Parameter: Cluster Turbines Extreme Wind Cut-out	Updated parameter name for clarity and consistency with farm level turbines extreme wind cut-out name.
72	Cluster Wind Speed	Data Parameter: Wind speed data Description: Measurements from turbine nacelle anemometers much preferred over measurements from meteorological mast(s). Also provide the height at which this is measured.	Data Parameter: Cluster Wind Speed Description: SCADA Wind Speed – Cluster level is a single wind speed measurement, which must be representative of wind conditions across the cluster. This is an average is of all turbine nacelle wind speed measurements within the cluster. 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	Parameter name and definition updated to be consistent with farm level wind speed calculation.

ID#	Data Parameter	Original	New	Comment
			cluster's active power output when not downregulated.	
73	Cluster Wind Direction	Data Parameter: Wind direction data Description: Wind direction measurements from turbine nacelle anemometers much preferred over measurements from meteorological mast(s) Also provide the height at which this is measured.	Data Parameter: Cluster Wind Direction Description: SCADA Wind direction - Cluster level is a single wind direction measurement, which must be an average of all turbine measurements within the cluster. This requires proper directional averaging (x-y decomposition). Example: https://en.wikipedia.org/ wiki/ Mean_of_circular_quantities	Parameter name and definition updated to be consistent with farm level wind direction calculation.
74	Geographical coordinates of Wind Turbine #1-20	Units: Coordinates in UTM WGS-84 or Latitude/ Longitude Description: [none]	Units: Decimal degrees Description: Coordinates in Latitude/ Longitude New columns: Latitude Longitude	Units updated to specify decimal degrees only as coordinates in UTM WGS-84 are no longer required (as per ID #21). Two new columns created 'latitude' and 'longitude' for simplicity.

Table 6 'Turbines Curves Table' tab

Two columns have been removed from this tab as the information is no longer required and the data parameter is no longer required in the Wind Farm Cluster tab (ID #56).

ID#	Data Parameter	Original	New	Comment
75	Speed (m/s)	Item deleted.	N/A	No longer required.
76	Thrust coeff. Ct	Item deleted.	N/A	No longer required.

2.2 Proposed changes to Solar ECM Guidelines

Table 7 'AEMO-use Only' tab (new tab)

Added this new tab for AEMO-approved fields for registration purposes. Contents to be filled out by AEMO. This is also consistent with the proposed Wind ECM.

ID#	Data Parameter	Original	New	Comment
77	DUID	N/A	New parameter: DUID	Approved DUID.
78	Solar Farm Maximum Capacity (MW)	N/A	New parameter: Solar Farm Maximum Capacity (MW)	Confirmed Maximum Capacity.
79	Cluster ID(s)	N/A	New parameter: Cluster ID(s)	Approved Cluster ID(s).
80	Cluster Maximum Capacity (MW)	N/A	New parameter: Cluster Maximum Capacity (MW)	Calculated Maximum Capacity.

Table 8 'Submission Guideline' tab (formally *Introduction*)

This tab's name has been changed to be consistent with the equivalent tab in the proposed Wind ECM. Additional information has been added in this tab to provide additional clarity on the submission guidelines. Multiple new headers have been added to provide the additional information and to be consistent with the proposed Wind ECM.

ID#	Data Parameter	Original	New	Comment
81	N/A	Headers: • How to use this document • Document structure • Facility Hierarchy • Terms and definitions • Cluster definition examples	Headers: • ECM Data template submission guideline • How to use this document • Who needs to submit an ECM • Document Structure • Facility hierarchy • Additional Information	Removed headers 'terms and definitions' and 'cluster definition examples' and relocated to the new 'Cluster Definition Guideline' tab below. Added headers 'ECM data template submission guideline', 'Who needs to submit an ECM' and 'additional information'. This tab contains extra information for clarity and is consistent with proposed Wind ECM.

Table 9 'Cluster Definition Guideline' tab (new tab)

Added this new tab to relocate headers here from the former *Introduction* tab above and to provide additional information and diagrams to clarify cluster arrangements. Note: the definition for Cluster PV technology has been modified to provide flexibility on cluster design. Please refer to definitions in the updated Solar ECM.

ID#	Data Parameter	Original	New	Comment
82	N/A	N/A	Headers: • Terms and definitions • Cluster definition examples Diagrams: • Azimuth and Slope angles with respect to fixed collector plane • East-west tracking system with slope angle range (-52,52).	Updated term and definition: 'Cluster (PV technology)' Added new terms with definitions for: 'Cluster (CPV technology)', 'Cluster (CST technology)', 'Dispatchable Unit', 'Tracking slope angle'. Updated Example 2 for further clarification. Added new diagrams for visualising fixed and tracking systems.

Table 10 'ECM PV', 'ECM CPV' & 'ECM CST' tabs

The following changes apply to non-concentrating, concentrating, and concentrating solar thermal farms but references the 'ECM PV' tab only (non-concentrating). From hereon, rows reference the 'ECM PV' tab.

ID#	Data Parameter	Original	New	Comment
83	N/A	Column: *required parameters in bold -Static parameters Column: Required Data type: Parameters that change infrequently or not at all	New column header: Data Parameter Column: Mandatory	Removal of headers '*required parameters in bold', 'static parameters' and 'parameters that change infrequently or not at all'. Added header 'data parameter' to be consistent with proposed Wind ECM. Column name changed from 'Required' to 'Mandatory' to be consistent with Rule S5.2.6.1(d)(3).

ID#	Data Parameter	Original	New	Comment
84	N/A	N/A	New column: Comments	Added new column 'comments' for participant to state additional information for each parameter (if required).
85	Farm Level	N/A	New parameter: Data Type: Parameters that apply to the solar farm. Value: Specify one distinct value per cell. If variants or a range exists, specify the most relevant value.	Added row to provide clarity on completing data parameter fields.
86	DUID	Item deleted.	N/A	AEMO approves DUID for the wind farm. AEMO states approved DUID in the 'AEMO-use Only' tab (ID #77).
87	Power Station name	Data parameter: Name Description: Name of the Solar farm. To be same as specified in the registration process.	Data Parameter: Power Station name Description: Name of the Solar farm. To be same as specified in the 'Application for Registration as a Generator in the NEM' document, section C.	Changed data parameter 'name' to 'Power station name' and description for clarity and consistency with registration application.
88	Region	Description: Name of NEM region of the facility. To be same as specified in the registration process.	Description: Name of NEM region of the facility. To be same as specified in the 'Application for Registration as a Generator in the NEM' document.	Updated Description for consistency.
89	Nameplate Rating	Valid Range: [none] Description: This Item corresponds to "Nameplate Rating" in Sections C and I.5 of "Application for Registration as a Generator in the NEM."	Valid Range: >0 Description: The total installed capacity of the Solar Farm (MW) as outlined in the Performance Standard. This equals the sum of the AC power rating of all inverters. This Item corresponds to	Description updated for clarity and consistency with the information outlined in the Generator Performance Standard and Registration application form.

ID#	Data Parameter	Original	New	Comment
			"Nameplate Rating of Generating System" in section C of "Application for Registration as a Generator in the NEM" document.	
90	Maximum Capacity	Valid Range: [none] Description: Maximum generation to which the semi-scheduled generating unit may be dispatched. This definition can be found in sections C, I.4 and I.5 of "Application for Registration as a Generator in the NEM",	Valid Range: >0 Description: Maximum generation to which the semi-scheduled generating unit may be dispatched as outlined in the Performance Standard, rounded down to the nearest whole MW. This definition can be found in sections C, F.2, I.4 and I.5 of "Application for Registration as a Generator in the NEM" document. The Maximum Capacity value must reference the same measurement point as the SCADA Solar Farm Active Power signal.	Description updated for clarity and consistency with the information outlined in the Generator Performance Standard and Registration application form.
91	Status of the solar farm	Item deleted.	N/A	Unnecessary information.
92	From which date is or will the solar farm be fully operational?	Item deleted.	N/A	Unnecessary information.
93	From which date will the solar farm be first connected to the grid or energised?	Item deleted.	N/A	Unnecessary information.
94	Facility time zone	Item deleted.	N/A	Unnecessary information.
95	Number of clusters	Valid Range: [none]	Valid Range: n/a	Updated cells.

ID#	Data Parameter	Original	New	Comment
		Description: [none]	Description: Provide list of measurement devices.	
96	NSP MW Control Schemes in Operation	N/A	New parameter. NSP MW Control Schemes in Operation	To be consistent with proposed Wind ECM (ID #32).
97	Any other restrictions	N/A	New parameter. Any other restrictions	To be consistent with proposed Wind ECM (ID #33).
98	Solar Farm SCADA to AEMO	N/A	New column: Provision.	Added new column 'provision' with 'yes/no' located underneath. Participant to specify in comments if the particular SCADA signal will be provided.
99	Solar Farm Active Power	Parameter: Active power generation Description: Per facility	Parameter: Solar Farm Active Power Description: Total solar farm active power. The SCADA Solar Farm Active Power measurement must reference the agreed point of dispatch.	Updated parameter name for consistency with proposed Wind ECM Active power signal. This parameter must reference the agreed point of dispatch. This is to ensure the forecasting model is developed with respect to the same dispatch point location.
100	Control System Set-Point	Data Parameter: Solar Farm Control System Set-Point.	Data Parameter: Control System Set-Point. Description [addition]: SCADA MW Set-Point must reference the same measurement point as the SCADA Solar Farm Active Power signal.	Parameter name shortened as this item is in the Solar Farm SCADA section. Only one control set-point exists. In addition to the already existing definition, the control set-point requires regulation of output at the agreed point of dispatch i.e. where the Active Power is measured.
101	Local Limit	Required: Yes, unless otherwise agreed by AEMO	Mandatory: Yes.	Now a mandatory item as it significantly improves dispatch targets in ASEFS.

ID#	Data Parameter	Original	New	Comment
			Description [addition]: SCADA Local Limit must reference the same measurement point as the SCADA Solar Farm Active Power signal.	In addition to the already existing definition, the Local Limit needs to also reference the agreed point of dispatch i.e. where the Active Power is measured.
102	Estimated Power	Item deleted.	N/A	This parameter is deleted as it's being replaced by the Market Participant 5min self-forecast (MP5F) option.
103	Possible Power	N/A	New parameter: Description: SCADA Possible Power is the Generator's estimate in MW of current unconstrained intermittent generation, subject only to technical factors affecting operation of its generation and connection assets. SCADA Possible Power is used to assess the performance of unconstrained intermittent generation forecasts. SCADA Possible Power must be calculated assuming that no transmission or distribution network constraints currently apply, and may assume that other limits managed by AEMO through the central dispatch process do not apply. SCADA Possible Power must reflect any Local Limits at the solar farm, unless agreed with AEMO. The SCADA Possible Power must not exceed the Maximum Capacity of the solar farm. SCADA Possible Power must reference the same measurement point as the SCADA Solar Farm Active Power signal.	New optional item that will be used to assess the performance of potential power output of the wind farms participating in MP5F during semi-dispatch cap intervals.

ID#	Data Parameter	Original	New	Comment
104	Barometric pressure	Item deleted.	N/A	No longer required.
105	Reactive power generation	Item deleted.	N/A	No longer required.
106	Global horizontal irradiance	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #132). This is consistent with the current location of cluster SCADA data in the Wind ECM.
107	Global inclined irradiance	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #133). This is consistent with the current location of cluster SCADA data in the Wind ECM.
108	Module surface temperature	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #134). This is consistent with the current location of cluster SCADA data in the Wind ECM.
109	Number of inverters available	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #135). This is consistent with the current location of cluster SCADA data in the Wind ECM.
110	Reduction through soiling	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #136). This is consistent with the current location of cluster SCADA data in the Wind ECM.
111	Actual tracking slope angle	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #137). This is consistent with the current location of cluster SCADA data in the Wind ECM.

ID#	Data Parameter	Original	New	Comment
112	Actual tracking azimuth angle	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #138). This is consistent with the current location of cluster SCADA data in the Wind ECM.
113	Tracking share of modules not on track	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #139). This is consistent with the current location of cluster SCADA data in the Wind ECM.
114	Trackers online	Item deleted.	N/A	Parameter item relocated to Cluster tab (ID #140). This is consistent with the current location of cluster SCADA data in the Wind ECM.

Table 11 'ECM PV Cluster', 'ECM CPV Cluster' & 'ECM CST Cluster' tabs

The following changes apply to non-concentrating, concentrating, and concentrating solar thermal farms but references the 'ECM PV Cluster' tab only (non-concentrating). From hereon, rows reference the 'ECM PV cluster' tab.

ID#	Data Parameter	Original	New	Comment
115	N/A	Column: *required parameters in bold Column: Required	Column: Data Parameter Column: Mandatory	Replaced '*required parameters in bold' with 'Data Parameter'. Column name changed from 'Required' to 'Mandatory' to be consistent with Rule S5.2.6.1(d)(3).
116	N/A	N/A	New column: Comments	Added new column 'comments' for participant to state additional information for each parameter (if required).
117	Cluster Level	Data Parameter: Cluster	Data Parameter: Cluster Level	Replaced 'Cluster' with 'Cluster level'.

ID#	Data Parameter	Original	New	Comment
		Description: A cluster is defined as a subset of the Facility with: • the same inverter type (manufacturer, model and rating) • the same combination and number of modules connected to each inverter • 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	Value: Specify one distinct value per cell. If variants or a range exists, specify the most relevant value. Description: A cluster is defined as a subset of the Facility with: • 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)	Added additional information for completing value column Description updated to reflect proposed definition in the 'cluster definition guideline' tab (ID #82). This definition provides extra flexibility when proposing cluster arrangement.
118	Cluster Reference	Data Parameter: Cluster ID Description: Unique ID of the cluster in the farm to be provided by the participant. Maximum 10 characters allowed. Example – SYDSLR_CL1. NOTE: to be same as specified in registration process	Data Parameter: Cluster Reference Description: Unique reference for this cluster. Note, following ECM submission, AEMO will allocate a unique cluster identification to each of your clusters.	Changed data parameter 'Cluster ID' to 'Cluster Reference' for consistency with proposed Wind ECM and for participant's reference. AEMO will allocated Cluster IDs to participant following ECM approval.
119	Technology Type and Tracking	Data Parameter: Technology Type	Data Parameter: Technology Type and Tracking	Updated parameter name for clarity.
120	Cluster centre altitude	Units: meters	Units: meters ASL	Updated unit for clarity.

ID#	Data Parameter	Original	New	Comment
121	Number of modules in cluster (grand total)	Data Parameter: Number of modules in cluster Description: The total number of modules in this cluster	Data Parameter: Number of modules in cluster (grand total) Description: The total number of modules in this cluster, used for cross-checking	Updated parameter name and description for clarity.
122	Inverter type reference	Data Parameter: Inverter model ID Description: Model ID for inverters in this cluster	Data Parameter: Inverter type reference Description: Manufacturer inverter type reference/model name for inverters in this cluster	Updated parameter name and reference for clarity.
123	Inverter DC power rating	Description: DC power rating for inverters in this cluster	Description: DC power rating for inverters in this cluster. Please specify the DC power rating from the datasheet of the inverter manufacturer (max DC rating), not the DC power of the modules attached to the inverter.	Updated description for clarity.
124	Inverter response	Valid Range: (0,100) Description: See the inverter response example worksheet	Valid Range: (0,1) Description: See the inverter response example worksheet. Please provide a table similar to the example. Pictures or pdf files will not be accepted. Please only provide a single curve.	Updated range and description for clarity.
125	DC power of modules connected to each	N/A	New parameter. Data type: Scalar decimal number (min, avg, max)	New mandatory parameter is to calculate the DC power of modules connected to each inverter within the cluster. Three

ID#	Data Parameter	Original	New	Comment
	inverter (min, avg, max)		Units: • min MW • avg MW • max MW Description: • The combined module DC power rating for all modules connected to a single inverter in this cluster, minimum of all inverters in this cluster Note: Must not be more than 2.5% below average • The combined module DC power rating for all modules connected to a single inverter in this cluster, average of all inverters in this cluster • The combined module DC power rating for all modules connected to a single inverter in this cluster, maximum of all inverters in this cluster. Note: Must not be more than 2.5% above average.	rows have been added to calculate the minimum, average, and maximum of this value. This supports the proposed cluster definition with added flexibility.
126	Module material	N/A	New parameter. Data type: String E.g. {"poly-Si", "mono-Si", "multi-Si", "CdTe", ...} Description: PV material used for all modules in this cluster. Material of interest is the substance that is used to convert sunlight to electricity (e.g. monocrystalline silicon, cadmium telluride).	New mandatory item to specify module material.

ID#	Data Parameter	Original	New	Comment
127	Tracking slope angle range	Valid Range: (0,90) Description: Minimum slope angle for clusters with slope tracking of the modules. The slope angle between the collector plane and the horizontal surface which varies between 0° for a horizontal plane and 90° for a vertical plane.	Valid Range: (-90,90) Description: Minimum slope angle for clusters with slope tracking of the modules. The slope angle between the collector plane and the horizontal surface which varies between 0° for a horizontal plane and -90°/90° for a vertical plane.	Corrected valid range for slope tracking systems and updated description for clarity.
128	Slope tracking direction	Data type: String	Data type: String, E.g. {"East-West", "North-South", ...}	Updated data type for clarity.
129	Tracking azimuth angle range	Required: Required for tracking systems only	Mandatory: Required for azimuth tracking systems only	Updated mandatory section for clarity that this parameter applies to azimuth tracking systems only.
130	Fixed slope angle	Required: Required for non-tracking systems	Mandatory: Required for non-slope-tracking systems	Updated mandatory section for clarity that this parameter applies to non-slope tracking systems.
131	Tracking azimuth angle range	Required: Required for non-tracking systems	Mandatory: Required for non-azimuth- tracking systems	Updated mandatory section for clarity that this parameter applies to non-azimuth tracking systems.
132	Global horizontal irradiance	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #106). This is consistent with the current location of cluster SCADA data in the Wind ECM.
133	Global inclined irradiance	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #107). This is

ID#	Data Parameter	Original	New	Comment
				consistent with the current location of cluster SCADA data in the Wind ECM.
134	Module surface temperature	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #108). This is consistent with the current location of cluster SCADA data in the Wind ECM.
135	Number of inverters available	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #109). This is consistent with the current location of cluster SCADA data in the Wind ECM.
136	Reduction through soiling	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #110). This is consistent with the current location of cluster SCADA data in the Wind ECM.
137	Actual tracking slope angle	N/A	New parameter. Description: For sign convention, refer to 'tracking slope angle' term in Cluster Definition Guideline tab.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #111). This is consistent with the current location of cluster SCADA data in the Wind ECM.
138	Actual tracking azimuth angle	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #112). This is consistent with the current location of cluster SCADA data in the Wind ECM.
139	Tracking share of modules not on track	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #113). This is consistent with the current location of cluster SCADA data in the Wind ECM.
140	Trackers online	N/A	New parameter.	Parameter item relocated from solar farm level tab 'ECM PV' (ID #114). This is

ID#	Data Parameter	Original	New	Comment
				consistent with the current location of cluster SCADA data in the Wind ECM.
141	Module Type 1 used in this Cluster	Data parameter: Module type used in this cluster Data type: Parameters that apply to a module type used within a cluster (part of cluster definition) Please copy this section of the sheet for each module type used in this cluster, if more than one (see Example 2 of Introduction worksheet)	Data parameter: Module type 1 used in this cluster Data type: Parameters that apply to a module type used within a cluster (part of cluster definition)	Parameter name updated to standalone type 1 module as this section of the sheet doesn't need to be copied for each module type in this cluster because two more sections (ID #144, #145) have been created below (Module Type 2, Module Type 3 etc.) in the proposed solar ECM.
142	Module type reference	Data Parameter: Module model ID Description: Model ID for PV modules in this cluster	Data Parameter: Module type reference Description: Manufacturer module/panel type reference/model name for modules in this cluster	Updated parameter name and reference for clarity, and consistency with 'Inverter type reference' parameter (ID #122).
143	Number of modules per inverter	Item deleted.	N/A	Parameter item relocated to underneath the 'Inverter' data parameter (ID #146).
144	Module Type 2 used in this Cluster	N/A	New parameter. [includes all data parameters within data parameter: Module Type 1 used in this Cluster] Data type: Parameters that apply to a module type used within a cluster (part of cluster definition). ONLY COMPLETE IF THIS CLUSTER HAS MORE THAN 1 MODULE TYPE.	As per the 'module type 1 used in this cluster' parameter (ID #141) and all items located within this parameter, this new parameter to be completed if the cluster has more than 1 module type.

ID#	Data Parameter	Original	New	Comment
145	Module Type 3 used in this Cluster	N/A	New parameter. [includes all data parameters within data parameter: Module Type 1 used in this Cluster] Data type: Parameters that apply to a module type used within a cluster (part of cluster definition) ONLY COMPLETE IF THIS CLUSTER HAS MORE THAN 2 MODULE TYPES. ADD MORE MODULE TYPE SECTIONS IF REQUIRED.	As per the 'module type 1 used in this cluster' parameter (ID #141) and all items located within this parameter, this new parameter to be completed if the cluster has more than 2 module types.
146	Inverter	Data type: Parameters that apply to an individual inverter. COPY THIS SECTION OF THE SHEET FOR EACH INVERTER IN THE CLUSTER.	Data type: Parameters that apply to an individual inverter. Please copy this section of the sheet for each inverter of the cluster.	Updated data type with capital letters for consistency with items above.
147	Number of modules of *Module Type 1* connected to this inverter	N/A	New parameter. Description: Please specify for each inverter	Parameter item relocated from data parameter 'Module Type 1 used in this Cluster' (ID #141).
148	Number of modules of *Module Type 2* connected to this inverter	N/A	New parameter. Description: Please specify for each inverter, only used if more than one module type	Parameter item relocated from data parameter 'Module Type 1 used in this Cluster' (ID #141).
149	Number of modules of *Module Type 3* connected to this inverter	N/A	New parameter. Description: Please specify for each inverter, only	Parameter item relocated from data parameter 'Module Type 1 used in this Cluster' (ID #141).

ID#	Data Parameter	Original	New	Comment
			used if more than two module types, add more if more than three module types.	
150	DC power of modules connected to this inverter	N/A	New parameter. Description: The combined module DC power rating for all modules connected to this inverter.	New mandatory parameter to supplement calculation of DC power of modules connected to each inverter (min, avg, max) (ID #125).

Table 12 'Spectral Response Example' tab

Header name has been updated to state these fields are optional. Two parameters have been added to link information outlined in the updated 'ECM PV Cluster' tab.

ID#	Data Parameter	Original	New	Comment
151	Spectral Response (optional)	Header: Spectral Response	Header: Spectral Response (optional)	Header name updated to state the information in this tab is optional as the 'Module normalised spectral response' parameter in the ECM PV Cluster tab states this field is optional.
152	Module Manufacturer	N/A	New parameter.	Added new parameter to be sure which module the curve is for. This is linked from ID #142.
153	Module type reference	N/A	New parameter.	As above.
154	Response	Number of decimal places: 0-2	Number of decimal places: 2	Updated Response column to have two decimal places for each wavelength rather than varying number of decimal places.

Table 13 'Inverter Response Example' tab

Two parameters have been added to link information outlined in the updated 'ECM PV Cluster' tab.

ID#	Data Parameter	Original	New	Comment
155	Inverter Manufacturer	N/A	New parameter.	Added new parameter to be sure which inverter the curve is for. This is linked to 'Inverter Manufacturer' parameter in the updated ECM PV Cluster tab.
156	Inverter type reference	N/A	New parameter.	As above. This is linked to ID #122.
157	Response	Number of decimal places: 0-4	Number of decimal places: 3	Updated Response column to have three decimal places for each Power (kW) rating rather than varying number of decimal places.

Table 14 'Temperature Response Example (new tab)

This new tab has been added to reference the temperature response parameter in the updated 'ECM PV Cluster' tab.

ID#	Data Parameter	Original	New	Comment
158	Module Temperature Response (optional)	N/A	New parameter. Header: Module Temperature Response (optional)	N/A
159	Module Manufacturer	N/A	New parameter.	Added new parameter to be sure which module the curve is for. This is linked from ID #142.
160	Module type reference	N/A	New parameter.	As above.
161	Temperature (°C)	N/A	New parameter. Column: Temperature (°C)	Added in 'temperature' column to be coupled with 'DC power at STC' column (ID #162) to produce a graph.

ID#	Data Parameter	Original	New	Comment
162	DC power at STC (%)	N/A	New parameter. Column: DC power at STC (%)	Added in 'DC power at STC' column to be coupled with 'temperature' column (ID #161) to produce a graph.

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
ASEFS	Australian Solar Energy Forecasting System
AWEFS	Australian Wind Energy Forecasting System
DUID	Dispatch Unit Identifier
ECM	Energy Conversion Model
SCADA	Supervisory Control and Data Acquisition