MARKET PARTICIPANT SELF-FORECASTING TECHNOLOGIES WORKSHOP

PARTICIPANT FEEDBACK

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

CONTENTS

ABBREVIATIONS

Abbreviation	Expanded name
ASEFS	Australian Solar Energy Forecasting System
AWEFS	Australian Wind Energy Forecasting System
CPF	Causer Pays Factors
DI	Dispatch Interval
DUID	Dispatchable Unit Identifier
MAE	Mean Absolute Error
MP5F	Market Participant 5-Minute Forecast
NER	National Electricity Rules
POE	Probability of Exceedance
SDC	Semi Dispatch Cap

1. INTRODUCTION

Following the self-forecasting technologies workshop (utility scale solar and wind) on **Thursday, 15 February 2018**, AEMO requested feedback on the requirements for participant self-forecasting by **Friday, 23 February 2018**.

AEMO received feedback frmm 16 respondents. These were:

- AGL
- Akuo Energy
- CSIRO
- CWP Renewables
- Foresight Group
- GE
- Infigen Energy
- Neoen Australia
- Proa Analytics
- Senvion Australia
- Solcast (Solar & Storage Modelling Pty Ltd)
- Suzlon Energy Australia
- Tilt Renewables
- University of NSW (School of Photovoltaic and Renewable Energy Engineering)
- University of South Australia (School of Information Technology and Mathematical Sciences)
- Windlab

All feedback discussed in this document relates to the materials shared and questions posed in the self-forecasting technologies workshop. These materials are available on the AEMO website at https://www.aemo.com.au/Stakeholder-Consultation/Industry-forums-and-working-groups/Other-meetings/Market-Participant-5-Minute-Self-Forecast.[1]

1.1 Summary of updates and further communication

After considering the feedback received, AEMO has made the following updates to the self-forecasting requirements:

- AEMO won't perform a frozen value check in its validations;
- AEMO range check will allow small negative values in its validations;
- AEMO intends to perform a rolling Mean Absolute Error (MAE) check against an error threshold in its validations;
- AEMO won't use Possible Power in its on-line validations. However, if available, Possible Power will form part of a suite of analysis in weekly offline checks.
- In addition to the variables proposed in the workshop, the confidential 5-minute reporting to participants will also include:
  - Persistence forecast (MW) (= SCADA Initial MW)
  - MP5F Validation Fail reason flag (Range Fail, MAE Fail, MP5F Quality Flag = "Not use")

[1] Available in the Market Participant 5 Minute Forecast – Workshop Pack – 15 February 2018 on the Market Participant 5-Minute Self Forecast web page.

  - Which forecast was used in Dispatch (MP5F, ANEMOS, PERSISTENCE, TARGET)
  - MP5F Forecast Rolling 15-minute MAE (MW)
  - ANEMOS Forecast Rolling 15-minute MAE (MW)
  - Persistence Forecast Rolling 15-minute MAE (MW)
- All data produced in the real time reporting will be published publically the next day.
- Participants will be able to re-submit MP5F for the same Next DI Ending as often as required within the MP5F submission acceptance window; and
- Participants will receive a time-stamped submission success notice, partial notice (for an incomplete 5MPD submission) or rejection notice with error message from AEMO via Web API.

AEMO also considers that further information needs to be provided on the following:

- Web API authentication and security information;
- Web API technical requirements and submission process; and
- MAE calculation and a specific list of suggested participant validations.

2. DISCUSSION OF QUESTIONS

2.1 Data submission requirements

AEMO proposed the use of Web APIs for participants to submit their MP5F. The proposed data structure included DUID, run-datetime, interval_datetime, MP5F and MP5F quality.

2.1.1 Summary of submissions

Ten respondents (**Akuo Energy, CSIRO, GE, Infigen, Neoen, Proa Analytics, Solcast, Tilt, UNSW, UniSA**) provided support for the use of Web API interface to receive the MP5F.

Senvion noted that for farms without existing Web APIs, a comprehensive technical manual and support should be available to assist the transition to this platform. They also noted a preference for existing interfaces to be updated to receive MP5F forecasts.

GE, Senvion, Solcast and Tilt raised the issue of Web API security and authentication. These respondents requested additional detail and further discussion on cybersecurity to ensure data integrity. Suggestions included: using token encryption to authenticate forecast information between a participant (or authorised third party) and AEMO (**Solcast**); and adherence to standards and best practices for market data access (e.g. ERCOT, PJM, ISO-NE) (**GE**).

Additional information on the submission process, bidding frequency and requirements was requested by six respondents (**AGL**, **Akuo Energy**, **CSIRO**, **Proa Analytics, Solcast, Tilt**).

Specific additional information requested on the Web API approach included:

- The response from the Web API to confirm receipt of submission – e.g. “ok”, “malformed request”, “authentication failed” etc. (**Infigen**, **Tilt**).
- Whether this application would be accessible through a MarketNet connection or directly from the Internet. (**Tilt**).
- More clarity around when bids will be accepted prior to the dispatch interval, how often forecasts can be re-submitted, and which will be accepted for final consideration. (**CSIRO**)
- Whether data sent to AEMO more than 5 minutes before a DI (for that DI) be used. (**Infigen**)

Submissions from **UNSW** and **UniSA** suggested submission of additional variables, including probabilistic forecasts (apart from the POE50, which is already included) and other variables used to create the power forecast (i.e. key weather variables). **Infigen** suggested splitting the participant quality flag into two, distinct tags: a binary data quality signal; and a binary use/ not use value.

2.1.2 AEMO’s comments

AEMO considers SCADA submission of a MP5F out of scope for this project. However, may consider it for a future piece of work.

Several submissions indicated a desire for further information and a discussion on Web API authentication, security and processes. AEMO agrees with respondents that security is of critical importance and that the Web API design should follow industry best practices. AEMO will provide further detail on these aspects in a draft Web API technical design document and invite further discussion from participants at that point.

AEMO considers the submission of additional variables and probabilistic forecasts a key feature of a possible future work piece to extend MP5F to a longer time horizon. However, for the current project, AEMO will not be including provisions for submitting probabilistic forecasts.

Infigen suggested that two binary flags could be submitted with each MP5F, one indicating the quality of the data used in the MP5F and the other a discretionary flag indicating whether the forecast should be

used. It is up to the participant to determine the validation checks that inform the use/ don't use flag. This could incorporate a check for good/ bad quality data.

2.2 Participant validation requirements

The proposed participant validation requirements included: submission in a valid format; frozen check; range check; forecast error consistently better than an error threshold (15-minute MAE < Megawatt (MW) error threshold, where the actual value in the MAE calculation was proposed as either active power (non-Semi Dispatch Cap (SDC) intervals) and Possible Power (SDC intervals) or Possible Power for all intervals).

Comments on frozen and range checks have been addressed in Section 2.3. Comments on Possible Power have been addressed in Section 2.5.

2.2.1 Summary of submissions

Feedback on this question mainly related to (a) measuring forecast error, (b) setting the benchmark and (c) defining the MW error threshold.

(a) Many respondents considered a 15 minute MAE to be a short time frame to measure forecast error, as collecting only 3 samples may not allow for solar and wind variability, which can be significant at times (**Solcast**, **Tilt**, **UNSW**, **UniSA**). **CSIRO** and **UniSA** suggested using RMSE to capture forecast performance during sudden events. **Solcast** suggested the use of a skill score for Solar farms (S = 1 – (RMSE_self-forecast / RMSE_persistence-forecast)). **Tilt** noted that the 15-minute window may be suitable to capture grossly erroneous forecasts, however is too short for the purpose of benchmarking.

(b) Additional information was requested in the definition of 'benchmark' and 'consistently worse' (**Solcast**), MAE and a specific list of suggested participant validations (**Tilt**). The merits of using Possible Power as the actual value for SDC intervals is discussed in Section 2.5.

(c) **AGL** proposed that the MW error threshold be a constant percentage of the facility maximum capacity. **UniSA** proposed a similar model, where the forecast is referenced to dynamically changing limits (this would also capture seasonal variability). **Solcast** suggested a purely persistence forecast be used (for Solar) as a benchmark.

CSIRO, **UNSW** and **UniSA** suggested probabilistic forecasting and use of prediction intervals to assist the validation of a forecast. The idea put forward was that the narrower the prediction interval (probability spread) for the forecasted output, the more reliable it is. **CSIRO** and **UniSA** also noted the benefit of using probabilistic forecasts over longer time horizons (i.e. greater than 5-minutes) to anticipate renewable energy uncertainty, such as approaching weather fronts or extreme events.

2.2.2 AEMO's comments

The initial proposal for checking forecast error was designed to initiate discussion. It is clear that there are different preferred methods to validate forecast accuracy. It is up to the participant to determine how they wish to validate their MP5F and reflect this validation in their use/ don't use flag. AEMO strongly advises participants to use a comprehensive suite of validation checks for their MP5F and suggests inclusion of a rolling MAE against a relevant error threshold.

Probabilistic forecasting was suggested as a measure of quality. AEMO considers probabilistic forecasting to be out of scope of this initial system implementation which focuses on 5-minutes ahead POE50 forecast.

2.3 AEMO validation requirements

The proposed AEMO validation checks included submission checks (valid format, no missing data, submitted before the start of the relevant DI and submitted by the correct participant) and

forecast checks (check participant quality flag, range check (0 < forecast < max capacity), frozen check).

2.3.1 Summary of submissions

AGL, Proa Analytics, UNSW and **UniSA** noted that the validation logic for accepting a MP5F seemed reasonable. On the other hand, **GE**, **Infigen** and **Tilt** indicated a preference for AEMO to perform all validation functions, in addition to the wind farm.

With respect to the proposed validation requirements, specific feedback was given on the range check and frozen values check. **Neoen**, **Tilt** and **Windlab** expressed concern over the frozen data checks returning false positives. In particular, it was noted that false positive frozen data checks could occur for solar farms overnight; when a wind or solar farm predicts maximum output for several periods; or in general for solar and farms with a small maximum capacity.

AGL, CWP Renewables, **GE** and **Infigen** requested that the AEMO range check should allow negative values. These respondents noted that the forecast should be able to take into account the internal consumption of a wind (or solar) farm during low wind (or sun) and potential battery charging. One suggestion was for the range check to reflect the maximum consumption of the facility (i.e. Max consumption ≤ output ≤ max capacity) (**CWP Renewables**).

2.3.2 AEMO's comments

AEMO agrees to implement basic data quality checks independent of the participant. These checks are designed to allow AEMO to fulfil its obligations with regards to power system security. As stated in Section 2.2.2, AEMO encourages participants to develop their own validation suites that reflect a commitment to providing an accurate MP5F.

AEMO agrees that a frozen check implemented by AEMO may, at times, yield false positive results. AEMO will remove the frozen check from the validation requirements performed by AEMO, however sees no reason why a participant (with full knowledge of their facilities operational requirements) couldn't include a frozen check in their validation suite.

AEMO agrees that a small negative value may be possible for some facilities. AEMO intends to allow a small tolerance below zero and above the maximum capacity when performing the range check on a MP5F.

2.4 Reporting of forecast information

AEMO proposed that a confidential real-time report should be sent to participants every 5 minutes containing the following information: DUID, participant forecast (MP5F), participant forecast quality flag, ANEMOS forecast, which forecast was used in dispatch, rolling forecast error for each forecast (optional). Feedback was requested on which of these variables (if any) should be made publically available.

2.4.1 Summary of submissions

There were two distinct views presented by proponents regarding the publication of MP5F information:

(1) All (or a subset of) data should be available: Several respondents agreed with the publication of all metrics put forward by AEMO in the interest of transparency (**AGL**, **CSIRO**, **GE**, **Infigen**, **Proa Analytics**, **Tilt, UNSW**, **UniSA**). These respondents were also in favour of a rolling forecast performance metric. **Proa Analytics** suggested a 7 or 30 day rolling error measure, while **Tilt** suggested a rolling performance indicator on a 15 min, 1 hr, 1 day and 1 month basis. Additional metrics suggested included key forecast variables (irradiance, wind speed and direction) (**CSIRO**).

(2) The data should not be publically available: It was noted that the industry standard for forecasts provided by vendors is for this information to be treated as commercial in confidence. Concern was

raised about the ability for third party vendors to access their data, which is typically purchased, for free (**Akuo Energy, Neoen**, **Solcast**).

For 5-minute real time reporting to participants, it was noted that it is preferable of AEMOs reporting to the generator (private report) to indicate which forecast (MP5F, ANEMOS, Initial MW, Previous target) was used, the reason for rejection of MP5F (if applicable) and the metric it was benchmarked against (**AGL**, **Tilt**).

2.4.2 AEMO's comments

The updated list of values to be confidentially reported to Market Participants after each Dispatch run is as follows:

- Run_DateTime (when participant created the MP5F)
- Interval_DateTime (DI Ending)
- DUID
- MP5F (MW)
- ANEMOS Forecast (MW)
- Persistence forecast (MW) (= SCADA Initial MW)
- MP5F Validation Fail reason flag (Range Fail, MAE Fail, MP5F Quality Flag = "Not use")
- Which forecast was used in Dispatch (MP5F, ANEMOS, PERSISTENCE, TARGET)
- MP5F Forecast Rolling 15-minute MAE (MW)
- ANEMOS Forecast Rolling 15-minute MAE (MW)
- Persistence Forecast Rolling 15-minute MAE (MW)

AEMO will also provide ad-hoc confidential reporting to the relevant Market Participant whenever their MP5F is manually disabled (including reason) or enabled by AEMO.

With regard to the publication of data, NER 3.13.4(p)(7) and (q)(1) require that AEMO publish all dispatch UIGF and dispatch targets the next trading day, respectively. AEMO intends to publish all the above information publically the next day.

AEMO will not publish details of the forecast provider, forecasting model or variable used in the production of forecasts, as this is confidential information.

Additional suggested metrics, including semi-dispatch cap flag and initial MW, are already available to the public.

2.5 Use of SCADA Possible Power for validation and reporting

AEMO proposed that Possible Power could be used in real-time validation by participants and in offline validation and reporting by AEMO (as a benchmark to compare their forecast performance).

2.5.1 Summary of submissions

Senvion, **Suzlon**, **UNSW** and **UniSA** noted that Possible Power would be a reasonable benchmark for validation in SDC intervals. However, several respondents did not agree with the use of Possible Power as a benchmark for forecast accuracy (**AGL**, **Akuo Energy**, **CWP Renewables**, **Infigen**, **Neoen**, **Tilt**). It was noted that the Possible Power signal is defined at the vendor/ OEM's discretion, making it inconsistent between facilities and potentially an unreliable benchmark signal (**AGL**, **Akuo Energy**, **CWP Renewables**, **Tilt**). A number of alternate suggestions were given by these respondents:

- For non-SDC intervals: Benchmark dispatch level against active power for non-SDC intervals (**Neoen**, **Proa Analytics**, **Solcast**, **Tilt**).
- For SDC intervals: **AGL** and **Neoen** suggested excluding these intervals from the performance benchmark calculation. Whereas, **Tilt** noted that this approach could also be used for SDC intervals to catch when the forecast was too high. They noted that this process would not assess if the forecast was too low, but the participant would be suitably incentivised to provide a high enough forecast in these SDC intervals.
- **CWP Renewables** suggested defining the Possible Power signal before incorporating it as a benchmark.

2.5.2 AEMO's comments

If available, Possible Power may be used by AEMO as part of an analysis suite for offline weekly checks. This would be a separate measure to determine performance in SDC intervals. Active power would be used for non-SDC intervals.

AEMO acknowledges that Possible Power definition varies between vendors/ OEMs and proposes to define it in Energy Conversion Model (EMC) as optional signal. In order to make this change an ECM consultation will need to be opened.

AEMO does not agree with the suggestion to exclude SDC intervals from the MP5F weekly performance measures. The absence of a performance measure for these intervals would unduly expose AEMO to the risk of scheduling errors. AEMO retains the right to reject forecasts during these periods if causing large dispatch errors or power system security issues.

2.6 Additional comments

2.6.1 Summary of submissions

Additional comments were made on the following:

1. Submitting forecasts for a more granular time interval (sub 5-minute) and whether an increased visibility over short term forecasts was beneficial to AEMO (**AGL, GE**).
2. Use of MP5F with batteries (specifically how the battery would affect the registration category). (**AGL**,)
3. Whether the MP5F would be extended to non-scheduled generators (**Infigen**, **Neoen**).
4. Inclusion of a causer pays factors (CPF) feedback loop as part of the real-time reporting (**GE**).

2.6.2 AEMO's comments

1. AEMO considers sub-5 minute forecasts out of scope for MP5F.
2. The proof of concept only encompasses facilities registered as Market Semi Scheduled. Facilities are subject to the current registration requirements under the NER Chapter 2 and the interim arrangements for utility scale battery technology.
3. AEMO considers the MP5F for non-scheduled units to be out of scope of the current work. Although AWEFS produces dispatch forecasts for significant non-scheduled wind farms, these forecasts are not currently used in Dispatch. AEMO considers the visibility of non-scheduled generators to be critical in maintaining power system security in the NEM and sees the value in considering this for a future piece of work.
4. AEMO considers the inclusion of CPF out of scope of this trial. This proof of concept focuses on the improved 5-minute ahead forecast. As a metric for success, it is impractical to isolate the impact of improved 5-minute forecast from the natural 4-second intermittency.

APPENDIX A. SUMMARY OF SUBMISSIONS AND AEMO RESPONSES

No.	Question No.	Respondent	Comment	AEMO Response
1.	2	AGL	"AGL would like to be able to submit a negative MW forecast"	Addressed in S2.3.2.
2.	2	AGL	"AGL proposes that the "MW Error Threshold" be a percentage of the wind or solar farm maximum capacity. The acceptable percentage error would be constant for each site, but the acceptable absolute MW error would be proportional to the size of the site."	Noted in S2.2.1.
3.	3	AGL	AGL agrees with the real time validation logic shown on slide 18 of the slide pack.	Noted in S2.3.1.
4.	4	AGL	"In addition to the items listed on slide 19 of the slide pack, AGL would like to include the rolling forecast error (signed error) for each forecast, the "initial MW" for the dispatch interval, and the state of the "SDC flag"."	Noted in S2.4.1.
5.	4	AGL	"AGL would like to view detail of which "ANEMOS" forecast is used: "ANEMOS" forecast, "Persistence" or "Previous Target"."	Noted in S2.4.1.
6.	5	AGL	"Since different algorithms are used by different wind turbine vendors, and turbine types of the same vendor, AGL does not agree with the proposal of using a "possible power" tag as a measure of prediction accuracy. AGL would like SDC intervals to be excluded from the performance benchmark calculation; forecast performance will only be compared with actual generation during non-SDC intervals, measured at the point of connection."	Noted in S2.5.1.
7.	6	AGL	"AGL would like to propose MACARTH1 as a participant in the trial. It is Australia's largest wind farm, and also one of the worst performers in terms of "causer pays" factors". AGL would like to propose NYNGAN1 as a participant in the trial. It is Australia's largest solar farm. AGL would like to propose WPWF as a participant in the trial. AGL believes there is just as much value in producing a MP5F for the non-scheduled assets as there are for the semi-scheduled assets. AGL would like to propose a wind or solar farm that has been registered for FCAS participate in the trial."	Project proposals for the trial should be submitted to ARENA.
8.	6	AGL	"AGL would like to understand how we will be officially notified of a poor performing forecast and the process to re-enable a MP5F after it has been "turned off"."	Further information to be provided on API requirements and process, noted in S2.1.2.
9.	6	AGL	"AGL would like to understand more about the API technical details."	Further information to be provided on API requirements and process, noted in S2.1.2.
10.	6	AGL	"AGL would like to understand how the 5MPF may be used when batteries start being installed behind the point of connection of semi-dispatchable sites? Will the site remain semi-dispatchable, and therefore require a 5MPF signal, or would the site be registered as dispatchable?"	Addressed in S2.6.2.
11.	6	AGL	"AGL would like to trial submitting a forecast at more frequent intervals than 5-minutes (i.e. 1 minute intervals). We are interested to know if there is any benefit to other markets (i.e. regulation FCAS) if AEMO had greater visibility of shorter term forecasts."	Noted in S2.6.1.

No.	Question No.	Respondent	Comment	AEMO Response
12.	1	Akuo Energy	"We are in favour of a Web API submission which allow the participant to submit forecasts within the right time frame. However, submitting / editing a report through a web API could be time consuming depending on the frequency and the process of the submissions. Could you precise how scalable your infrastructure will be (slide 14)?"	Further information to be provided on API requirements and processes, noted in S2.1.1.
13.	2	Akuo Energy	"Benchmark on forecast error should not prevent a participant from sending a forecast to AEMO. The participant will already be warned by AEMO through the weekly report and be turned off in case its forecasting performance is not good enough."	AEMO will always accept MP5F submissions, but won't use them if validation checks fail.
14.	4	Akuo Energy	"AEMO should not disclose forecast information to the public. Indeed, the operators have confidentiality agreements with forecasters preventing them to disclose this information. Additionally, various sets of data are purchased in order to perform the forecast, and disclosing them will result in giving the information for free to the public."	Addressed in S2.4.2.
15.	5	Akuo Energy	"SCADA Possible Power is not a good performance benchmark. The calculation method is different according to each operator so comparing forecasts based on this value would not be accurate."	Noted in S2.5.1.
16.	6	Akuo Energy	"No mention of remuneration system has been done during the workshop. However, the investment needed to set up the forecasting system is substantial, so does AEMO intend to compensate the participants in any way?"	AEMO will not fund the Web API development costs. For information on the potential proof of concept, contact arena at forecasting@arena.gov.au.
17.	1	CSIRO	"The proposed self-forecasting submission structure and data fields are generally acceptable, but we believe that the additions as noted in question 2 would improve the process."	Noted in S2.1.1.
18.	2	CSIRO	"More clarity around the MP5F forecast's meaning and how forecast accuracy will be evaluated by AEMO would be advantageous … Most modern forecasting techniques allow for probabilistic outputs, and this should be strongly considered for inclusion in the self-forecasting specification."	If the participant deems that probabilistic forecasting will assist with determine the quality of their forecast, then they may use this metric. Intention to distribute additional information noted in S2.1.2. Use of probabilistic forecasts in participant validation noted in S2.2.1.
19.	2	CSIRO	"Forecasts with longer lead-times than 5 minutes should also be considered."	Addressed in S2.1.2 and 2.2.2.
20.	2	CSIRO	"More clarity is also desirable around when bids will be accepted prior to the dispatch interval, how often forecasts can be re-submitted, and which will be accepted for final consideration."	Further information to be provided on API requirements and process, noted in S2.1.1.
21.	4	CSIRO	"Information released to the public should also include, for each participant: • All forecasts submitted, with submission timestamps. • Key variables used in producing the forecast such as irradiance, wind speed & direction. • Power actually dispatched during the interval. • Data on any factors influencing power dispatched, such as dispatch caps. Market participants should have access to this data in real time, to accommodate additional uses for this data (such as by Energy Services Companies)."	Noted in S2.4.1.

No.	Question No.	Respondent	Comment	AEMO Response
22.	2	CWP Renewables	"Forecast within range (0->Max Capacity) validation doesn't allow for MW consumption of intermittent generators at 0 MW output."	Addressed in S2.3.2.
23.	3	CWP Renewables	"Forecast within range (0->Max Capacity) validation doesn't allow for MW consumption of intermittent generators at 0 MW output. This could be anywhere between 0-2% of maximum output. Suggestion: range changed to reflect the maximum consumption, i.e. (Max_consumption =< Output =< Max_Capacity)."	Addressed in S2.3.2.
24.	5	CWP Renewables	"The definition of the "Possible Power" signal is defined at the vendor's/OEM's discretion, and is therefore potentially an unreliable reference signal. Suggest defining possible power signal, or other, to reflect a distinctly defined quantity (e.g. Possible (Active) Power, Mean Active Power over 5-minutes, etc) and certifying the signal for use before incorporating as a benchmark in any interval."	Addressed in S2.5.2.
25.	6	CWP Renewables	"If (intermittent) generators are expected to provide a MP5F signal, or in fact any future interval, perhaps the anticipated/predicted wind/irradiance conditions should be offered to each generator as an input. If generators are expected to provide their own short-term predictions, then it is likely that generators would require support to realise that capability."	AEMO doesn't forecast wind speed of solar irradiance. For information on the potential proof of concept, contact arena at forecasting@arena.gov.au.
26.	NA	Foresight Group	"Note that if the MP5F forecast is worse than ANEMOS forecast then the MP5F forecast will not be used. My initial comment is it will be interesting to see how often this occurs in practice."	The MP5F will always be used unless the associated quality flag indicates 'don't use', it fails AEMOs real time validations or has been turned off following failed offline validation checks process.
27.	1	GE	"We believe that a design based on a Web API would be an improvement on the "Estimated Power" tag in the SCADA and that the structure proposed covers all the tags required."	Noted in S2.1.1.
28.	1	GE	"We would recommend referring to the standards and best practices below for market data access: ERCOT: http://www.ercot.com/mktrules/nprotocols/current in particular Load Forecasting requirements: - Protocol section -3.2.2 Long-Term Demand Forecasts - Protocol section -3.12 Load Forecasting - Protocol section -4.2.2 Wind Powered Generation Resource Production Potential. - Protocol section-4.2.3 Posting Forecasted ERCOT System Conditions - Protocol section -5.5.1 Security Sequence - Protocol section -8.2 ERCOT Performance Monitoring and Compliance PJM: http://www.pjm.com/markets-and-operations/etools/edatafeed.aspx ISO-NE: https://www.iso-ne.com/participate/support/web-services-data."	Noted in S2.1.1.
29.	1	GE	"We would also require additional detail and further discussion on cybersecurity to ensure data integrity."	Further information to be provided on API requirements and process, noted in S2.1.1.
30.	1	GE	"We would recommend UTC timestamps. Also need to consider wind farm time zones for data submission"	As the NEM operates on AEST, these time stamps will be used in preference to UTC.
31.	2	GE	"We believe that the minimum forecast range should allow negative values."	Addressed in S2.3.2.

No.	Question No.	Respondent	Comment	AEMO Response
32.	2	GE	"We believe that Participants data validation should be optional but driven by the need to ensure their submissions are accepted and to increase forecasting accuracy. Hence this shouldn't be a requirement as such."	Addressed in S2.3.2.
33.	4	GE	We are comfortable with the proposed approach.	Noted in S2.4.1.
34.	5	GE	"We would welcome the opportunity to discuss what this benchmark would be used for and how it would affect the [Causer Pays Factors]."	Addressed in S2.6.2
35.	6	GE	Given that the main objective for the market operator and participants is to optimise the FCAS requirements (hence reducing Causer Pays charges), it would be great to ensure that we drive and measure forecast accuracy based on its impact on the Causer Pays Factor of each wind farm (in isolation from their potential broader portfolios). A couple of ideas that could improve the alignment between Self-forecast and Causer Pays: 1. including a CPF feedback loop as part of the real-time reporting. In particular the CPF with ANEMOS forecast vs CPF with Self-forecasting over the last 5min interval; and 2. increasing the resolution of the self-forecast (e.g. forecast the power every minute within the 5min interval instead of just forecasting the instantaneous power at the end of the interval). We believe that the second one could be looked at longer terms as it might require broader market changes to have an impact. However, the first one would be a great way to incentivise the best outcome for both the market and the wind/solar generators."	Addressed in S2.6.2
36.	1	Infigen	"Overall the proposed structure of the data submission looks good, however we think the submission should also include a way for participants to elect to use the ANEMOS forecast that doesn't involve tagging the data quality as 'bad.' We are of the view that data quality should be separated from forecast accuracy so that at any time 'good' quality data can be communicated to indicate a 'bad' forecast. We propose that the MP5F Quality signal be split into two distinct signals: - Data Quality signal including "range check", "logical checks", "inputs data quality checks", etc. - MP5F Use (binary value for use/not use) This would cover situations where the data quality is good but there's a preference to use the ANEMOS forecast instead of MP5F."	Data structure information noted in S2.1.1. MP5F quality signal addressed in S2.1.2.
37.	1	Infigen	"AEMO should send back to participant the Run_DateTime heartbeat with the MP5F acknowledgement time (i.e. when the signal was received by AEMO) and flag whether the forecast was used by AEMO (i.e. was received in time to be used by AEMO)."	Further information to be provided on API requirements and process, noted in S2.1.1. Information on which forecast was used would be provided in the real time reporting (S2.4).
38.	2	Infigen	"Range: The forecast range should include negative values (i.e. to account for auxillary load). Frozen forecast: We don't believe testing for 'not frozen' specifically is relevant as it should be reflected more broadly in the 'data quality signal' we agree should be added to the submission signal. (see question 1)	Addressed in S2.3.2.
39.	2	Infigen	"Forecast error: Infigen does not think participants should be responsible for ensuring the forecast error is consistently more accurate than the benchmark."	Addressed in S2.3.2.

No.	Question No.	Respondent	Comment	AEMO Response
40.	2	Infigen	"Benchmark: Infigen does not believe SCADA Possible Power value can be used as the forecast accuracy benchmark for a range of various reasons: - OEM's Possible Power data does not perfectly reflect what the park possible generation is… - …believe the decision on which forecast (self-forecast or ANEMOS) is used should be made by AEMO. How would AEMO access to the Possible Power data to decide which forecast is consistently more accurate? … - The Possible Power is usually not calculated at the initial MW reading measurement point… Infigen's suggestion is to exclude SDC dispatch interval from the forecast performance assessment."	Addressed in S2.5.2.
41.	3	Infigen	"AEMO should validate that the self-forecast performs consistently better than ANEMOS. AEMO should be able to switch between ANEMOS and the self-forecast and always use the most accurate (with system security priority in mind)."	Addressed in S2.3.2.
42.	4	Infigen	"All information on the slide can be public the next day. It would be useful to have in addition to which forecast has been used in dispatch, the reason why MP5F wasn't used when that's the case (ie signal quality bad, no data received, not as accurate as AWEFS etc)"	Noted in S2.4.1.
43.	5	Infigen	"Is AEMO considering including non-scheduled generators in the self-forecasting trial?"	Addressed in S2.6.2.
44.	6	Infigen	"As a result of this program, it would be interesting for the industry to understand the network and operational benefits of better intermittent generation forecasting (e.g impact on frequency and regulation requirements)."	AEMO intends to publish findings to the market following the proof of concept.
45.	6	Infigen	"The primary driver for wind farms implementing a forecast shouldn't be the reduction in FCAS cost but the added benefit to system security. (slide 9)"	AEMO notes this comment.
46.	6	Infigen	"Can you confirm the long-term aim is to use self-forecast for pre-dispatch as well?"	PD is out of scope of the current MP5F project.
47.	6	Infigen	"Will data sent to AEMO more than 5 minutes before a DI (for that DI) be used?"	Further information to be provided on API requirements and process, noted in S2.1.1.
48.	1	Neoen	"Looks good"	Noted in S2.1.1.
49.	2	Neoen	"I'm concerned about the "frozen" check. I think it has a high chance of a false positive. AEMO's performance check of MP5F could pick up a legitimately frozen forecast."	Addressed in S2.3.2.
50.	4	Neoen	The self-forecast is technically private data. More thought on this required.	Addressed in S2.4.2.
51.	5	Neoen	"I would prefer active power, and don't benchmark periods with a semi dispatch cap. That creates problems if units are frequently constrained though."	Addressed in S2.5.2.
52.	1	Proa Analytics	"Proa is happy with the proposed data submission requirements."	Noted in S2.1.1.
53.	1	Proa Analytics	"We would like to see more details on the proposed authentication and receipt of submission procedures."	Further information to be provided on API requirements and process, noted in S2.1.1.
54.	2	Proa Analytics	"Proa is satisfied with the proposed validations."	Noted in S2.3.1.

No.	Question No.	Respondent	Comment	AEMO Response
55.	4	Proa Analytics	"Proa supports transparency in self-forecasts. We see no adverse commercial impacts to publishing forecast information on the next day, and we are happy to for all the information on slide 19 to be published."	Noted in S2.4.1.
56.	4	Proa Analytics	"We suggest a 30 day period for the Rolling Forecast Error, although 7 day would also be suitable."	Addressed in S2.4.2.
57.	5	Proa Analytics	"As a general principle, Proa supports performance measurements using actual measurements where possible. In this case, however, we do not object to using SCADA Possible Power to calculate the performance benchmarks."	Noted in S2.5.1.
58.	6	Proa Analytics	"Proa believes this is an important project for the market and supports the implementation of self-forecasting by participants."	AEMO notes support.
59.	1	Senvion Australia	"Currently our wind farm control systems are not exposed to public internet and remote access via secure VPNs. Please consider Cyber security aspects associated with proposed IT Interface."	Addressed in S2.1.2
60.	1	Senvion Australia	"We have no web API available in either the wind farm SCADA. It would have to be developed at additional cost and time if required. Comprehensive technical manual and technical support should be available from AEMO if this interface is to be developed."	Noted S2.1.1.
61.	1	Senvion Australia	"Senvion believes strongly that existing AEMO to generator interfaces should be used to provide any new data points. Specifically the existing NSP (DNP3 SCADA) interface or the existing Marketing/Bidding database interface (MMS interface)."	Noted in S2.1.2.
62.	5	Senvion Australia	"Senvion have found that the possible power signal (provided as (current time) "capable active power" in the Senvion SCADA system and using this as a forecast of power output 5 minutes ahead in time) is generally accurate to within a reasonable confidence interval. Senvion may be able to share analysis with AEMO on a confidential basis. Future Senvion SCADA software versions seek to improve the accuracy of the "capable active power" signal. Analysis has shown that the current available power signal is most inaccurate when prevailing weather conditions cause a sudden drop in wind speed."	AEMO welcomes the Senvion analysis on Possible Power.
63.	1	Solcast	"Solcast strongly supports the use of a Web API for the forecast submissions. "	Noted S2.1.1.
64.	1	Solcast	"The AEMO web API must be secured with token encryption … API messages need to be 'signed' each way. Usage of a non-SCADA system is not without risk. … Security (based primarily on education of API users) is a key concern here, but is primarily due to risky behaviour by the API users with their API keys."	Noted S2.1.1.
65.	3	Solcast	""Benchmarks" are not clear."	Addressed in S2.3.2
66.	3	Solcast	"Solcast suggests that a persistence forecast be utilised for solar forecasts; meaning that the benchmark forecast uses the current observed power output value from the farm (total MW) as the forecast at t+5min."	Noted in S2.2.1.
67.	3	Solcast	"The definition of 'consistently worse' needs to be clarified. Particularly, if persistence is selected as a benchmark, not all forecasts will outperform persistence under all conditions."	Noted in S2.2.1.

No.	Question No.	Respondent	Comment	AEMO Response
68.	3	Solcast	"MAE as a metric will have issues with non-stationarity due to changes in sun intensity with time of day for solar forecasting errors. Larger errors will be more common during the middle of the day, with smaller absolute errors in the evening. Modern solar forecasting evaluations use a skill score (S) calculation, computed as: S = 1 – (RMSE_self-forecast / RMSE_peristence-forecast) This can be further explored in the provided manuscript: http://coimbra.ucsd.edu/publications/papers/2013_Inman_Pedro_Coimbra.pdf"	Noted in S2.2.1.
69.	4	Solcast	"Solcast does not recommend publication of the participant self-forecast, as this is not aligned with industry standards, and exposes forecast vendors to unsolicited third-party reviews of their performance which could be cherry-picked by competitors."	Addressed in S2.4.2.
70.	5	Suzlon Energy Australia	"SCADA possible power is better tag to consider and in addition if we can include tag with available turbine for next 5 minutes from Wind Farm Power Plant Controller (PPC) will be beneficial. As PPC will be able to predict most of the Scheduled activity which is going to happen for next 5 minutes. Eg:Pitch Lubrication,Pitch Safety Test, Cable auto unwind."	Noted in S2.5.1.
71.	1	Tilt Renewables	"We agree that the Web API is an appropriate interface that is scalable for future needs and the data listed is suitable."	Noted in S2.1.1.
72.	1	Tilt Renewables	"ECM at present lists "Estimated Power" under "Wind farm SCADA to AEMO", as an optional signal. If AEMO doesn't intend to use this signal, the ECM needs to be modified to remove it, and potentially add the MP5F in some form. OEMs and others may be developing systems based on the ECM."	SCADA Estimated Power is optional in ECM. It will be reviewed in the next ECM consultation.
73.	1	Tilt Renewables	"Authentication is a key issue that we would like to see further information on – what this requires us to do, and how participant security is assured. We would also like further information on the response from the Web API – e.g. "ok", "malformed request", "authentication failed" etc. Also, would this be accessible only through a MarketNet connection, or directly from the Internet? Our preference is directly from the Internet to simplify interactions with the providers of the forecast, as long as the authentication is sufficient."	Further information to be provided on API requirements and process, noted in S2.1.1.
74.	2	Tilt Renewables	"To ensure consistency between participants, we propose that AEMO does not specify the validations required by the participant but instead does its own validation. The "not use" flag is still of value if the participant identifies an issue (for any reason) with its own forecast, but its systems still make a submission."	Addressed in S2.3.2.
75.	2	Tilt Renewables	"It would be useful to the participant for AEMO to provide a list of suggested validations to the participant, but not to rely on the participant to implement them."	Noted in S2.2.1
76.	2	Tilt Renewables	"We strongly disagree with the requirements on the participant to benchmark performance: - We consider a 15-minute window (only 3 samples) to be too short for benchmarking… We consider Possible Power to be a poor benchmark, as it varies between turbine models and can be particularly poor for old models (especially around high-wind cutout etc.). … Instead, we suggest: Compare the dispatch level to the actual MW, to catch when the forecast was too high. It's not possible to assess if the forecast was too low, but you can rely on the participant losing revenue when capped to a forecast that is too low as a strong incentive to get it high enough."	15-minute MAE is notes in S2.2.1. Possible Power addressed in S2.5.2.
77.	3	Tilt Renewables	"We believe AEMO should implement all the validation rules regardless of what the participant may or may not be doing, and that AEMO should implement any performance validation itself using the methodology."	Addressed in S2.3.2.

No.	Question No.	Respondent	Comment	AEMO Response
78.	3	Tilt Renewables	"As well as notification of which forecast was used by AEMO, we would like an indication of the reason for its rejection, including the metric it was benchmarked against if appropriate."	Reason for rejection metric addressed in S2.4.2.
79.	3	Tilt Renewables	"The definition of "Mean Absolute Error" needs to be further defined to say the timeframe it refers to – is it the last 1-min average of the Actual MW, or a snapshot (e.g. INITIALMW)?"	Instantaneous active power measured at dispatch time. Addressed in S2.2.2.
80.	3	Tilt Renewables	"AEMO needs to be very clear about the "forecast stuck" rules, as these could be difficult for solar farms, when at maximum or minimum output, and limits local to the windfarm that may appear the forecast is stuck need to be considered."	Addressed in S2.3.2.
81.	4	Tile Renewables	"For public reporting: we would find useful a series of rolling forecast performance indicators – e.g. 15 min, 1 hr, 1 day, 1 month, etc, for ready review of performance, and for comparison with other participants. We suggest that AEMO could publish all of the information listed on slide 19 in the interests of transparency."	Addressed in S2.4.2.
82.	1	UNSW	"The format appears reasonable …a probability index would also be useful to include … along with the variables that were used to create the power forecast e.g. wind speed, wind direction, GHI etc."	Data structure noted in S2.1.1. Probabilistic forecasts addressed in S2.1.2.
83.	2	UNSW	"Probabilistic forecasting of solar irradiation would reduce the uncertainty/certainty associated with a forecast, which in turn assists in validation of the forecast."	If the participant deems that probabilistic forecasting will assist with determine the quality of their forecast, then they may use this metric. Noted in S2.1.1.
84.	2	UNSW	"One aspect in the validations that is also missed is any sudden event, as if only validating on a 15 minute MAE, you aren't looking at a long time frame. You would also look at RMSE to capture how well the forecast is capturing the sudden events."	Noted in S2.2.1.
85.	3	UNSW	"The validation rules for accepting a forecast seem reasonable."	Noted in S2.3.1.
86.	4	UNSW	"ANEMOS forecast and rolling forecast error"	Noted in S2.4.1.
87.	5	UNSW	"Seeing as the forecast is a prediction (or prediction interval) of possible power using that value as a benchmark for validation would seem reasonable."	Noted in S2.5.1.
88.	6	UNSW	"AEMO could actually make use of the self-participant forecasts to create their own blended forecast model."	AEMO notes this.
89.	1	UniSA	"The format appears reasonable … some estimates of quantiles apart from just the 50th would also be useful to include … along with the variables that were used to create the power forecast (e.g. wind speed, wind direction, GHI, ambient temperature etc)."	Data structure noted in S2.1.1. Probabilistic forecasts addressed in S2.1.2.

No.	Question No.	Respondent	Comment	AEMO Response
90.	2	UniSA	"AEMO stated that they are interested in the quality of the forecasts. … There are two inherent ways to characterize the quality. One is to simply examine whether the forecast is feasible, that is within the physical limits for the output of the installation, and sensible given the recent history of output. This could be enhanced by reference to dynamically changing limits if there are seasonality influences to be considered. One other estimation of quality is derived from constructing a probabilistic forecast. ... A probabilistic forecast on a half hour or hour horizon can be very useful. If in this case the PI is considered to be wide, then presumably the operator would have enough time to call on lower cost resources to fill the gap, in the case that the actual output is at the lower end of the interval."	Dynamic limit threshold noted in S2.2.1. If the participant deems that probabilistic forecasting will assist with determine the quality of their forecast, then they may use this metric. Noted in S2.1.1.
91.	2	UniSA	"One aspect in the validations that is also missed is any sudden event, as if only validating on a 15 minute MAE, you aren't looking at a long time frame. You would also look at RMSE to capture how well the forecast is capturing the sudden events."	Noted in S2.2.1.
92.	3	UniSA	"They seem reasonable."	Noted in S2.3.1.
93.	4	UniSA	"ANEMOS forecast and rolling forecast error, along with notice of any critical events."	Noted in S2.4.1.
94.	5	UniSA	"Seeing as the forecast is a prediction (or prediction interval) of possible power it would seem sensible to use that value as a benchmark for validation."	Noted in S2.5.1.
95.	6	UniSA	"AEMO could actually make use of the self-participant forecasts to create their own blended forecast model. There are good optimisation tools to be able to select the best members or combination of members at various epochs."	AEMO notes this.
96.	2	Windlab	"My concern is with the frozen forecast prediction. For wind (and solar) I expect it will be quite common to predict an unchanging max capacity, or unchanging zero output. So, a frozen prediction at either of these levels should not be taken to be invalid."	Addressed in S2.3.2