Semi-Scheduled Generation Dispatch Self-Forecast – Assessment Procedure

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Current version release details

Version	Effective date	Summary of changes
~~3~~4.0	~~4 April~~12 July 2023	~~Reduced dispatch SF gate-closure time to 10 seconds (was 15 seconds).~~Added clarification regarding source of UIGF in MMS Data Model table.

Note: There is a full version history at the end of this document.

1. Introduction

1.1. Purpose and scope

AEMO has prepared this document for information purposes only. It provides information about the process that AEMO intends to follow for its initial and ongoing assessment of participant-provided dispatch self-forecasts for *semi-scheduled generating units*.

The National Electricity Rules (**NER)** and the National Electricity Law prevail over these procedures to the extent of any inconsistency.

1.2. Definitions and interpretation

1.2.1. Glossary

Terms defined in the National Electricity Law and the NER have the same meanings in these procedures unless otherwise specified in this clause.

Terms defined in the NER are intended to be identified in these procedures by italicising them, but failure to italicise a defined term does not affect its meaning.

The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in these procedures.

References to time are references to Australian Eastern Standard Time.

Term	Definition
AEMO	Australian Energy Market Operator
ASEFS	Australian Solar Energy Forecasting System
AWEFS	Australian Wind Energy Forecasting System
AWEFS_ASEFS	AWEFS/ASEFS forecasting systems
DUID	Dispatchable Unit Identifier
ECM	*Energy Conversion Model* for AWEFS and ASEFS
EMS	Energy Management System
FCST	Short for 'forecast' - AEMO's EMS calculated initial dispatch UIGF
MAE	Mean Absolute Error
NEMDE	National Electricity Market Dispatch Engine
PP	SCADA Possible Power
RMSE	Root Mean Squared Error
SCADA	Supervisory Control and Data Acquisition
SF	Participant's 5-minute ahead Dispatch Self-Forecast of unconstrained intermittent generation from a semi-scheduled generating unit
UIGF	*Unconstrained Intermittent Generation Forecast*
Web API	Web Application Programming Interface

1.2.2. Interpretation

The following principles of interpretation apply to these Procedures unless otherwise expressly indicated:

(a) These Procedures are subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

(b) References to time are references to Australian Eastern Standard Time.

1.3. Related documents

Title	Location
Semi-Scheduled Generator Self-Forecast - Application Form	https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/nem-forecasting-and-planning/operational-forecasting/solar-and-wind-energy-forecasting/participant-forecasting

2. Background

AEMO must prepare a forecast of available capacity for wind and solar generating units (to be known as an unconstrained intermittent generation forecast (UIGF)) in accordance with rule 3.7B for the purposes of the dispatch, pre-dispatch and projected assessment of system adequacy processes (that is, forecasts for the period 5 minutes to 2 years ahead). This procedure is only concerned with the UIGF for 5 minutes ahead.

When preparing a UIGF, AEMO must take into account a number of matters set out in clause 3.7B(c). AEMO currently uses the Australian Wind Energy Forecasting System (AWEFS) and Australian Solar Energy Forecasting System (ASEFS) as part of this process.

AWEFS and ASEFS use a combination of statistical and numerical weather prediction-based forecasting models fed by the following inputs:

- Supervisory Control and Data Acquisition (SCADA) measurements from the power station.
- Numerical weather prediction data from multiple weather data providers.
- Standing data from the power station as defined in the Energy Conversion Model (ECM).
- Additional information provided by the power station, including inverter/ turbine availability and upper MW limit on the facility.

The 5-minute ahead UIGFs from AWEFS and ASEFS are used by AEMO's National Electricity Market Dispatch Engine (NEMDE) to determine the dispatch of semi-scheduled wind and solar generating units.

In 2018, a Market Participant Self-Forecasting trial was initiated as a collaboration between AEMO, the Australian Renewable Energy Agency (ARENA) and industry (forecasting service providers, existing and new wind/solar generators) to explore the benefits of self-forecasting unconstrained wind and solar generation. The initial focus of the trial is to determine the relative benefits of using the participant's 5-minute ahead dispatch self-forecast (SF) in dispatch, in preference to the equivalent forecast from AWEFS or ASEFS.

This document defines the participant 5-minute ahead dispatch self-forecast and explains the process and criteria that AEMO intends to apply when assessing the suitability of participant self-forecasts for use as UIGFs in dispatch.

3. Participant Dispatch Self-Forecast

This section sets out requirements that a participant's dispatch self-forecast must meet for the purposes of use as UIGFs in dispatch.

The participant's dispatch SF is the Semi-Scheduled Generator's forecast, in megawatts, of unconstrained intermittent generation from a semi-scheduled generating unit at the end of the next dispatch interval, subject only to technical factors affecting operation of its generation and connection assets. The participant dispatch SF must be referenced to the same location as the agreed dispatch point, which corresponds to the location of the generating unit's SCADA active power signal used in AWEFS and ASEFS and defined in the relevant ECM.

The participant dispatch SF must be calculated assuming limits managed by AEMO through the central dispatch process (including applicable distribution or transmission network limits) do not apply at the end of the next dispatch interval.

The participant dispatch SF must be capped at all local limits that are forecast to apply at the end of the next dispatch interval. These are defined under "SCADA Local Limit" in the relevant ECM[1].

The participant dispatch SF must not be negative and must not exceed the generating unit's registered Maximum Capacity[2].

Participant dispatch SF is not eligible for use by AEMO unless AEMO is satisfied that it meets the reliability and accuracy requirements described in this procedure.

AEMO expects that the participant would already have tested any new forecasting model underlying their dispatch SF before submitting it to AEMO for assessment and use in dispatch. AEMO also expects that dispatch SF submissions would include the unique Model ID assigned by AEMO associated with each underlying forecasting model.

Note that AEMO only interacts directly with the participant, and not any third-party forecast providers. It remains a participant's responsibility to coordinate the forecasts across their forecast providers.

[1] At http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Solar-and-wind-energy-forecasting.

[2] The registered Maximum Capacity is an integer, typically rounded-down from the Maximum Capacity stated in the generator's Generator Performance Standards (GPS).

4. Initial Assessment

4.1. Process

Consistent with its power system security responsibilities, AEMO seeks to use the most accurate forecasts reasonably available.

Before a participant dispatch SF is eligible for acceptance for use in dispatch, AEMO will assess its performance against the forecasts produced by AWEFS or ASEFS as applicable ("AWEFS_ASEFS"). This assessment is performed to provide a reasonable level of assurance that the SF will not provide materially worse inputs to dispatch than the current forecasts from AWEFS_ASEFS. AEMO's assessments are based on the overall SF, and will not differentiate between different model forecasts[3].

As shown in Figure 1, the steps in the initial assessment process are:

1. Participant works with AEMO to implement their SF into AEMO's web API pre-production and then production environments. During this stage, the participant is able to submit SF to AEMO's production environment for assessment purposes, but AEMO initially suppresses its use in dispatch. AEMO only assesses SFs collected within its production environment.
2. Participant advises the earliest dispatch interval after which AEMO should include SFs in its assessments.
   - AEMO's assessment window covers full calendar weeks and ends at midnight AEST on Mondays[4] (or as otherwise advised by AEMO). The minimum assessment window is eight weeks, so AEMO conducts its first assessment after eight weeks of collecting SFs.
   - For a solar DUID, the assessment window only includes dispatch intervals ending 0405 to 2100 AEST inclusive, to minimise biasing the assessment during night-time periods.
3. **Preliminary assessments:** AEMO conducts preliminary assessments over the current assessment window of the reliability of the SF submission process, and whether there are sufficient SF samples to conduct a SF performance assessment.
   - AEMO provides a summary of its preliminary assessments to the participant.
   - Refer to Section 4.2 for further details of the SF preliminary assessments.
4. If the SF fails the preliminary assessments, AEMO does not conduct a SF performance assessment and repeats the preliminary assessments next week extending the current assessment window by one week (up to a maximum of 16 weeks).
   - This process repeats each week until the SF passes the preliminary assessments.
5. **Performance assessment:** If the SF passes the preliminary assessments, AEMO conducts a SF performance assessment over the current assessment window.
   - AEMO provides both its preliminary and performance assessments and related information to the participant.

[3] If a participant submits multiple model forecasts, AEMO may, at the participant's request, assess the individual performance of each model separately and provide feedback to the participant. However, AEMO will only use overall self-forecast performance as the basis for acceptance for use in dispatch regardless of individual model performance.

[4] 00:00 (AEST) on Tuesdays

- Refer to section 4.3 for further details of the SF initial performance assessment.

6. If the SF fails the performance assessment, steps 3 to 5 are repeated next week extending the current assessment window by one week (up to a maximum of 16 weeks).
   - This process repeats each week until the SF passes the performance assessment.
7. If the SF passes the performance assessment, AEMO enables the SF for use in dispatch by unsuppressing the SF[5], and AEMO commences ongoing performance assessment of the SF.
   - AEMO automatically issues a report to the relevant participant when it unsuppresses the SF.

4.2. Preliminary assessments

Before AEMO can conduct a SF performance assessment and for a SF to be eligible for acceptance for use in dispatch, the SF must be reliably provided and there must be sufficient SF samples over the assessment window.

1. Minimum DIs for Reliable SF.
   - For at least 95% of dispatch intervals over the current assessment window, AEMO received a SF at least 10 seconds[6] prior to the start of the dispatch interval.
2. Minimum DIs for SF Performance Assessment.
   - AEMO will only conduct a SF performance assessment if at least 60% of dispatch intervals satisfy the following criteria over the current assessment window:
     i. the SF was used in dispatch[7] for the dispatch interval, or AEMO received an unsuppressed SF at least 10 seconds[6] prior to the start of the dispatch interval; and
     ii. for the dispatch interval, the generating unit's energy target was greater than or equal to its UIGF (that is, the generating unit is not constrained off), unless the participant submitted a good quality SCADA Possible Power[8] for the dispatch interval
   - AEMO will assess SF performance for all dispatch intervals that satisfy the above criteria over the current assessment window.
   - Note that the "Minimum DIs for SF Performance Assessment" test might fail if the generating unit is constrained off for significant periods and there is no good quality SCADA Possible Power provided to allow AEMO to assess SF performance in those intervals.

     This situation might occur during the initial commissioning stages of a new generating

[5] Even after AEMO approves a SF for use in dispatch, the relevant participant may suppress that SF for any dispatch interval via its Web API submission.

[6] AEMO recommends that participants submit a single or additional SF earlier (eg. at least 15 seconds prior to the start of the dispatch interval). This is to ensure that at least one SF is accepted in the Reliability and Performance assessments for the respective dispatch interval.

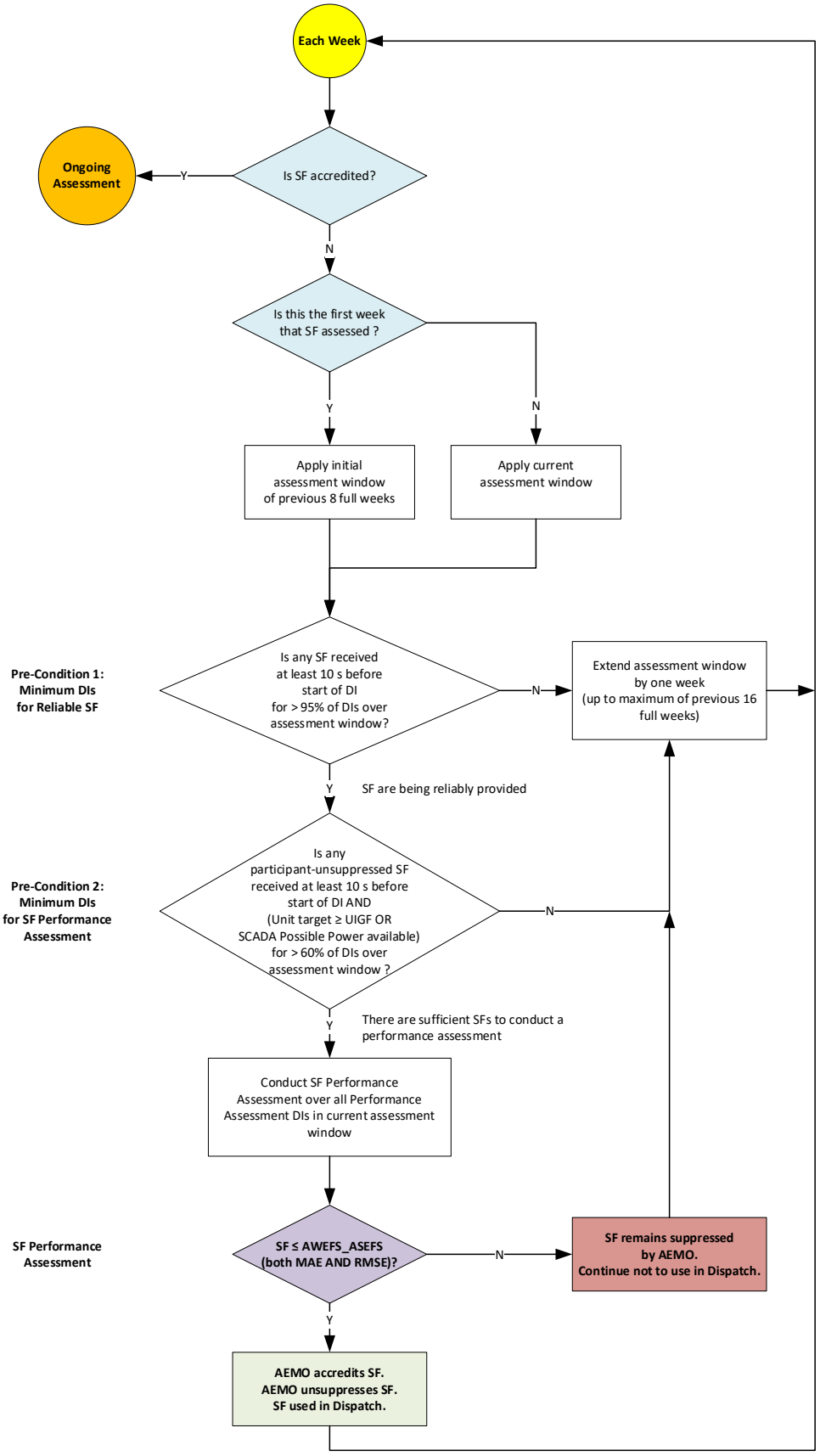
[7] Not relevant during the initial assessment stage

[8] AEMO may use Possible Power in this scenario where available, unless the participant indicates to the contrary prior to the initial assessment.

unit, or for an existing generating unit due to a binding system normal or outage constraint.

- This might delay the initial acceptance of a SF for use in dispatch.

Figure 1 Participant Dispatch Self-Forecast – initial assessment process



4.3. Initial performance assessment

The initial assessment involves comparing the relative performance of the SF and AWEFS_ASEFS against measures of Mean Absolute Error (MAE) and Root Mean Squared Error (RMSE) over the sample period. These measures are defined below.

The threshold for passing the MAE assessment is that, over the current assessment window, MAE_{SF} must be less than or equal to MAE_{AWEFS_ASEFS}, that is:

$$\boldsymbol{MAE_{SF} \leq MAE_{AWEFS\_ASEFS}}$$

The threshold for passing the RMSE assessment is that, over the current assessment window, $RMSE_{SF}$ must be less than or equal to $RMSE_{AWEFS\_ASEFS}$, that is:

$$\boldsymbol{RMSE_{SF} \leq RMSE_{AWEFS\_ASEFS}}$$

The SF must pass both the MAE and RMSE initial performance assessment tests to be eligible for acceptance by AEMO for use in dispatch.

Mean Absolute Error

For i = 1…n 5-minute intervals over the current assessment window, the calculations are:

$$MAE_{SF} = \frac{1}{n}\sum_{i=1}^{n} Absolute(SF_i - Actual_i)$$

$$MAE_{\text{AWEFS\_ASEFS}} = \frac{1}{n}\sum_{i=1}^{n} Absolute(\text{AWEFS\_ASEFS}_i - Actual_i)$$

Root Mean Squared Error

For i = 1…n 5-minute intervals over the initial assessment window, the calculations are:

$$RMSE_{SF} = \sqrt{\frac{\sum_{i=1}^{n}(SF_i - Actual_i)^2}{n}}$$

$$RMSE_{AWEFS\_ASEFS} = \sqrt{\frac{\sum_{i=1}^{n}(AWEFS\_ASEFS_i - Actual_i)^2}{n}}$$

Where:

$\boldsymbol{SF_i}$ = 5-minute ahead MW forecast from the participant for time i, which is the forecast that is not suppressed by the participant with the highest forecast priority number used in dispatch[9] or received on or before the dispatch gate closure time at i-10 seconds.

For participant forecasts of equal highest priority number, the forecast with the latest offer datetime on or before dispatch gate closure at i-10 seconds is used.

[9] Not relevant during the initial assessment stage

This is illustrated in Figure 2 below.

If no participant forecast satisfies the above criteria, the dispatch interval is not included in the "Minimum DIs for SF Performance assessment" and the SF performance assessment.

$AWEFS\_ASEFS_i$ = 5-minute ahead MW forecast from AWEFS/ASEFS for time i, or where there is no AWEFS/ASEFS forecast, the FCST or SCADA Initial MW is used as the default forecast[10].

$Actual_i$ =

IF
Energy Target $_i$ ≥ UIGF $_i$[11]
THEN

$$Actual_i = MAX(0, NEMDE\ Initial\ MW_{i+5minutes})$$

ELSE
Energy Target $_i$ < UIGF $_i$

IF
SCADA Possible Power (PP_i) is available and good quality:

$$Actual_i = MAX(0, PP_i)$$

ELSE

SCADA Possible Power is unavailable or bad quality
Dispatch interval is not included in the "Minimum DIs for SF Performance assessment**"** and the SF performance assessment

$NEMDE\ Initial\ MW_{i+5minutes}$ =

NEMDE SCADA active power MW at time i
(if SCADA active power is good quality)

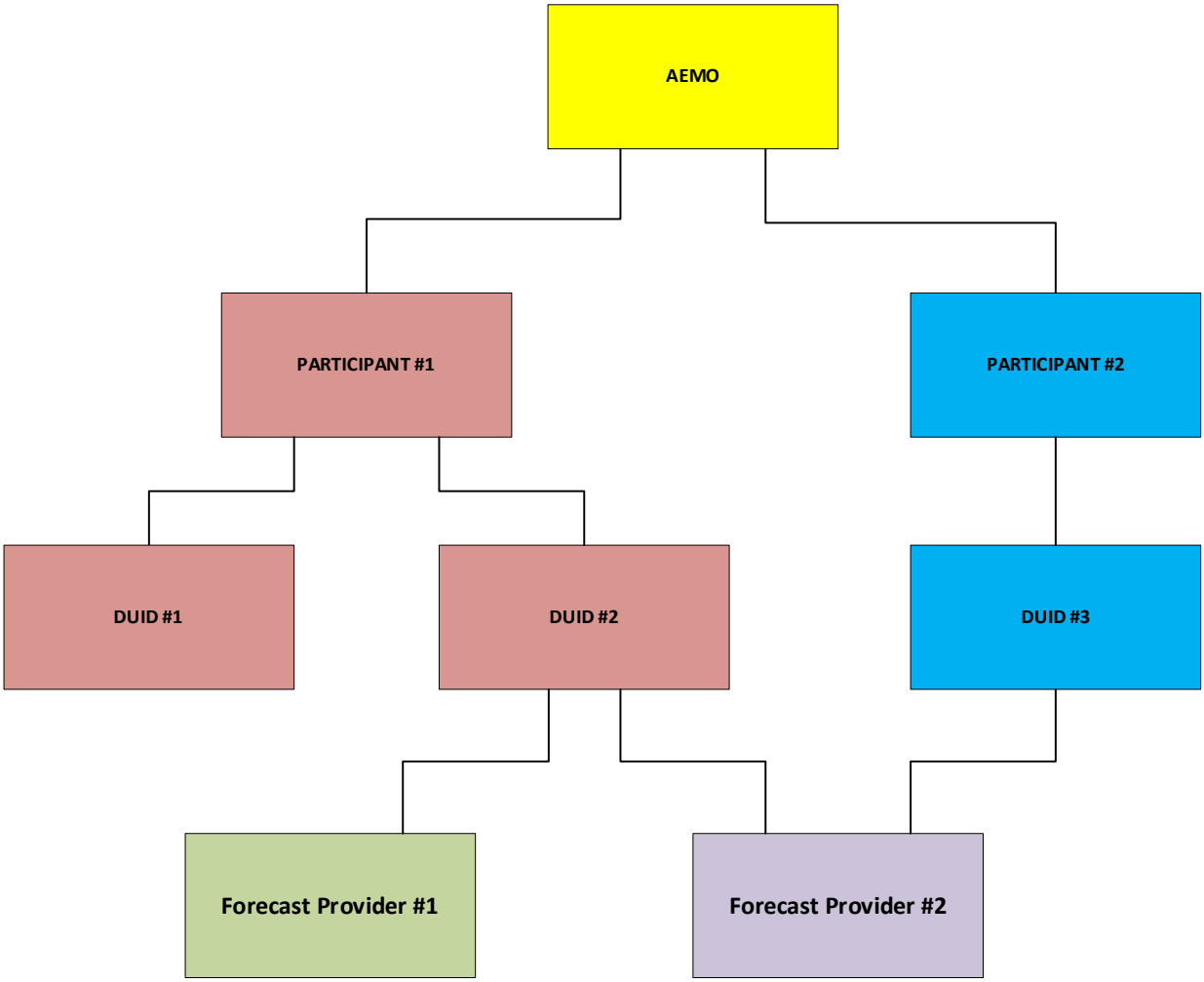
OR

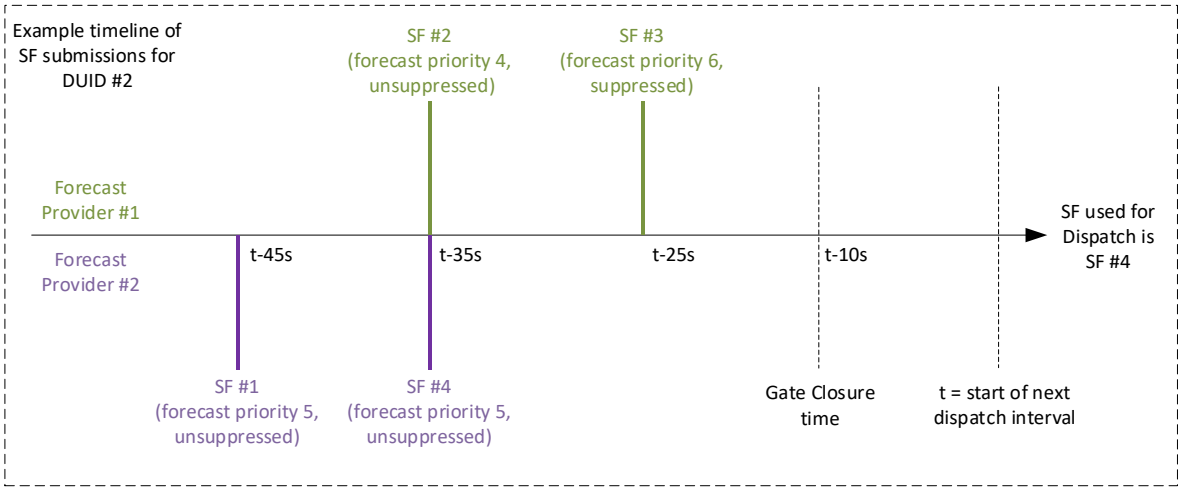
NEMDE energy target at time i from previous dispatch run
(if SCADA active power is bad quality)

[10] The use of FCST or SCADA Initial MW as the default forecast depends on when the AWEFS/ASEFS dispatch model is implemented. Further information on model implementation and timing can be found at https://www.aemo.com.au/-/media/files/electricity/nem/security_and_reliability/dispatch/policy_and_process/nem-operational-forecasting-and-dispatch-handbook-for-wind-and-solar-generators.pdf

[11] The Energy Target and UIGF is the TOTALCLEARED and UIGF fields, respectively, in the DISPATCHLOAD table of the MMS Data Model Report, found at https://visualisations.aemo.com.au/aemo/di-help/Content/Data_Model/MMS_Data_Model.htm.

Figure 2 SF used in AEMO assessments





5. Ongoing Assessment

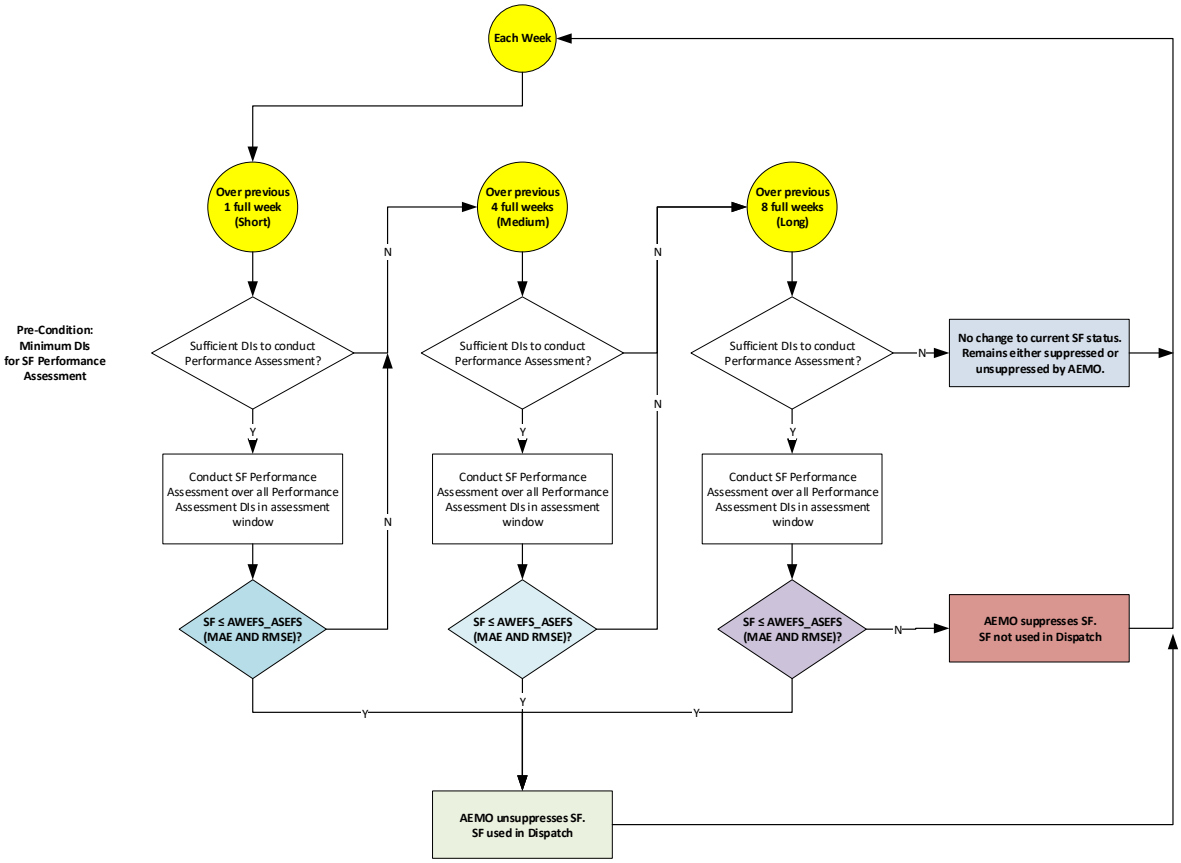
5.1. Process

AEMO will assess ongoing performance on a weekly basis (based on rolling one, four and eight full week assessment windows) to verify that the SF is no worse than AWEFS_ASEFS over at least one of the assessment windows.

The short assessment window (one week) allows the SF performance to reflect more recent, potentially large SF model improvements, while the medium and long assessment windows (four and eight weeks) capture the impact on SF performance of a greater diversity of weather conditions and reduce the risk that SF are not assessed for constrained off generating units.

Note that the length of the assessment window used for initial acceptance no longer applies for the ongoing assessment process.

Figure 3 Participant Dispatch Self-Forecast –ongoing assessment process



As shown in Figure 3, the steps in the ongoing assessment process are:

3. **Preliminary assessment:** AEMO assesses whether there are sufficient SF samples to conduct a SF performance assessment over each of the short, medium and long assessment windows.

    - If there are insufficient SF samples over the short assessment window, the test is repeated for the medium assessment window. If this test fails, the test is repeated for the long assessment window. If this test fails, AEMO does not conduct a SF

performance assessment and the SF remains in its current state (either suppressed or unsuppressed by AEMO) until the next weekly assessment.

- AEMO provides a summary of its preliminary assessment to the participant.
- Refer to section 4.2 “Minimum DIs for SF Performance Assessment” for further details.

4. **Performance assessment:** AEMO conducts a performance assessment over each of the assessment windows where there are sufficient SF samples. AEMO will assess SF performance for all dispatch intervals that satisfy the “Minimum DIs for SF Performance Assessment” criteria.

   - AEMO provides its performance assessment and related information to the participant.
   - Refer to section 5.2 for further details of the SF ongoing performance assessment.

5. If the SF fails the ongoing performance assessment over **all of** the short, medium or long assessment windows, AEMO disables the SF for use in dispatch by suppressing the SF until the next weekly assessment.

   - AEMO automatically issues a report to the relevant participant when it suppresses the SF.

If the SF passes the ongoing performance assessment for **any of** the short, medium or long assessment windows, AEMO enables the SF for use in dispatch by unsuppressing the SF.

AEMO automatically issues a report to the relevant participant when it unsuppresses the SF.

5.2. Ongoing performance assessment

The threshold for passing the MAE assessment is that, for the relevant assessment window, MAE_{SF} must be less than or equal to MAE_{AWEFS_ASEFS}, that is:

$$\boldsymbol{MAE_{SF} \leq MAE_{AWEFS\_ASEFS}}$$

The threshold for passing the RMSE assessment is that, for the relevant assessment window, $RMSE_{SF}$ must be less than or equal to $RMSE_{AWEFS\_ASEFS}$, that is:

$$\boldsymbol{RMSE_{SF} \leq RMSE_{AWEFS\_ASEFS}}$$

6. Ongoing Monitoring for Gross Errors

The AEMO control room monitors the SF and AWEFS/ASEFS dispatch forecasts for gross errors and may suppress the relevant forecast if their use in dispatch is causing, or could cause, market or power system security issues.

In the case where the AEMO control room identifies the SF is causing such issues:

6. AEMO may suppress that SF (if the participant has not already chosen to do so) until the next weekly assessment. Dispatch will then automatically default to using the AWEFS_ASEFS forecast.

    - AEMO will automatically report the suppression of its SF to the relevant participant. AEMO might not contact the participant directly prior to suppressing its SF.

7. The following week, AEMO Operational Forecasting will reassess the SF performance:

    - If the SF passes the ongoing performance assessment, AEMO will unsuppress the SF and automatically report this to the relevant participant.
    - If the SF does not pass, the SF will remain suppressed until the following weekly assessment.

Version release history

Version	Effective Date	Summary of Changes
1.0	21 December 2018	First Issue
2.0	25 January 2022	Reduced dispatch SF gate-closure time to 15 seconds (was 70 seconds). Reduced minimum DI threshold required for SF assessment to 60% (was 80%). Included FCST analog as one of the dispatch forecast model sources when there is no AWEFS/ASEFS forecast.
3.0	4 April 2023	Reduced dispatch SF gate-closure time to 10 seconds (was 15 seconds).