AEMO FPP Consultation Team
c/- Australian Energy Market Operator
GPO Box 2008
Melbourne
VIC 3001

(Lodged electronically via FPPconsultation@aemo.com.au) **15 March 2023**

FREQUENCY CONTRIBUTION FACTORS PROCEDURE (FCFP)
RESPONSE TO THE DRAFT REPORT
Date of Report Publication: 7/02/2023

Delta Electricity operates the Vales Point Power Station located at the southern end of Lake Macquarie in NSW. The power station consists of two 660MW conventional coal-fired steam turbo-generators.

Delta Electricity appreciates the opportunity to comment further on the development of a new Frequency Contribution Factor Procedure (FCFP) to incentivise primary frequency response (PFR) and commends AEMO on both the structure and process utilised for this review focusing on the parameters AEMO designers are specifically targeting, considering and continuing to seek comment on.

It is acknowledged that the procedure as proposed will yield a performance/causation measure approaching the purpose of the Rules. The forums and workshops have been informative and constructive providing excellent opportunities to learn how the procedure will take shape and impact.

The weakest link in the chain towards greater overall accuracy is the performance trajectory which will impact on all the outcomes of this procedure. It is acknowledged that this aspect of the process was not reconsidered as it was implied within the Rules as produced. However, the Rules as produced do propose latitude for AEMO designers to consider in detail what a target to target trajectory really means and design whatever adjustments AEMO considers is needed to improve it whilst still conforming to be target to target. Whilst the target to target trajectory proposed is already applied in the existing procedure, the inaccuracies it assigns to trading interval trajectory is smoothed by the 28 day averaging process and the general assignment of single factor for a subsequent 28 days of FCAS regulation settlements produces less concern for this inaccuracy in participants. The focus on trading interval performance, as driven by the new Rules, ought to signal greater concern about getting the performance trajectory more accurate. To be a reasonable performance expectation, Units with traditional controllers should be measured against what can be expected from them in automatic conformance. A target-to-target trajectory applied each trading interval does not respect the assigned ROC of the local unit controller or acknowledge the ROC is an applied setting not presently designed to be automatically adjusted to cater for expectations that arise from the performance trajectory. Modifying unit controllers to provide reactive and varying local unit controller rates of change (ROC) to suit an unnatural trajectory should not be an objective of procedures to incentivise better PFR.

To be truly incentivising, the process and the resultant factors need to respect the realities of what Units, subject to Automatic Control driven by an AEMO targeting and 4s control system, can presently do as designed. In particular, the central dispatch targeting system in coordination with faster local controllers contain some mismatch in objectives. e.g. Both the central controller and the local controller have setpoint tracking features but the local

Sunset Power International Pty Ltd t/as Delta Electricity ABN 75 162 696 335 ACN 162 696 335
SYDNEY OFFICE Level 7 / 287 Elizabeth Street, Sydney NSW 2000 PO Box 7285 Mannering Park NSW 2259
Telephone 02 4352 6406 Facsimile 02 4352 6460 www.de.com.au

controller is faster and more continuously reacting than the central dispatch is and the local unit setpoint controlling the unit is derived from the dispatched target. For such Units, the central controller and/or the FCFP need to respect that the faster local controller is always approaching its local setpoint, and should not:

1. Read a reference basepoint, from which to determine the next target, that is:
   a. too volatile to be considered a stable reference or,
   b. more importantly, not representative of where the Unit will be, or will be approaching, closer to time zero of the next interval in between the time that the central controller can actually read an energy output condition to provide a basepoint and when it can then commence delivering the new target,

2. Subsequently, due to the basepoint choice and timing of the reading of it, issue targets that Units on **automatic** control cannot meet, and/or

3. Expect a full 5minute's worth of ramping can take place when an interval is effectively being shortened because new targeting information from the central controller is delayed in arrival to the unit eliminating some ramping time from the 5-minute period and therefore reducing the possible obtainable ramp from an automatic unit controller set with the same ROC as the unit energy bid.

Either the targeting system and its interactions with Unit controllers should be collectively modified to reduce the targeting inadequacy so that the procedure's target-to-target trajectory is a more appropriate performance measure or the procedure considered for a further review to overcome the inadequacies contained within the targeting process to improve the reliability of the performance trajectory used in the calculations. The PFR incentivisation is meant to be assigning incentives to have better PFR reactions and the inadequacies mentioned above are not, in some opinions, representative of inadequate PFR reactions. Instead, they represent inadequate coordination between the control systems of AEMO and participants. It is hoped the forums to be held during 2023 on AEMO's Automatic Generation Control (AGC) examine these points and improve understanding within AEMO and participants of the control systems of each party. This effort and any resultant changes to the systems may address the above issues that erode the accuracy of the proposed targeting trajectory as being a PFR performance reference for this procedure.

However, unless the design of this procedure can now or in the future reconsider the design of the target to target trajectory, the central controller in combination with local Unit dispatch controllers designed similarly to Vales Point Unit controllers, will remain partially contributing to why Units will be regularly off "PFR performance" trajectory lines. When Units have higher rates of change (ROC) on the local controller than the unit energy bid or when energy market outcomes require an output change that is less than the change that can occur on the unit moved at the ROC of the energy bid over the full five minutes, Units like those at Vales Point with a rigid local Unit ROC for energy dispatch will not drive to a linear trajectory over the full five minutes. In these cases, a straight line 5-minute trajectory is simply incorrect as an accurate performance/causation guide. Whilst efforts could be made to redesign the controllers in such periods, regular variations in applied local controller ROC appear to be needed which could impact on other decisions in the FCAS market which actually refer to and utilise the local controller ROC expecting it to conform with other Rules and the energy bid obligations. Units with local controller designs similar to those at Vales Point will only ramp at the ROC assigned by the local controller and any 5minute target that results in MW changes less than the maximum possible contained in the equation 5 * Local

Controller ROC, will be linear but ramps will reach the target in less time than the full five minutes. How is a 5minute linear target to target trajectory representative for such periods?

In order to explore the overall impacts on general outcomes, a single random day of dispatch data of a single Vales Point Unit was explored and charted and is attached to this letter for examination by AEMO.

Of 288 dispatch intervals of the sampled day:

- 179 intervals of this sample day (or 62%) are steady loading which as previously discussed are worth reviewing in consideration of whether actual to target trajectory lines rather than target to target trajectories offer any particular merit for such conditions but also demonstrate how the variations in Unit output will sometimes present as performance and causation partially influenced by frequency erraticism. However, in assigning trajectories from 5minute data, results from an actual to target trajectory would probably display similar performance/causation variations to that of the target to target trajectory.
- The remaining 109 dispatch intervals are therefore periods of some form of ramping to the energy target of the unit.
- 27 ramping targets from the AEMO AGC are beyond the reach of the Unit setpoint moving automatically at the applied Unit ROC rate from the time t=0 of the trading interval (another two also assigned targets so marginally beyond reach as to be ignored in this analysis). Any delay in the timing of arrival of the dispatch also reduces the time available for a ramp to complete before the end of trading interval but this analysis of such has not been summarised here. Delays in commencement can be observed in the charts.
- The 27 impossible targets also affect the subsequent trajectory generated for the next interval meaning 54 trading intervals are affected. Collectively, this means during the energy ramping conditions of a typical sample day on a typical unit, around 50% of target to target trajectories, are not reliable PFR performance guides. As a proportion of the entire day, this represents 18.8% of the day.
- 52 of the ramping targets (48% of ramps or 18% of the day), some coincident with targets following impossible targets, also display the effects resulting from the local Unit ROC being under utilised either due to energy dispatch not requiring the full capability of the energy bid at the bid ROC or the Unit ROC being higher than the energy bid ROC achieving the assignment often in half the required time in the trading interval. True performance trajectories for such dispatch on Unit such as Vales Points could be designed from the local unit setpoint read at least twice in every dispatch interval and a reference to the applied Unit ROC.

Although all participants will be assessed against a similar designed trajectory which means some sort of consistency in itself results, the performance trajectory currently utilised in the existing system and proposed for the new system carries too much inherent randomness to be an effective “PFR performance” guide from trading interval to trading interval to offer a reliable enough PFR performance assessment to convince control engineers of various participants that better PFR will fix performance against such trajectories. Instead, participants may choose to design controllers to deliver better performance against the trajectories from the arithmetic of the performance measures. Such modifications will need to assign variable ROC capability in the local unit controller which would not represent better PFR and may actually contribute to worsening overall frequency coordination.

In addition, the highly erratic nature of the standing frequency conditions will still impact on the frequency measure as presently proposed but it is acknowledged that the smoothing factor as proposed based on 2021 data may undergo adjustment over time and also that nothing will be perfect when experiencing such erraticism. Eliminating the frequency erraticism, if at all possible, by other coordinated actions from AEMO and participants would probably improve the overall performance of PFR.

It also would be better if the performance trajectory for this procedure was designed with more consideration of local Unit controller setpoint conditions and trajectory and with better consideration of automatic dispatch. Such performance measures, if designed correctly, ought to capture only the variations from that expected from automatic dispatch controllers, as applied locally, rather than expect local unit automatic reactions, designed and implemented for many years to respond to central dispatch in the way they do, to conform to performance trajectories that present both unreachable targets and targets requiring a regularly revised ROC to achieve smooth conformance over 5-minutes instead of a shorter period as driven by the applied local ROC.

Thank you again for the opportunity to contribute to the redesign of the Frequency Contribution Factors Procedure. If AEMO wishes to discuss any details of this submission, please contact Simon Bolt on (02) 4352 6315 or simon.bolt@de.com.au.

Yours sincerely

Simon Bolt
Marketing/Technical Compliance

Attachments

1. **6 February 2023 – VALES POINT UNIT 5 DISPATCH RESPONSE**

ATTACHMENT – 6 February 2023 – VALES POINT UNIT 5 DISPATCH RESPONSE

Basepoint choice

The choice of referring to a single snapshot of actual MWs from a fedback value from the Unit has two sources of inaccuracy:

1. The single snapshot is taken from a volatile value. It would be better to get an averaged value or allow for the volatility with some level of adjustment. The volatility contributes to the possibility of erroneous next target determinations.
2. The timing of the read, understood to be 20s before the end of a trading interval, is also prone to contributing to error in dispatch in two ways, due to the possible changes that occur in the twenty seconds following, one affecting dispatch conformance and one affecting the next target:
    a. The dispatch conformance arithmetic and the reliance on an actual MW value read 20s before the end of the trading interval, often reports off targets that, from data read locally and precisely at the end of the trading interval, do not truly occur and
    b. A basepoint assignment, based on that actual MWs read 20s before the end of the trading interval, is likely to result in erroneous targeting other than just because the signal is highly variable but also because of unit response that follows that reading.

The local Unit Setpoint signal is a more reliable guide from which to set a basepoint for the AEMO AGC central controller because it is a steadier value more realistic of where the Unit is locally driven by the faster local control processes. However, it has to be acknowledged that plant conditions can, on occasion, result in causation under this procedure and so any use of the Unit setpoint continuously would not always result in a fair outcome. Some adjutsments to the local setppint can be due to FCAS controller reactions, which generally should generate performance against a trajectory assigned in advance of real-time conditions and some reactions can be automatic plant reactions to secure the Unit, which generally should generate causation. However, at the start of a dispatch interval, the basepoint has to be set from something and the evidence in this report suggests that the volatile actual MW meter value read some 20s before the end of a trading interval is not the best choice and results in many 5-minute intervals when the PFR performance outcomes measured against such a trajectory are erroneous because the target generated from the AGC from a reading of the volatile MW value is often unachievable by a unit in automatic dispatch.

The Unit setpoint, which is the produced from the received dispatch target, could be referred to by AEMO as the target of relevance to base the start of the trajectory for each interval without contradiction with the PFR incentivisation Rules. Where Units return this value to AEMO each 4s, AEMO could opt to utilise this accurate targeting information to develop the next target in the AGC more precisely in basepoint reference at time zero of each trading interval or use the data in the proposed calculations of this procedure. Similar data is understood to be available in the AEMO system as returned from large Units.

When a unit is off its local setpoint, this is true cause of frequency support or causation from a local perspective. However, sometimes the setpoint will include outcomes from the Unit controller, in response to sudden contingent plant conditions, that adjust the unit setpoint to the safest level the Unit can maintain, which can be significantly off the expected and possible dispatch trajectory. Despite this possibility, in developing the target for the next trading interval, the AGC would in general benefit from adopting the local unit setpoint as the basepoint for dispatch decisions rather than the Actual MWs value which is more volatile.

The AGC targeting, by assigning a basepoint from a volatile reading of Actual MWs read in advance of reactions which continue after it has been read, adds randomness to the targeting result because the next target is based upon a single snapshot of energy at a single point in time. This continual process introduces a great source of randomness and inaccuracy in the overall dispatch and frequency control objective. Setting the basepoint for dispatch targeting from the Unit setpoint, a more stable signal and the local target the Unit is controlling to, will provide a steadying impact on overall dispatch and frequency control objectives.

The existing FCAS contribution factor system with its 28 day assessment and determination from averaged points of view of raise and lower FCAS regulation status Not Enabled and Enabled and eliminating only the positive outcomes from the Raise and Lower Enabled intervals seems to get a more sensible causation factor because, as AEMO expects will occur with the new system, the errors in trajectory from trading interval to trading interval cancel out. However, if the default contribution factors of the new system are specifically eliminating all positive factors both enabled and not enabled, it is expected the default contribution factors in the new procdure will worsen relative to the present ones, partly due to the trajectory choice which, according to the sample charts from a typical day of dispatch at Vales Point, regularly results in individually poor trading interval outcomes. From a control engineer perspective looking at the relevant case examples below of poor or good performance, the data and charts presented in this report suggest to Delta Electricity that incentives to improve Unit PFR reactions will not result from performance/causation based on flawed trajectory assignments. It continues to be our recommendation that AEMO, now or in the future, reconsiders the trajectory design of this procedure and/or raises the priority on actions to better coordinate NEMDE/AGC arithmetic and controllers with Unit controllers to improve the accuracy of outcomes from the procedure and the resultant settlements.

For Units that are returning the local setpoint to AEMOs AGC every 4s, a future FCFP could design a more accurate target to target trajectory from referencing the local setpoint signal more often than once each 5 minutes. Catering for possible automatic unit reactions to local conditions that seek to prevent unit interruption would be required suggesting some caution is required in simply relying upon a continuous monitoring of the 4s setpoint but in many intervals where no plant conditions impact, the setpoint provides a continuous information source from which a more concise performance trajectory could be designed one that would not need to compromise on performance objectives that linearising all ramping trajectories across a full five minutes leads to. From the evidence presented below many actual applied trajectories during ramping on Units like at Vales Point do not follow such simplified expectations.

Unit AGC Delay in Target signal arrival

If the AEMO AGC dispatch signal doesn't commence arrival to a Unit until 30-60s into the trading interval, the delay in commencement represents time already lost from the achievable 5 minute ramp that ought not result in causation for a Unit under this procedure.

The Unit has to change the energy output by the amount dispatched which is usually caclulated on the full five minute interval. Unless the local controller ramp rate is greater than the energy bid ramp rate (which is possible but not mandatory) the Unit may not be able to achieve a late arriving target. Therefore, the targeting system, or this procedure, ought to make an allowance for the delay in target commencement to the Unit and only expect the ramp of a Unit to achieve the target represented by Ramp Rate * (5 – AGC target delay time). e.g. if the Unit ramp rate is 3MW/min, then in 4.5minutes due to deficiency in the AEMO AGC delivery, a dispatched Unit can only achieve 13.5MW in the 5 minute interval and not 15MW as would be theoretically possible if the AGC delivery was never delayed in arrival. However, it is also possible that the AEMO system (not well understood by the author) makes some adjustments for this effect.

6 February 2023 – Vales Point Unit 5 Dispatch charts and result

In the suite of charts of dispatch below, the target to target trajectory proposed yields impossible targets for 9.4% of all trading intervals (27 separate 5-minute intervals; two further dispatch intervals also generated impossible targets so small as to be ignored in this assessment). When an impossible target is dispatched, it also affects the precision of the trajectory in the following interval because, although the next target is achievable, a unit following the possible trajectory as determined by the local unit setpoint respectful of the local ROC, is on a different trajectory line. Therefore, the original impossible target affects 18.8% of all dispatch intervals and as the condition is only produced when the Unit is ramping, potentially affects 50% of all ramping intervals.

Intervals where energy ramps are required at less than the maximum capable from the applied local controller ramp rate, also take place on 52 occasions, some coincident with those following impossible targets, also impacting on the accuracy of the trajectory because the proposed linear 5minute to 5minute target to target trajectory does not properly cater for Units ramping precisely at the locally applied ramp rate. The actual Unit trajectory for Vales Point Units observing automatic dispatch will observe the local Unit ROC and, in such intervals, the Unit will reach its dispatch target minutes before the end of the trading interval. Is this sort of dispatch something AEMO is seeking to be corrected by those being incentivised by this procedure? If not, the trajectory for the procedure, or a future revision to it, should seek to respect local Unit ROCs and, where necessary, expect the target to be reached at some time before the end of the trading interval.

As a result of the collected observations of a complete day of dispatch of a single Vales Point unit, it is considered that the inaccuracy of the AGC determination of the next target and the fact that units always ramp at their ramp rate, collectively means the target to target trajectory is inaccurate for at least 18.8% of the time, and for potentially more than 50% of all energy ramping intervals in the typical day example through no real inadequate PFR from a typical Unit and that the subsequent resulting performance/causation arising from the proposed trajectory is therefore potentially random more than 50% of the periods involving energy ramping. The fact that the measured performance/causation will sometimes benefit and sometime tax the participant does indeed mean the overall financial result from random performance will smooth the variability but the intent of the procedure and the Rules is meant to be incentivising participants for better PFR control. It is difficult for participants to be incentivised by a process that shows performance or causation that a participant cannot influence except by building a very unusual controller that won't necessarily correct output for frequency conditions and more than 19% of the time appears to be measuring targeting trajectory limitations as performance/causation instead of PFR or the lack thereof.

To aid AEMO in observations of the following charts several trajectory lines are drawn and/or contained in the data as plotted:

- Target to Target (green dashed line)
- Actual to Target (black dashed line)
- Unit Setpoint to a possible linearly determined target based on the energy target assigned or that which is achievable on the maximum energy ramp contained in the energy bid (navy blue dashed line)
- Continuously Tracked Local Unit setpoint (Cyan) – This setpoint is produced with adherence to the AEMO dispatch but observes the capability assigned from the setpoint and the local ROC as determined from when the AEMO dispatch starts to change early in any dispatch interval where ramping is required. This data is returned to AEMOs AGC very 4 seconds for use in central control and could be used by this procedure to design a more accurate trajectory.
- A value of 50 was added to a calculated FM_t that uses the proposed frequency measure with the proposed initial smoothing factor to compare against the plot of local unit frequency as recorded on the Unit high speed recorder.