CAUSER PAYS PROCEDURE CONSULTATION

ISSUES PAPER

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AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

EXECUTIVE SUMMARY

Publication of this Issues Paper commences the first stage of a Rules consultation process to consider amendments to the Procedure for Determining Contribution Factors (Causer Pays Procedure) made under clause 3.15.6A(k) of the National Electricity Rules (NER).

This procedure describes the calculation of Market Participant Factors (MPFs), which AEMO uses as the basis for recovering costs associated with procuring regulation Frequency Control Ancillary Services (FCAS).

Regulation FCAS is required to counteract small changes in power system frequency caused by changes in the supply-demand balance, and AEMO enables this service to either raise or lower system frequency. Once enabled, these services are activated as needed every four-seconds based on detected system frequency deviations.

The MPFs are intended to attribute these costs to those market participants who have most contributed to frequency deviations in the recent past (a 'causer pays' approach).

The paper highlights the key assumptions and settings used when producing MPFs, and identifies practical options that may improve the current methodology. In all cases, these options represent compromises between complexity, volatility, accuracy, and the utility of market signals that a causer pays approach provides.

The paper identifies ten issues for comment:

1. Calculation of causer pays factors when regulation FCAS requirements apply within a local region.
2. Ability for positive and negative performance[1] to balance within a portfolio.
3. Ability for positive and negative performance to balance across the sample period.
4. The most appropriate sample period, notice period, and application period.
5. The treatment of non-scheduled generation.
6. Resolving cases where all factors are positive.
7. Treatment of facilities with changing registration status during the sample period.
8. Producing factors when significant periods of input data are deemed unreliable or inapplicable.
9. The appropriate form and granularity of published causer pays datasets.
10. Consolidation and clean-up of causer pays documentation.

This review is only intended to consider the calculation of appropriate MPFs for allocating regulation FCAS costs, and does not consider processes used to procure regulation FCAS itself.

While this consultation considers amendments to the Causer Pays Procedure, some identified options may also require changes to the NER to implement. Where applicable, this has been identified in the text.

In October 2016, AEMO also commenced a specific consultation on calculation of factors for asynchronous regions to comply with a determination by the Dispute Resolution Panel. The outcomes from that consultation will conclude in March 2017, and may ultimately be revised or superseded by broader changes being made through this consultation.

AEMO invites stakeholder feedback on issues, options, and any alternatives that should be considered to improve the current Causer Pays Procedure. AEMO also asks stakeholders to identify any unintended adverse consequences of the proposed changes.

Stakeholders are invited to submit written responses on the issues and questions identified in this paper by 5.00 pm (Melbourne time) on 27 January 2017, in accordance with the Notice of First Stage of Consultation published with this paper.

[1] 'Positive performance refers to a deviation that reduces frequency error, negative performance increases the frequency error.

Contents

1 Stakeholder Consultation Process

AEMO is consulting on opportunities to improve the Causer Pays Procedure used to recover Regulation Frequency Control Ancillary Services (Regulation FCAS) costs.

This consultation considers only the calculation market participant factors (MPFs), and does not consider the process used to procure regulation FCAS itself.

As required by the National Electricity Rules (NER), AEMO is consulting in accordance with the Rules consultation process in Clause 8.9.

AEMO's indicative timeline for this consultation is outlined below. AEMO intends to host technical workshops during the consultation process and has allowed additional time to accommodate these. Based on the number and complexity of issues raised through the consultation, the dates below may be adjusted.

DELIVERABLE	INDICATIVE DATE
Issues Paper published	05/12/2016
Submissions due on Issues Paper	27/01/2017
Draft Report published	13/03/2017
Submissions due on Draft Report	26/04/2017
Final Report published	07/06/2017

While this consultation focuses on changes to the Causer Pays Procedure, AEMO will also consider the development of rule change proposals if necessary to support the most appropriate options and remove any ambiguity. If changes to the NER are warranted, these would be subject to standard rule change timeframes.

Depending on the nature of any proposed rule change (i.e., whether the change is one that is considered necessary or desirable to support the chosen option, or seeks to remove ambiguity in the causer pays rules more generally), AEMO may decide to revise the Causer Pays Procedure at the end of this consultation, and/or wait for the outcome of any rule change proposal before implementing a final set of procedure changes.

Prior to the submission due dates, stakeholders can request a meeting with AEMO to discuss topics relating to the Causer Pays Procedure and this Issues Paper.

Appendix A contains a glossary of terms used in this Issues Paper.

2 Background

2.1 NER Requirements

Clause 3.15.6A(k) of the National Electricity Rules (NER) requires AEMO to prepare and publish a procedure for determining contribution factors (the 'Causer Pays Procedure'[2]), and sets out principles to be taken into account in preparing that procedure.

AEMO last reviewed the full Causer Pays Procedure with stakeholders in 2008. In October 2016, AEMO also commenced a consultation on calculation of factors under clause 3.15.6A(j)(2) of the Rules, to comply with a determination by the Dispute Resolution Panel dated 3 October 2016. This matter is being run as a separate consultation because of the tight timeframes associated with the Panel determination.

The matters considered in this consultation are substantially broader, and a final determination is unlikely to be made for several months – possibly longer if rule changes are also required. As a result, the outcomes from this consultation may ultimately revise or supersede the changes being made through the other consultation process.

[2] http://www.aemo.com.au/Electricity/Market-Operations/Ancillary-Services/Process-Documentation/Ancillary-Services-Causer-Pays-Contribution-Factors

2.2 Driver for review

In October and November 2015, multiple planned network outages in South Australia required regulation FCAS to be sourced locally, and resulted in higher than average regulation FCAS costs. In December 2015, AEMO published a Market Event Report[3] analysing these market outcomes.

At the National Electricity Market Wholesale Consultative Forum held on 27 January 2016, AEMO summarised the methodology used to calculate causer pays factors and stakeholders supported a review of the associated procedure to ensure that it remained appropriate and effective.

In February 2016, a Market Participant initiated a dispute with AEMO under Rule 8.2 of the NER in relation to the FCAS recovery calculations in October and November 2015. To avoid prejudicing the outcomes of either process, AEMO suspended consultation on the Causer Pays procedure until the dispute was resolved.

The dispute process concluded in October 2016, and AEMO is now recommencing the Causer Pays Procedure review with this issues paper.

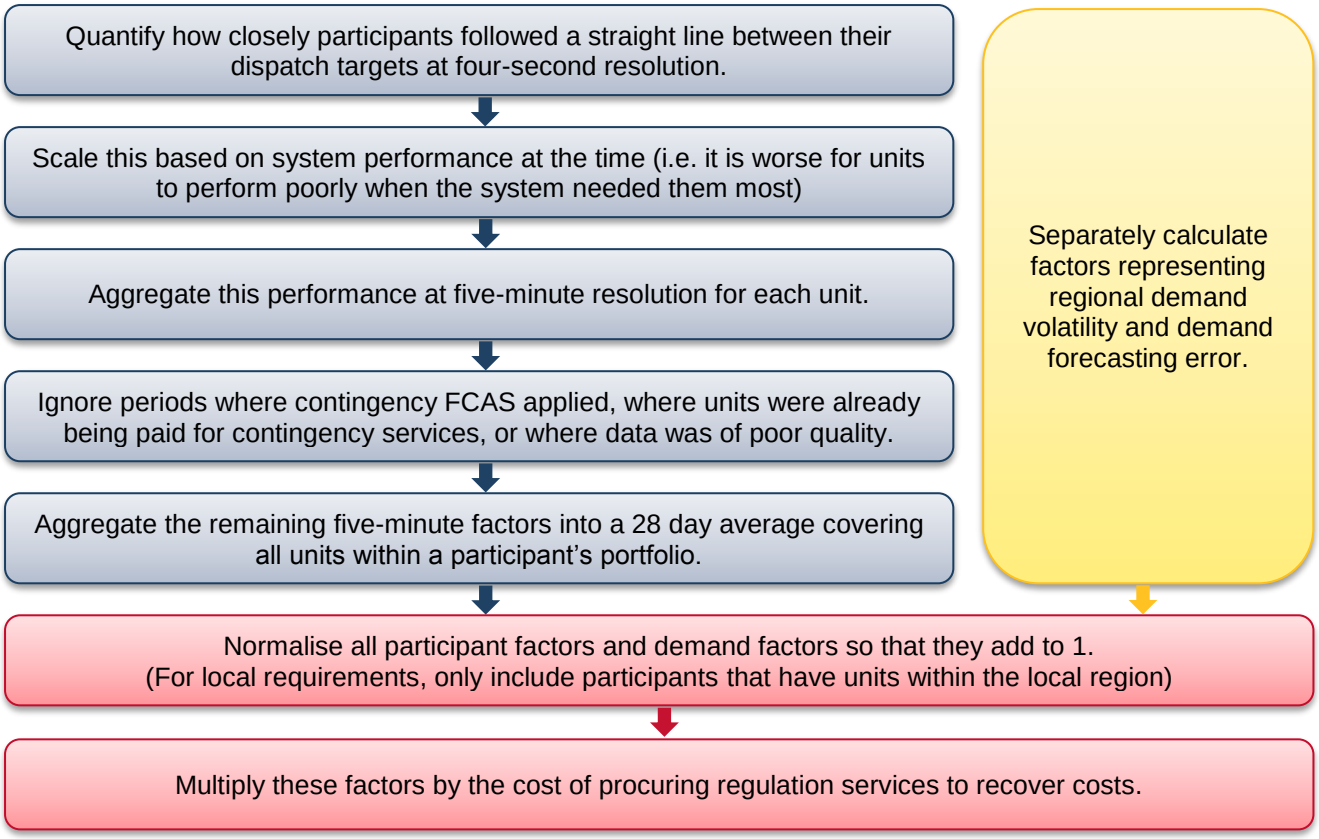
2.3 Regulation FCAS & Causer Pays Factors

Regulation FCAS is used to correct small changes in power system frequency caused by changes in the supply-demand balance. Through a five-minute spot market, AEMO enables regulation FCAS to either raise or lower system frequency. Once enabled, these services are activated as needed every four-seconds based on detected system frequency deviations.

The costs of procuring regulation FCAS are recovered from market participants on the basis of contribution factors that attribute costs to those market participants who have most contributed to frequency deviations in the recent past (a 'causer pays' approach).

Figure 1 summarises the current procedure for determining the contribution of market participants, and Appendix A provides a more detailed description of the approach.

Figure 1 – Overview of current calculation process for market participant factors



[3] http://aemo.com.au/-/media/Files/PDF/NEM--Market-Event-Report--High-FCAS-Price-in-SA--October-and-November-2015.pdf

2.4 Principles for the review

Clauses 3.1.4 and 3.15.6A(k) of the NER set out principles that should apply when developing a Causer Pays Procedure (See Appendix C).

The market design principles in clause 3.1.4 set the direction for all Chapter 3 mechanisms, which should seek to achieve maximum levels of market transparency, competition and efficiency; avoid special treatment in respect of different technologies; and where possible, provide incentives that lower the overall costs of the NEM.

To achieve these objectives with respect to the Causer Pays Procedure, AEMO has applied the following high-level set of principles as the basis for discussion on issues and opportunities.

1) The 'causer pays' concept remains appropriate as reflected in clause 3.15.6A, with causers identified by comparing actual performance with target performance.
2) The causer pays methodology should be as representative as possible of the likely contribution of units towards regulation FCAS requirements, including that local requirements should be recovered on the basis of contributions only from local units.
3) The positive and negative performance of different facilities within the same portfolio should net out, but only if the regulation requirement encompasses both units (i.e. they are within the same region for local requirements). This reflects that only units within a particular regulation requirement area can physically contribute to frequency control or deviations.
4) Periods where the system frequency moves outside the normal operating frequency range should continue to be excluded from the calculation of causer pays factors because Contingency FCAS services apply under these conditions.
5) The calculation approach should treat non-scheduled generating units consistently regardless of whether they provide voluntary metering data.
6) The potential benefits of any proposed changes must be weighed against associated system costs and increases in operational costs.
7) AEMO should provide participants with sufficient data and documentation to allow them to validate their causer pays factors, and to incentivise behaviours that lower the overall costs of the NEM.

3 Discussion of issues

AEMO's internal review of the causer pays methodology has identified several areas for potential improvement, which are detailed in the following sections. Each section describes the current approach, potential limitations, and alternative options that may offer improvements.

The main focus of the discussion in this section is on causer pays factors for market participants with generating units or loads whose contribution to power system frequency can be individually measured – that is, the contribution factors that apply under clause 3.15.6A(i)(1) of the NER. For convenience, these facilities are referred to as 'units' because the majority are generating units.

Section 3.5 addresses some issues relating to the determination of the residual contribution factor under clause 3.15.6A(i)(2).

Specific questions are included at the end of each section for participant consideration.

3.1 Local requirements

Option 1 – (status quo) Global factors calculated for participants, and scaled into regional factors when required.

When a local regulation FCAS requirement exists within a mainland region, AEMO currently recovers the cost of that requirement from all participants with a unit in the region, based on the NEM-wide (portfolio) factor for each of those participants. Specifically, the process:

- Calculates a global factor for each participant based on the performance of all its appropriately metered units in the NEM.
- Ignores factors for participants that do not have market units in the local area.
- Normalises the remaining factors so they add to 1 for the region.

A simplified example for three generic participants is shown in the table below. In this example a local factor is calculated for Region X.

	Unit 1	Unit 2	Global Factor	Region X Factor	Normalised
Participant A	Region X -0.5	Region X -0.5	-1	-1	**67%**
Participant B	Region Y -0.3	Region X -0.2	-0.5	-0.5	**33%**
Participant C	Region Y -0.1	Region Y -0.4	-0.5	0	**0%**

While this approach ensures that local costs are only recovered from local participants – it also allows the performance of all participant units to impact the local causer pays factor, even if those units are outside the local requirement. For example, the local factors for Participant B in the above example include contributions from units in both Region X and Region Y.

Under this option, AEMO calculates and publishes global factors, and only calculates the local contribution (using the same factors but across a subset of participants) when local requirements apply.

System Changes	Procedure Changes	Rule Changes
None	None	None

Option 2 – Separate factors calculated for participants for all region combinations.

An alternative approach is to calculate local factors only on the basis of units within the local requirement. This would ensure that local causer pays factors only reflect the performance of units that have the ability to contribute to local frequency deviations.

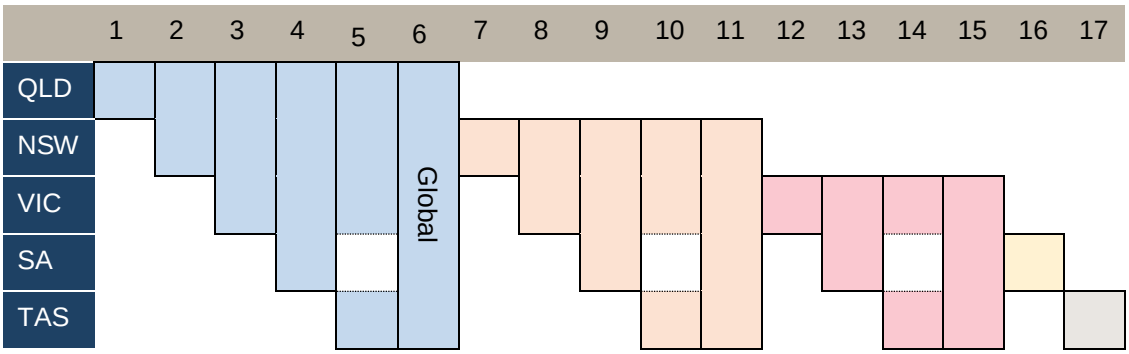
A simplified example of this approach is shown in the table below. Note in particular the impact on Participant B's local factor compared to the previous example – in this case participant B's local factor is only based on Participant B's performance in Region X.

	Unit 1	Unit 2	Global Factor	Region X Factor	Normalised
Participant A	Region X -0.5	Region X -0.5	-1	-1	**83%**
Participant B	Region Y -0.3	Region X -0.2	-0.5	-0.2	**17%**
Participant C	Region Y -0.1	Region Y -0.4	-0.5	0	**0%**

This is AEMO's preferred approach as it improves the relevance of local factors, whilst remaining consistent with the calculation methodology used for global factors.

Under this arrangement, AEMO would separately publish a causer pays factor for each participant in each of the 17 possible regional areas (shown in the table below). These factors would reflect the performance of all units within the respective areas, and would be applied any time a local requirement existed corresponding to one of these areas. By calculating these values in advance, participants will be able to gauge their exposure to potential local requirements before they occur.

AEMO could also use this calculation approach if sub-regional factors were ever required (e.g. Northern SA, QLD + Northern NSW, etc). However, these unique factors would be produced on a case-by-case basis only.



This option would require significant system changes from a cost and complexity perspective. Rule changes would also be required to remove the current tie between local residual factors and the real-time demand ratio. Leaving this rule unchanged would prevent AEMO from calculating and publishing local factors in advance.

Sub-regional factors are not contemplated by the NER, and any application of factors at this level would require a rule change for clarification.

System Changes	Procedure Changes	Rule Changes
Significant	Moderate	Moderate

Option 3 – Separate factors calculated for participants in each NEM region, aggregated as required.

This is a simplified version of the previous option, where causer pays factors are calculated for each of the five NEM regions in isolation, and then aggregated and normalised into global and multi-region factors only when required.

It is important to note that near the end of the calculation process, positive factors are ignored (to prevent participants being in credit as a result of the causer pays process). This means that calculating regional factors in isolation would remove the ability for participants to trade positive and negative performance across region boundaries. This is the key drawback of this approach compared to the previous option. It is also likely that rule changes would be highly desirable before implementing this option, to either:

- amend the application of clause 3.15.6A(j)(2) to local requirements for combinations of regions for which a contribution factor has not been calculated and published in advance; or
- remove clause 3.15.6A(j)(2) and clarify the application of paragraph (i)(1) to those circumstances.

Under this approach, participants are still incentivised to improve the performance of their units but the incentive is reduced as any benefit is limited to individual regions. However, this approach can be implemented with minimal changes to AEMO internal systems, and has the added benefit of discouraging participants from sourcing frequency deviations across interconnectors to balance their portfolios, resulting in unexpected interconnector deviations.

System Changes	Procedure Changes	Rule Changes
Minor	Moderate	Minor

Questions

1. Do stakeholders agree that calculating factors for local regulation requirements should be done based only on the performance of units within the local requirement area?
2. Do stakeholders agree that calculating factors for the set of possible region combinations is more appropriate than aggregating factors only when required?
3. Are there any adverse or unintended consequences associated with the proposed options?
4. Are there any viable alternative options for calculating causer pays factors for local regulation requirements?

3.2 Treatment of positive performance within a portfolio

Within a given sample period, units that deviate in a way that helps system frequency are able to offset for unhelpful performance by other units within the same portfolio.

This is consistent with NER 3.15.6A(k)(5)(iii), which requires that participants who deviate in a way that helps system frequency are not to be considered causers. However this clause does not explicitly require helpful deviations to be used as credit.

The treatment of helpful deviations is important as it determines whether factors reflect the absolute causers, or net causers of frequency deviations. This choice can change the incentives for participants to provide additional frequency support to reduce their causer pays exposure.

Option 1 – (status quo) Performance netted across portfolio

The current causer pays approach firstly calculates 5-minute performance factors for each unit, and subsequently averages values across all units within the same portfolio (and across the sample period). Later in the process, all net positive factors are set to zero, i.e. participants cannot ultimately be in credit as a result of the causer pays process.

This approach allows helpful performance from one unit to balance against unhelpful performance from another unit within the same portfolio – regardless of where these units are located in the system. This recognises that, within synchronous systems, frequency deviations can come from anywhere, and has the effect of considering all units within a portfolio as a single frequency deviation source.

The simplified example below shows how this approach works for two participants, each with three units.

$$ParticipantFactor = IgnorePositive\left[\sum_{Units} Factors\right]$$

	Unit 1	Unit 2	Unit 3	Sum	Ignore	Normalised
Participant A	+1	-1	-0.5	-0.5	**-0.5**	**100%**
Participant B	+0.6	0	-0.5	+0.1	**0**	**0%**

This remains AEMO's preferred approach as it recognises the net performance of the system, and incentivises participants to provide frequency support within their portfolio to hedge against any poorly performing units.

A drawback of this approach is that participants are less incentivised to improve the performance of their poorly performing units where they have a mix of well-performing units in their portfolio. Though this incentive would be strengthened with regional factors as proposed in Section 3.1, but only for participants with poorly performing units in regions that are more susceptible to local regulation FCAS requirements.

Depending on the local recovery option selected (as discussed in Section 3.1), AEMO proposes that causer pays factors calculated for local requirements would only consider units within the relevant region(s).

System Changes	Procedure Changes	Rule Changes
None	None	None

Option 2 – No performance netting across portfolio

An alternative approach would be to calculate a separate causer pays factor for each unit or station in isolation, and subsequently combine these into a factor for each participant by taking the simple sum of unit factors.

This method is illustrated below, applied to the previous example.

$$ParticipantFactor = \sum_{Units} IgnorePositive[Factors]$$

	Unit 1	Unit 2	Unit 3	Ignore	Sum	Normalised
Participant A	+1	-1	-0.5	[-1, -0.5]	-1.5	**75%**
Participant B	+0.6	0	-0.5	[-0.5]	-0.5	**25%**

This approach removes the ability for positive unit performance to offset negative performance from other units. Participants are still incentivised to improve the performance of their units – however this incentive is reduced as any benefit is limited to the unit in question. For example, Participant B in the example can only their improve overall factor by changing the performance of Unit 3; providing additional frequency support from Unit 1 or Unit 2 will have no effect.

This approach has an additional benefit in discouraging interconnector flow deviations where participants are trying to compensate within their portfolios but across different regions.

This option would require moderate system and procedure changes. Minor Rule changes would also be required because the NER indicates that causer pays factors should reflect the individual contribution of a market participant to the aggregate need for regulation FCAS, rather than the individual contribution of the market participant's units.

System Changes	Procedure Changes	Rule Changes
Moderate	Moderate	Minor

Option 3 – Partial performance netting across portfolio

There are alternative options between the two listed above, where positive performance is weighted differently than negative performance. However, this approach would be complicated, appears to suffer from the drawbacks of both previous options, and it is not clear how an appropriate weighting factor could be established.

Questions

5. Do stakeholders agree that allowing helpful performance to offset unhelpful performance within a portfolio is appropriate?
6. Do stakeholders agree that positive performance should carry an equal weighting with negative performance during the netting process?
7. Are there any adverse or unintended consequences associated with the proposed options?
8. Are there any viable alternative options for aggregating performance into participant factors?

3.3 Treatment of positive performance within the sample period

As described in the previous section, units that deviate in a way that helps system frequency are able to offset unhelpful contributions within the sample period.

The treatment of helpful deviations across time is important as it determines whether factors reflect the absolute causers, or net causers of frequency deviations. This choice can change the incentives for participants to improve or provide additional frequency support from their units during the sample period.

Option 1 – (status quo) Performance netted across the sample period.

The current causer pays approach firstly calculates 5-minute performance factors for each unit, and subsequently averages values across the full 28-day sample period. Later in the process, all net positive factors are set to zero – i.e. participants cannot ultimately be in credit as a result of the causer pays process.

This approach means that helpful performance can balance against unhelpful performance anywhere within the 28-day window.

This remains AEMO's preferred approach as it recognises that the causes of the regulation FCAS services that AEMO procures are based on longer term average system performance, rather than individual unit performance in any given 5-minute period[4]. This approach is also important in ensuring a representative view of average unit performance when then sample and application periods are different (discussed further in Section 3.4).

System Changes	Procedure Changes	Rule Changes
None	None	None

Option 2 – No performance netting across the sample period.

This option effectively treats each 5-minute period in isolation; where all positive (helpful) periods are set to zero before aggregating across the sample.

Depending on the option selected in the previous section (netting across portfolios), this approach may still allow participants to leverage positive performing units within their portfolio. However, it would force this balancing to occur concurrently, and would therefore ensure that positive and negative performance only offsets in periods that have the same regulation costs. However, this option also reduces participant incentives to provide additional frequency support in the sample period as any positive periods would be ignored.

System Changes	Procedure Changes	Rule Changes
Minor	Minor	None

Questions

9. Do stakeholders agree that allowing positive performance to offset negative performance across the sample period is appropriate?
10. Are there any adverse or unintended consequences associated with the proposed options?
11. Are there any alternative options that may be more appropriate for netting performance across the sample period?

3.4 Size and timing of the sample period

Causer pays factors currently reflect the average performance of participants during a 28 day period. NER clause 3.15.6A(na) requires that AEMO publishes the factors at least 10 business days before they are applied. Subject to public holidays, this typically translates into a 14 calendar day notice period. AEMO also undertakes up to one week of analysis to validate results, and to align factors with settlement periods for convenience.

[4] The amount of regulation FCAS activated every 4 seconds is based on real-time system frequency performance, however the total volume enabled through the regulation FCAS market represents an upper bound of what may need to be activated – this upper bound is procured (paid for) and is based on longer term system security performance assessments.

The choice of sample size and timing is important because it must:

- represent (as closely as possible) expected participant behaviour during the application period.
- ensure that there are sufficient samples to produce a valid result – despite some periods being discarded due to contingency services or bad SCADA data.
- balance computational and settlement effort against the value of producing factors more frequently or closer to real-time.
- balance volatility in the causer pays factors against the ability for participants to respond to them.

Option 1 – (status quo) 28 day sample period, 10 day notice period, 28 day application period

The current 28 day sample period is long enough to deliver an 'average' representation of performance, while also accounting for data that must be discarded due to the presence of contingency services or bad SCADA.

On the other hand, 28 days could be considered too long to adequately reflect changing system conditions and appropriately link cost with cause. This is especially true when paired with a long notice and application period that means causer pays factors can be applied to regulation costs accrued up to 11 weeks after the performance measures on which they're based.

System Changes	Procedure Changes	Rule Changes
None	None	None

Option 2 – Real time factors

At the other extreme, real time factors would result in very volatile and unpredictable causer pays factors, and increased complexity in recovering costs during bad SCADA periods. This approach may also break the cost-to-cause connection because the enabled regulation FCAS volume (for which costs must be recovered) does not change based on 5-minute system performance, but is rather based on the longer term frequency performance of the system[5].

This approach would ensure that only units that are electrically connected and running would incur regulation FCAS costs associated with a given period, however it may send perverse incentives for units to withdraw capacity to attain a causer pays factor of zero at times when regulation prices may be high – further exacerbating the system's frequency sensitivity.

The increased volatility and uncertainty in moving to real time factors may also have prudential implications for some participants, and limit the ability for participants to foresee or manage this risk ahead of time.

This option would require significant system changes to collect, store, calculate, and publish real time causer pays factors – including substantial changes to settlement systems to allow new factors to be applied correctly in cost allocation processes. In addition, new processes would need to be developed to either:

- automatically validate data and process periods of bad SCADA quality (currently a manual process); or
- utilise interim causer pays factors for initial settlement purposes, and finalise the real time factors after subsequent processing and validation for use in final settlement runs.

Rule changes would also be required to modify the definition of MPFs and the provisions that require them to be based on historical performance and published them in advance.

System Changes	Procedure Changes	Rule Changes
Significant	Moderate	Moderate

[5] The amount of regulation FCAS activated every 4 seconds is based on real-time system frequency performance, however the total volume enabled through the regulation FCAS market represents an upper bound of what may need to be activated – this upper bound is procured (paid for) and is based on longer term system security performance assessments.

Option 3 – Seven day sample period and application period

A second alternative approach is to move towards a compromise between the two previous options, and choose a sample period of 7-days as a way of ensuring sufficient data to be representative, while also allowing factors to adapt quickly to reflect changing operating patterns over time.

The approach could be further improved by reducing (or removing) the 10 business day notice period required under NER 3.15.6A(na) – allowing the sample and application periods to move even closer together.

Analysis time would still be required for data validation processes, but for convenience this approach could remain aligned with the settlement period so that a single set of causer pays factors applies in any given settlement run.

As a compromise between the previous two options, this approach also carries elements of their potential drawbacks. In particular, compared to the status quo, this option may increase the volatility of factors by reducing the sample size, and reduce participant foresight by reducing the notice period. In addition, bad data periods would represent a bigger proportion of the smaller sample period (See discussion on unreliable data in Section 3.5).

This option also allows positive and negative behaviour for a given unit to net-out over the course of a week, and therefore.

This is AEMO's preferred approach, as it represents a reasonable balance between the competing factors accuracy, volatility, and a representative sample. The approach would require minor changes to the system, procedure, and Rules.

System Changes	Procedure Changes	Rule Changes
Minor	Minor	Minor

Questions

12. Do stakeholders feel that real time factors would provide more effective signals than those coming from a longer averaging period?
13. How do stakeholders value the certainty of factors published in advance and the ability to average their portfolio performance across a longer period of time, versus the potential increase in accuracy and volatility of moving to shorter sample periods?
14. Do stakeholders believe that a 7 day sample and application period might represents a good compromise between the benefits of long-term and real-time factors?
15. Do stakeholders value the 10 day notice period between publishing and applying causer pays factors? Would a longer, shorter or absent notice period be desirable for any reason?
16. There are other timeframe combinations not listed as options, however AEMO welcomes feedback on whether more appropriate compromises exist between the sample, notice, and application periods.
17. Are there any adverse or unintended consequences associated with the proposed options?

3.5 Other matters for comment

This section highlights six smaller issues identified in AEMO's initial review of the causer pays procedure and surrounding processes.

Treatment of non-metered market generation

In addition to generator performance, the causer pays methodology also considers the impacts of demand volatility, and demand forecasting error at 4-second resolution. These demand components inherently include deviations due to non-metered generation.

The causer pays factors resulting from demand contributions (including non-metered generation) are combined and allocated to a quantity known as the 'residual'. However, NER clause 3.15.6A(i)(2) requires that this residual component be recovered only from Market Customers. This means that non-metered generation may not be allocated costs under the current methodology.

Under NER clause 2.2.2, only scheduled generating units are required to have adequate telemetry to participate in central dispatch, and as a result, many non-scheduled generating units under 30 MW fall into the category of non-metered generation.

AEMO is proposing that to resolve this, a Rule change is required to NER Clause 3.15.6A(i)(2) to allow recovery from both market customers and non-scheduled generation which does not receive an explicit factor in part (1) of the clause.

This size of this component and the incentive/disincentive it sends are generally small, however AEMO believes this discrepancy is worth addressing.

System Changes	Procedure Changes	Rule Changes
Minor	Minor	Minor

Questions

18. Do stakeholders agree that a portion of the residual should be recovered from non-metered generation, in accordance with their contributions to this frequency deviation component?
19. Are there any adverse or unintended consequences associated with the proposed option?
20. Are there any alternative options that may be more appropriate for allocating regulation FCAS costs to non-scheduled generation?

Resolving cases where all market participant factors are zero or positive

Under some conditions when local requirements apply, all generators and market customers within a region can receive positive (beneficial) factors when averaged over the sample period. This is most prevalent in the Tasmanian region which always operates asynchronously from the mainland – and therefore always has a local set of factors produced.

When this happens, the resulting causer pays factors will be zero for all participants within the region.

Under these circumstances, all regulation costs are allocated to market customers through the residual demand factor. This approach is consistent with the Rules, however is not currently documented in the Causer Pays Procedure.

AEMO proposes to keep the same approach, but document it thoroughly in the procedure.

System Changes	Procedure Changes	Rule Changes
None	Moderate	None

Questions

21. Do participants agree that regulation FCAS costs should be recovered from market customers through the residual demand factor in cases where all participant factors are positive/zero?
22. Are there any adverse or unintended consequences associated with the proposed option?
23. Are there any alternative options that may be more appropriate for resolving cases where all market participant factors are positive?

Facilities changing registration status during a sample period

Units that are classified (as part of AEMO's registration process) with an effective date part way through a sample period are currently treated as though they have contributed zero deviation prior to that effective date. Adding a potentially large number of zeros into the averaging process for these units may result in a favourable causer pays factor for their first/final month.

AEMO proposes that in such cases, a unit's contributions should only be based on data for the period where the units were classified as registered (i.e. NULL rather than 0 for unregistered periods).

System Changes	Procedure Changes	Rule Changes
Minor	Minor	None

Questions

24. Do stakeholders agree with the proposed approach to calculating causer pays factors for plant registered partway through a sample period?

Calculation of factors when a significant portion of the sample period is unreliable

AEMO current disregards any 5-minute periods where SCADA data is deemed to have been of bad quality. These periods are excluded for all units in all regions. To date, the 28-day sample period has meant that sufficient good quality data exists to calculate representative causer pays factors. This may no longer be the case if the sample period or calculation approach are modified as discussed in previous sections.

AEMO is proposing to add a minimum threshold to the Causer Pays Procedure to account for the possibility that a significant part of the data is unreliable (or has contingency FCAS in effect). In particular, AEMO proposes that if less than 20% of dispatch intervals in the sample period are viable, then the previous set of good causer pays factors should apply.

System Changes	Procedure Changes	Rule Changes
Moderate	Minor	None

Questions

25. AEMO seeks stakeholder views on whether 20% is a reasonable form and value for a minimum data threshold, and whether reverting to the last set of good causer pays factors is an appropriate course of action in this circumstance.

Publication of causer pays datasets

AEMO currently publishes the following causer pays datasets:

- Causer Pays Factors for each participant. These are published 10 days before the factors become effective. They are published on AEMO's website, and loaded into the participant information system.
- Four second input data used to calculate causer pays factors. These are raw data files, grouped by dispatch interval, and published every day (with one day lag).

The four second data files are unwieldy and difficult to use effectively for analysis purposes. AEMO proposes to aggregate this information into a more useful form that makes it easier for participants to validate their causer pays factors, and respond to any signals these factors provide.

In particular, AEMO proposes that in addition to the applicable causer pays factors for each participant, AEMO will publish the 5-minute causer pays contributions for each unit, for regional demand variance, and for demand forecasting error. These would be published in parallel with the final factors, and indicate which (if any) of the periods had been excluded due to SCADA quality or Contingency FCAS.

System Changes	Procedure Changes	Rule Changes
Moderate	None	None

Questions

26. AEMO seeks participant comments on the types of causer pays data that would be most useful to publish, including the most appropriate form, and frequency for this publication.
27. Are there any additional causer pays inputs, or regulation FCAS datasets that participants would find useful?

Consolidation and clean-up of causer pays documentation

AEMO currently has multiple published documents relevant to the causer pays methodology, including both the Causer Pays Procedure[6] itself, and a design specification document[7] which includes details on the calculation of local causer pays factors.

AEMO proposes to combine the content of these two documents when forming its final Causer Pays procedure. In addition, AEMO intends to revise and clarify many sections of the procedure to remove any ambiguity.

Questions

28. AEMO seeks participant views on any other topics or information gaps that should be documented, or more clearly described in the Causer Pays Procedure.

4 Summary of preferred options

Considering each of the Section 3 issues in isolation is impossible, as the merits of particular options are affected by the options chosen in other sections. In picking a set of preferred options, AEMO has weighed the interactions, and selected a set which it believes best addresses the principles discussed in Section 2.4.

In summary – the overall preferred approach is to:

1. Calculate separate causer pays factors for each region and region combination. These factors would be based only on the performance of units within the region or region combination, would be published in advance, and the appropriate factor would be applied whenever global or local FCAS requirements are in effect.
2. These factors would be for each participant, allowing participants to leverage positive performance from one unit against negative performance from another unit within their portfolio.
3. These factors would be netted across the sample period, allowing a more representative view of average participant performance.
4. New factors will be calculated and published each week, and would be based on unit performance over a one week period.
5. Non-metered generators will be apportioned part of the residual factor, to align with their contributions to this factor. Currently non-metered generators are not apportioned any factor.
6. In cases where all factors are positive, regulation FCAS costs will be allocated to market customers through the residual demand factor – consistent with the current Rules.
7. In cases where units are registered or deregistered partway through the sample period, their causer pays factors will only be based on data collected while the units were classified as registered.
8. Where more than 80% of the sample period contains unreliable data, or uses contingency FCAS, the previous set of good causer pays factors will apply.

[6] http://www.aemo.com.au/-/media/Files/PDF/AEMO_Causer_Pays_Procedure_4_0.pdf
[7] http://www.aemo.com.au/-/media/Files/PDF/0160-0049-pdf.pdf

9. In addition to the causer pays factors for each participant, AEMO will publish the 5-minute causer pays contributions for each unit, for regional demand variance, and for demand forecasting error, to allow participants to validate and analyse their factors.
10. AEMO will combine and clarify the current procedure and design specification document into a single, comprehensive Causer Pays Procedure.

Appendix A - Glossary

TERM OR ACRONYM	MEANING
Application period	The period over which calculated Market Participant Factors are used to allocate Regulation FCAS costs to individual participants.
Market Participant Factors (MPFs)	Market Participant Factors, also known as Causer Pays Factors, are calculated based on the 4-second performance of generating units, and regional demand over a 28 day period. These factors are intended represent which participants have most contributed to frequency deviations in the recent past, and are subsequently applied to allocate any costs associated with procuring regulation FCAS.
Negative (unhelpful) performance	Negative performance refers to a deviation that increases the frequency error in a given 4-second period.
Positive (helpful) performance	Positive performance refers to a deviation that reduces frequency error in a given 4-second period.
Regulation Frequency Control Ancillary Services (FCAS)	Regulation Frequency Control Ancillary Service is required to counteract small changes in power system frequency caused by changes in the supply-demand balance, and AEMO enables this service to either raise or lower system frequency. Once enabled, these services are activated as needed every four-seconds based on detected system frequency deviations.
Residual factor	The residual factor represents frequency deviations *not* caused by market generators or loads with adequate metering to participate in central dispatch (i.e. it reflects all sources of frequency deviation that cannot be individually identified). This component of regulation FCAS costs is recovered from market customers in proportion to their energy.
Sample period	The period over which 4-second performance data is collected and processed to calculate Market Participant Factors.

Appendix B – Summary of the Causer Pays Procedure

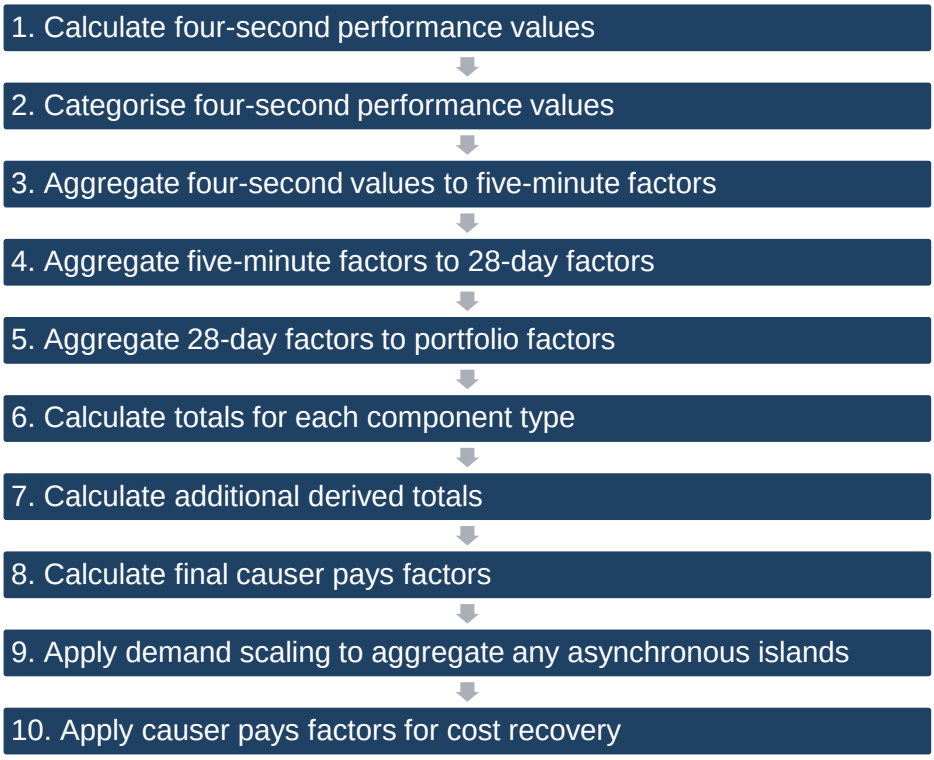
This appendix summarises AEMO's Causer Pays Procedure, available on the AEMO website[8].

Overview

Causer pays factors are intended to reflect the relative contribution of each participant to frequency deviations that are the underlying driver for procurement and activation of regulation FCAS.

Figure A1 below shows a high level overview of the Causer Pays process. Each step is described in more detail in the following sections.

Figure A1 – Overview of the causer pays methodology



Basic Concepts

There are four key component types for frequency deviations that are considered by the causer pays methodology:

- Scheduled and semi-scheduled units and loads that do not move linearly between their dispatch targets.
- Non-scheduled units and loads, with appropriate metering, that do not remain constant in each dispatch interval.
- Residual load that doesn't move linearly within a dispatch interval.
- Residual load that doesn't align with demand forecasts for each dispatch interval.

Factors are calculated for each generation/load portfolio based on the above classes.

The term portfolio is used to define units that belong to the same registered entity.

1. Calculate four-second performance values

Four-second SCADA data is extracted for each scheduled, semi-scheduled, and non-scheduled unit/load with appropriate metering. SCADA is also extracted for total regional demand.

Deviations are calculated for each type, and for each four-second snapshot by comparing a measured trajectory against a linear base trajectory as follows.

[8] http://www.aemo.com.au/Electricity/Market-Operations/Ancillary-Services/Process-Documentation/Ancillary-Services-Causer-Pays-Contribution-Factors

Component type	Measured trajectory	Linear Base trajectory
Scheduled and semi-scheduled generation and load	SCADA measurement of the unit output (4 second resolution)	From previous NEMDE target to current NEMDE target.
Non-scheduled generation and load with monitoring	SCADA measurement of the unit output (4 second resolution)	Constant based on SCADA value at the start of the dispatch interval
Regional demand variation within dispatch interval (5 minutes)	SCADA regional demand calculated as the sum of measured generation minus the measured export (corrected for interconnector losses)	Least square line of best fit for the regional demand during the dispatch interval.
Regional demand forecast error	Least square line of best fit for the regional demand during the dispatch interval	Regional demand forecast from the previous and current NEMDE runs.

These four-second deviation values are multiplied by the regulation requirement within that four-second snapshot to produce a performance factor.

The regulation requirement is the sum of all regulation deployed by AEMO's Automatic Generation Control (AGC) system. This results in a factor for each unit/load/region for each four-second period.

2. Categorise four-second performance values

Each 4 second performance value is further categorised to reflect whether the deviation occurred when Raise or Lower service was required, and whether the unit was enabled to provide regulation services at the time.

In subsequent steps, this allows the causer pays calculation to identify when deviations helped or hindered system frequency, and whether or not units have already been compensated for providing regulation services.

This results in a collection of categorised factors for each unit/load/region, for each four-second period as shown below.

Component type	Factor categories
Each scheduled or semi-scheduled unit or load.	Can have up to four factors: • Raise required and raise enabled • Lower required and lower enabled • Raise required and raise not enabled • Lower required and lower not enabled
Each non-scheduled unit or load with appropriate metering.	Can have up to two factors: • Raise required and raise not enabled • Lower required and lower not enabled
Each region (demand variation component)	Can have up to two factors: • Raise required and raise not enabled • Lower required and lower not enabled
Each region (forecast error component)	Can have up to two factors: • Raise required and raise not enabled • Lower required and lower not enabled

**Note: only scheduled units/loads can be enabled to provide regulation FCAS services.*

3. Aggregate four-second values to five-minute factors

The above four-second values are averaged to give a single performance factor for each five minute period. The averaging is done for each category individually (and for each unit/load/region).

Periods containing bad SCADA data are discarded at this point. Periods where the frequency was outside normal operating frequencies are also discarded as contingency FCAS applies during these periods.

4. Aggregate five-minute factors to 28-day factors

The remaining five minute factors are averaged to give a single performance factor for each 28 day sample period. The averaging is done for each category individually (and for each unit/load/region).

5. Aggregate 28-day factors to portfolio factors

The 28 day factors for units within a portfolio are summed to produce a single factor for each portfolio. This summation is done for each category individually. Demand factors remain aggregated at regional level and are not affected by this step.

In this step a single factor for each portfolio is then calculated by summing the factors in different categories as shown in the table below.

Note that values are ignored where units were enabled to provide raise regulation services, and did provide them. Similarly for units enabled to provide lower regulation services. If the total portfolio factor is positive, it is set to zero as the portfolio had a net-positive impact on frequency control during the 28-day period.

For Each	Step 1	Step 2
For each portfolio (scheduled/semi component)	Sum the following factors: • Raise required and raise enabled [Ignore if positive] • Lower required and lower enabled [Ignore if positive] • Raise required and raise not enabled • Lower required and lower not enabled	Set to zero if total sum is positive
For each portfolio (metered non-scheduled component)	Sum the following factors: • Raise required and raise not enabled • Lower required and lower not enabled	Set to zero if total sum is positive

6. Calculate totals for each component type

The calculated portfolio factors from Step 6 are then summed to calculate component totals, alongside the region (demand variation), and region (forecast error) components from Step 4. This is performed separately for Tasmania and the mainland as two asynchronous islands. This results in four totals as follows (for each island):

Component type	Factor Name	Code
Scheduled and semi-scheduled units	Market scheduled Factor	MSF
Non-scheduled with appropriate metering	Metered non-scheduled unit total	MNSTOT
Region (variation)	System deviation factor	SDF
Region (forecast error)	System forecast error factor	SFF

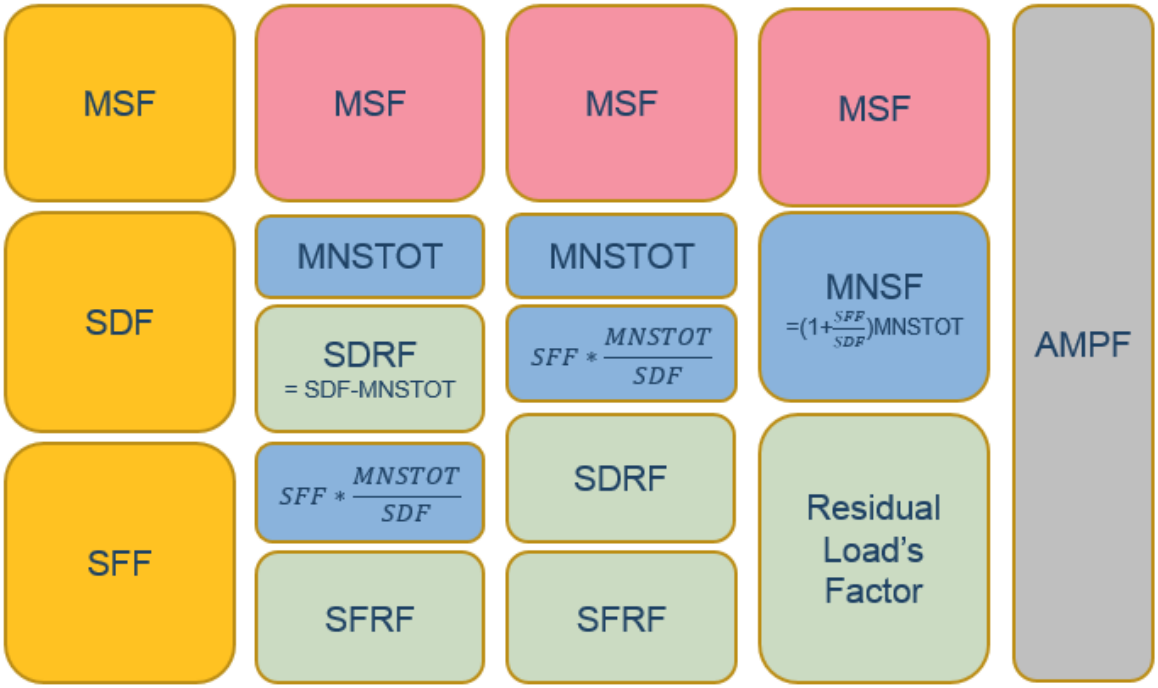
7. Calculate derived totals

These totals are then processed into a collection of derived values (for Tasmania and the mainland separately) as follows:

- System deviation factor is split into a component due to metered non-scheduled units, and a residual.
- This same split ratio is used to divide the system forecast error factor into a component due to metered non-scheduled, and a residual.

- The two residuals are combined into a single residual factor.
- The sum of all factors is calculated to give an Aggregate Market Participant Factor (AMPF) for that island.

Figure A2 – Calculation of derived totals



8. Calculate final causer pays factors

Using the portfolio totals from Step 7, and the derived totals from Step 8, the final causer pays factors are calculated as follows.

Factor	Calculation
For each portfolio containing scheduled and semi-scheduled generation or load	$\frac{Portfolio\ Factor}{AMPF}$
For each portfolio containing non-scheduled generation or load with appropriate metering	$\left(1+\frac{\mathrm{SFF}}{\mathrm{SDF}}\right)*\frac{Portfolio\_Factor}{AMPF}$
Total NEM Residual demand	$\frac{Residual\ Load\ Factor}{AMPF}$

Note that the sum of all factors will be equal to 1.0 (100%).

9. Apply demand scaling to aggregate any asynchronous islands

The previous steps are all performed for asynchronous islands separately (i.e. mainland and Tasmania both independently follow the above steps until this point).

Factors are combined into a single set of NEM causer pays factors by multiplying the individual island factors by the average island demand compared to the average NEM demand.

10. Apply causer pays factors for cost recovery

In each dispatch interval, regulation requirements are defined using FCAS constraints. These constraints can be global (i.e. provided from any location in the NEM), or local (i.e. provided from a smaller defined region of the system).

The cost of regulation services are defined as the payments made to the dispatched (enabled) regulation FCAS service providers in satisfying associated FCAS constraints.[9]

Costs associated with global requirements are recovered using the NEM causer pays factors calculated in the previous step as the proportion owed by each participant/region.

Costs associated with requirements specific to one or more regions use a derived regional causer pays factor as described in the following section.

Calculation of localised causer pays factors

A Constraint Market Participant Factor (CMPF) value is produced, representing the sum of all causer pays factors for portfolios with at least one unit/load in the relevant region.

A Constraint Residual Market Participant Factor (CRMPF) value is produced by scaling the global residual causer pays factor by the relative demand in the relevant region. This value changes in every trading period based on the local demand at the time.

These two values are summed to calculate a Regional Aggregate Market Participant Factor (RAMPF).

The causer pays factor for each portfolio or customer is then normalised based on the RAMPF, and local recovery costs are therefore calculated as follows:

- For a portfolio $= \frac{\text{MPF}}{\text{RAMPF}} *$ Local Regulation Cost
- For a customer $= \frac{\text{CRMPF}}{\text{RAMPF}} * \frac{\text{Customer\_Demand}_{\text{TI}}}{\text{Local\_Demand}_{\text{TI}}} *$ Local Regulation Cost

[9] Costs may not be equal to the regulation price multiplied by the amount dispatched because regulation services can also be used to meet delayed (5 minute) contingency FCAS, and in some cases the same enablement is able to meet both local and global requirements simultaneously. These aspects are beyond the scope of this paper, and are described in more detail on the AEMO website: http://www.aemo.com.au/Electricity/Market-Operations/Ancillary-Services/Specifications-and-Standards/Efficient-Dispatch

Appendix C – Guiding Principles from the NER

NER 3.1.4 (General market design principles)

(a) This Chapter is intended to give effect to the following market design principles:

(1) minimisation of *AEMO* decision-making to allow *Market Participants* the greatest amount of commercial freedom to decide how they will operate in the *market*;

(2) maximum level of *market* transparency in the interests of achieving a very high degree of *market* efficiency;

(3) avoidance of any special treatment in respect of different technologies used by *Market Participants*;

(4) consistency between *central dispatch* and pricing;

(5) equal access to the market for existing and prospective *Market Participants*;

(6) *market ancillary services* should, to the extent that it is efficient, be acquired through competitive market arrangements and as far as practicable determined on a dynamic basis. Where dynamic determination is not practicable, competitive commercial contracts between AEMO and service providers should be used in preference to bilaterally negotiated arrangements;

(7) the relevant action under section 116 of the *National Electricity Law* or direction under clause 4.8.9 must not be affected by competitive market arrangements;

(8) where arrangements require participants to pay a proportion of *AEMO* costs for *ancillary services*, charges should where possible be allocated to provide incentives to lower overall costs of the *NEM*. Costs unable to be reasonably allocated this way should be apportioned as broadly as possible whilst minimising distortions to production, consumption and investment decisions; and

(9) where arrangements provide for *AEMO* to acquire an *ancillary service*, *AEMO* should be responsible for settlement of the service.

NER 3.15.6A (Principles for preparing a Causer Pays Procedure)

(k) *AEMO* must prepare a procedure for determining contribution factors for use in paragraph (j) and, where *AEMO* considers it appropriate, for use in paragraph (nb), taking into account the following principles:

(1) the contribution factor for a *Market Participant* should reflect the extent to which the *Market Participant* contributed to the need for *regulation services*;

(2) the contribution factor for all *Market Customers* that do not have *metering* to allow their individual contribution to the aggregate need for *regulation services* to be assessed must be equal;

(3) for the purpose of paragraph (j)(2), the contribution factor determined for a group of *regions* for all *Market Customers* that do not have *metering* to allow the individual contribution of that *Market Customer* to the aggregate need for *regulation services* to be assessed, must be divided between *regions* in proportion to the total *customer energy* for the *regions*;

(4) the individual *Market Participant's* contribution to the aggregate need for *regulation services* will be determined over a period of time to be determined by *AEMO*;

(5) a *Registered Participant* which has classified a *scheduled generating unit*, *scheduled load*, *ancillary service generating unit* or *ancillary service load* (called a Scheduled Participant) will not be assessed as contributing to the deviation in the *frequency* of the *power system* if within a *dispatch interval*:

(i) the Scheduled Participant achieves its *dispatch* target at a uniform rate;

(ii) the Scheduled Participant is *enabled* to provide a *market ancillary service* and responds to a control signal from *AEMO* to *AEMO's* satisfaction; or

(iii) the Scheduled Participant is not *enabled* to provide a *market ancillary service*, but responds to a need for *regulation services* in a way which tends to reduce the aggregate deviation;

(6) where contributions are aggregated for *regions* that are operating asynchronously during the calculation period under paragraph (i), the contribution factors should be normalised so that the total contributions from any non-synchronised *region* or *regions* is in the same proportion as the total *customer energy* for that *region* or *regions*; and

(7) a *Semi-Scheduled Generator* will not be assessed as contributing to the deviation in the *frequency* of the *power system* if within a *dispatch interval*, the *semi-scheduled generating unit*:

(i) achieves its *dispatch level* at a uniform rate;

(ii) is *enabled* to provide a *market ancillary service* and responds to a control signal from *AEMO* to *AEMO's* satisfaction; or

(iii) is not *enabled* to provide a *market ancillary service*, but responds to a need for *regulation services*.