OPTIONAL FIRM ACCESS
AEMO FIRST INTERIM REPORT

FOR THE NATIONAL ELECTRICITY MARKET

PUBLISHED: **JULY 2014**

AEMO
AUSTRALIAN ENERGY MARKET OPERATOR

EXECUTIVE SUMMARY

In February 2014, the Standing Council of Energy and Resources (SCER) requested AEMO conduct, in collaboration with the AEMC, an analysis and design of the proposed Optional Firm Access (OFA) reform. AEMO's tasks relate primarily to "access settlement", or the settlement payments that recognise access rights during network congestion. These payments are core to the OFA proposal. The request by Ministers focusses AEMO's work on the functional design and modelling of access settlements and considering their potential staged development — either in time or by region.

This is AEMO's first report to stakeholders on the work being undertaken. AEMO plans to release further reports on the project with the final report back to Ministers due in June 2015.

AEMO's work on OFA is closely coordinated with that of the AEMC who are acting under their own terms of reference. The AEMC is concurrently releasing their first interim report and stakeholders wishing to understand the overall status of the OFA project should read the reports of both institutions.

Scope of this report

This report is written to specifically address AEMO's terms of reference within the joint OFA evaluation project.

Should OFA eventually be implemented, it is possible that AEMO will gain additional tasks in the scheme's operation. The scope of any such tasks is not yet defined and, as such, are not discussed in this report.

AEMO's functions as National Transmission Planner, Victorian Transmission Planner and Procurer and South Australian Advisor will also be affected should OFA be introduced. AEMO is considering these issues but they are not part of AEMO's terms of reference within the joint project and are not discussed in this report.

Access Settlement

AEMO has carefully considered the access settlement algebra developed in the AEMC's Transmission Frameworks Review (TFR) and the ability to incorporate it into the existing NEM arrangements. A number of issues have arisen which are being progressively worked through with the AEMC.

AEMO has constructed a model environment which can recreate real NEM events of network congestion and simulate market outcomes were access settlement in place at the time. The development of this detailed model has been valuable and given insights intothe detailed design and implementation issues of the proposed regime. Modelling is continuing and AEMO intends to document the results in future reports.

It is generally assumed that the incentives created by access settlement will encourage generators to offer in a more cost reflective manner during periods of network congestion, and thereby result in more efficient and predictable dispatch. AEMO has reviewed recent events of non cost-reflective offers in order to test this hypothesis. In each of these events, generator behaviours were also affected by a number of market design and structural issues which are outside of the scope access settlement. It will be difficult to identify the incremental benefits that arise from access settlement alone. AEMO seeks expert industry views on how to approach this problem.

Implementation

The institutions' Terms of Reference task us to consider different implementation options, where parts of the reform are implemented in stages, temporally and/or geographically and a "stage one" where access settlement alone is introduced, and whether this could be done in only some regions. The institutions have jointly considered this.

With respect to access settlement, the design would appear to be similar in all implementation scenarios. Geographic staging creates some technical challenges but these appear manageable. Depending on the implementation option chosen, a transition path from the current Settlement Residue Auction (SRA) arrangements will be required.

Assistance to AEMC

Whilst the bulk of the OFA development, including economic analysis, has been tasked upon the AEMC, AEMO has been able to assist their work as requested by them. This was done for the allocation of transitional access to incumbent generators. It is presently occurring with the modelling of the transmission incentive scheme and the pricing model. It will occur for estimating AEMO market operator costs.

AEMO seeks feedback on this report by Thursday 4 September 2014.

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1 INTRODUCTION

1.1 Background to this report

In February 2014, the Standing Council of Energy and Resources (SCER) tasked AEMO to conduct, in collaboration with the AEMC, certain analyses of the proposed Optional Firm Access (OFA) reform. AEMO's focus is the "Access Settlement" part of the reform, being the automatic settlement adjustments within and between generators and firm interconnector rights that occur following network congestion. This limited part of the total reform is most relevant to AEMO's market/system operator responsibilities and expertise. AEMO's electricity planning functions will also be affected by the OFA, but those matters are not covered in this report. The bulk of the OFA development, and economic analysis in the joint project, is the responsibility of the AEMC.

The two institutions have collaborated closely, and technical matters that arise have been dealt with jointly. Nevertheless the SCER's Terms of Reference establishes a separate governance and reporting structure for each institution, and therefore separate reports are being prepared. To the extent practicable, the institutions aim to co-ordinate the release of these reports such that they can be read as an integrated package.

This report employs concepts and terminologies introduced in the Transmission Frameworks Review (TFR) Final Report and Technical Report: Optional Firm Access. Familiarity with these documents is assumed, which can be found on the AEMC website[1].

1.2 Objectives of this report

In releasing this first interim report, AEMO aims to provide stakeholders:

- An explanation of how AEMO has interpreted SCER's Terms of Reference[2] and it's expectations of AEMO.
- AEMO's plan for meeting these expectations.
- A summary of some early findings and observations.
- An opportunity to provide input or comments to OFAConsultation@aemo.com.au by Thursday 4 September 2014.

[1] **http://www.aemc.gov.au/Markets-Reviews-Advice/Transmission-Frameworks-Review**

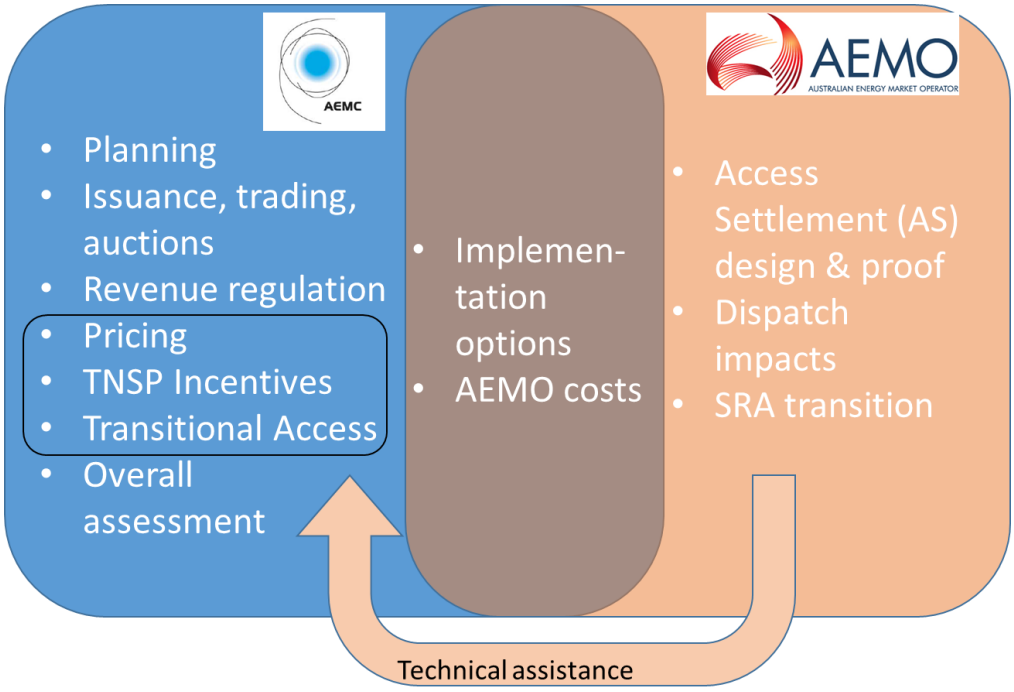
[2] SCER's Terms of Reference for AEMC and AEMO can be found here **http://www.aemo.com.au/Electricity/Market-Operations/Optional-Firm-Access**

2 AEMO'S OFA ACTIVITIES

2.1 AEMO's roles in the SCER Terms of Reference

The Terms of Reference identifies a series of investigative tasks for AEMO and AEMC. The institutions are closely engaging to ensure a joint understanding of the expectations of our individual tasks, and the delivery of a cohesive result.

The following diagram gives a general picture of the split of responsibilities being taken under the project. Discussion of each of AEMO's activities are described in this section. Discussion of AEMC's activities can be found in the AEMC First Interim Report.



2.2 Access Settlement - functional design

Access settlement is the adjustments made to generator market settlements when network congestion occurs. These settlement transfers occur within and between generators and the holders of Firm Interconnector Rights (FIRs) according to the firm access rights that they hold.

For the purposes of this report, AEMO considers transfers associated with the Transmission Network Service Provider (TNSP) incentive scheme are not part of access settlement. Depending upon design decisions by the AEMC, such transfers may eventually be made through market settlements.

The Terms of Reference requires AEMO to deliver a "detailed functional design" of the access settlements. AEMO is approaching this by

- Considering the TFR proposals conceptually against the existing NEM Dispatch Engine (NEMDE), the Settlement Residue Auction (SRA), NEM settlements timeframes and prudentials.
- Directly testing the access settlement proposal through the development of prototype models.

In view of the AEMC's responsibility to specify and assess the overall OFA design, of which Access Settlements is only one component, issues that arise from our Terms of Reference are raised with the AEMC, with a view to collaboratively developing adaptations that are incorporated into the overall design. Examples of these can be found in AEMC's First Interim Report's access settlement chapter.

Through this approach, it is expected that all of the key functional design elements of access settlement should be identifiable within the overall OFA design articulated by the AEMC. Presuming this design remains workable and acceptable to AEMO, we will draw on the description of the overall OFA to the extent practicable, and AEMO's reports will identify aspects of the access settlement design as needed to meet the specific needs of AEMO's work.

With OFA access settlement, additional pre-dispatch forecast and real-time market information may be useful to help participants understand positions. AEMO hopes to identify key desirable items as part of this Terms of Reference, and allow for detailed specification to emerge during the implementation period. AEMO welcomes suggestions regarding potentially useful information releases. Should OFA be introduced, it is anticipated that further informational suggestions would emerge over time to effect continual improvement.

2.2.1 Access Settlement - testing

The Terms of Reference asks AEMO to

> "Develop modelling techniques to estimate the likely benefits of implementing a first stage of the OFA framework where access had been allocated but there was no capacity for participants to purchase additional access."

AEMO will assess the dispatch implications of access settlements as a standalone part of the reform without the more dynamic features of OFA between Market Participants and TNSPs. The TFR design expects that access settlement can function with any allocation of access, and therefore the capacity to purchase additional access is not relevant to AEMO's assessment. AEMO will thus assess the benefits of dispatch with an access settlement arrangement that would apply to both a "first stage" and complete OFA.

> "- As part of this work, test market outcomes that would have occurred for a past period of time, had access settlement been in place during that period.
>
> - From the modelling results, estimate the system impacts of the option(s), taking guidance where appropriate from the decision framework."

AEMO has developed a prototype model of the settlement adjustments required for access settlement. This model can be applied to past network congestion events, and by being linked to simulations of the dispatch process, it can postulate changed incentives and model changed offer behaviours.

This will posit static dispatch efficiency benefits from specific historical events, had access settlement been in place. AEMO has not identified a practical way of estimating a total of such benefits over time given the irregular and episodic occurrence of network congestion events and their impacts on the market.

The AEMC has prepared an assessment framework for the OFA work. The static dispatch efficiency benefits described above are included within that framework. It is likely that other benefits would arise from access settlement that are included in the framework, such as lower hedging risks for firm generators and allocative efficiency benefits from more stable spot pricing. These are more practically addressed by AEMC within their broader analysis of the reform and thus AEMO will not attempt to identify them.

2.2.2 "Stage One"

The Terms of Reference asks AEMO to

> "Develop a detailed functional design and proposed draft rule change proposal with justification under the NEO to implement stage 1."

AEMO assumes this "Stage One" refers to the "first stage of the OFA framework" discussed in the preceding section, i.e. an operation of access settlements without involvement of TNSPs. AEMC and AEMO have collaborated on options for staging the implementation of OFA, and our conclusions are presented in the implementation chapter of AEMC's first interim report.

That work concluded that the standalone access settlements design will be the same as its design within full OFA. Therefore it will not be necessary for AEMO to prepare a separate "Stage one" access settlement design from the ground up. In 2015, should it determine that it is worth progressing, the AEMC intends to prepare draft Rule Changes for the full OFA as part of their Final Report. AEMO will collaborate with the AEMC with respect to the access settlement part of the draft rules. We expect those draft rules will meet the requirements of this request upon AEMO.

Another conclusion from this work is that for a "Stage One" to operate, there will need to be more mechanisms in place than access settlement alone, such as:

- A process for allocating and sculpting transitional access.
- A mechanism for the trading of access and possibly the periodic re-allocation of access.

As these elements are also part of the full OFA, AEMO will again collaborate with the AEMC on their design and draw on the full OFA design description for their detailed documentation to the extent practicable.

> "Estimate changes in modelled system benefits that result from staged implementation."

This statement is made in the context of AEMC assessing the most efficient implementation option. AEMO will comment upon the system benefits of the implementation that the AEMC has recommended. As AEMC have not yet made this recommendation, AEMO will respond to it in later reports.

> "Recommend to SCER an implementation plan for access settlements, including a rule change proposal and specification of necessary systems changes, reflecting AEMC's recommendation on most efficient option for staging implementation".

AEMO will meet this requirement in the same way as the discussion above: AEMO will collaborate with the AEMC on their design and draw on the full OFA design description for detailed documentation to the extent practicable.

2.2.3 Geographic Staging

The Terms of Reference requires AEMO to consider the design changes to allow OFA implementation in some regions ahead of others. The AEMC implementation chapter describes two ways this might arise:

- Where the "Stage One" access settlement is introduced NEM-wide at first, but the TNSP functions are rolled out progressively with regulatory resets.
- Where a "Stage One" access settlement is introduced in only some NEM regions, followed by the TNSP functions according to those regions' regulatory resets.

AEMO will consider the second form of geographic staging. The practicality of operating access settlement in separate regions will be discussed. Note that the complexity will vary depending on the particular regions excluded. This is further discussed in section 3.4.

AEMO will also also develop a general view of the workability of a partial introduction of access settlement considering the operation of the broader spot market.

2.2.4 Settlement Residue Auction (SRA) transition

The Terms of Reference requires AEMO to consider resulting changes to "SRA and associated instruments". AEMC is tasked with the development of inter-regional access, which under the proposal is delivered through a FIR [3]. The overall regime to develop and auction FIRs is intended to replace the current SRA processes in the full OFA design[4]. AEMO therefore interprets this requirement as:

- For a scenario where access settlement is simultaneously introduced across the mainland regions[5], AEMO will consider how to retire the existing SRA which is forward sold three years.
- For a scenario where access settlement is partially introduced, AEMO will consider which SRA instruments would need to be retired, and how the AEMC's inter-regional access design could be partially introduced. AEMO will also determine whether some of the current SRA instruments could be left in place. For those SRA instruments that remain, AEMO will conceptually consider whether the fair value of forward sold products materially change.

[3] FIR's are issued, traded and settled in combination with generator access rights. They are fungible with generator rights from an issuance and auction perspective, and are treated equally with generator rights during access settlement.

[4] The access settlement design distributes all congestion residues to FIRs or generators. There may be a small amount of remaining inter-regional settlement residue emerging from loss factor pricing. This will not be auctioned and will be credited to TNSPs as per the existing intra-regional loss factor residue.

[5] There is no SRA between Victoria and Tasmania.

2.2.5 Costs and Benefits

The Terms of Reference vest the AEMC with determining whether all forms of OFA implementation, which includes a "Stage One", contribute to the National Electricity Objective. AEMO's sees its role as determining whether the access settlements part of the OFA is practical to implement, and how it is likely to influence dispatch. This will be highly relevant to AEMC's assessment. AEMO can also provide some information about its likely own build costs, which will be helpful to the AEMC, but is likely to be only a small part of the overall costs and benefits that it considers.

AEMO will not attempt to analyse the broader economic implications to the industry of the full OFA or any interim stage.

2.3 Assisting the AEMC

As required in the Terms of Reference, AEMO has been closely collaborating with AEMC. AEMC and AEMO have co-ordinated our respective project plans into an overall plan. AEMO is a member of the Industry Working Group and contributes to the AEMC's package of work. Some specific tasks being carried out in that regard are listed below.

2.3.1 AEMO implementation costs

As discussed previously, the AEMC will perform a cost/benefit analysis of the entire reform including staging options. Some of these costs will be incurred at AEMO. To assist AEMC, AEMO will undertake research into the expected costs to be incurred by AEMO's Market Operator function, which would be recovered through NEM participant fees. Items to be costed include:

- Changes to the settlements processes to operate access settlement.
- Changes to constraint formulation or tagging[6] processes necessary to support the access settlement concept.
- Provision of additional market information to assist participant engagement with OFA settlements.
- Transition from the existing SRA arrangements and possible ongoing savings should it be retired.

At this time, the AEMC has not made governance recommendations regarding operation of key new systems supporting OFA. It is possible that AEMC may recommend AEMO is the most appropriate agency to take on functions beyond access settlement. Such functions are described in the TFR final report, and include the pricing model, auction and trading platforms and the TNSP incentive calculation. For these functions, the institutions will discuss whether a detailed AEMO costing would be helpful to the AEMC's work.

Items that will not be costed are any changes to the Victorian transmission planning and South Australian advisory functions which are not recovered through NEM participant fees. AEMC will be estimating TNSP OFA costs, and these costs for Victoria and South Australia can be reasonably presumed as consistent with other TNSP models.

The scope of the AEMO's costings will be clarified in the second interim report.

2.3.2 Transitional access

The TFR proposed a method for granting incumbent generators firm access rationed on the basis of existing capacity and network capability. The method makes use of AEMO's dispatch tools, and so the AEMC requested AEMO perform a proving run of this method using 2014 market conditions as the foundation for the assessment. This work contributed directly to refinement in the details of the allocation methodology, and identified a number of issues. The work has been discussed with the AEMC and industry working group, and is summarised in a report published with the AEMC's first interim report, "Transitional Access Allocation Project". This work is outside AEMO's Terms of Reference and is not covered further in this report.

2.3.3 TNSP incentive regime

The AEMC will develop a new TNSP incentive regime which uses as input the outputs of access settlement. As part of the prototyping, AEMC is back calculating payments had the incentive regime been in place historically. To

[6] For an explanation of tagging constraints as flowgates, see 4.3.8 of the Technical Report: Optional Firm Access.

support this work, AEMC is requesting from AEMO historical network congestion information. This work is continuing and will be reported by AEMC in their second interim report.

2.4 Stakeholder Engagement

Stakeholder input upon AEMO's work within the Terms of Reference is valuable and taken seriously. Relevant stakeholders include Market Participants, TNSPs, AER, consumer representatives and the COAG Energy Council. Consistent with the collaborative approach, AEMO has principally engaged with stakeholders through the AEMC's OFA forums, being the Industry Working Group and Advisory Panel. The two institutions have also jointly engaged with COAG's Energy Market Reform Working Group (EMRWG), the Private Generators' Forum, AEMO's NEM Wholesale Consultative Forum (NEMW-CF) and the AER.

AEMO intends to continue this collaborative approach, and outputs of its tasks will be presented to the AEMC's OFA forums and other groups as required. As AEMO's work progresses into more detailed issues, it may become efficient for AEMO to engage with stakeholders through other means. Examples would include:

- Access settlement predispatch informational requirements.
- SRA retirement.

AEMO could use the existing NEMW-CF and Settlement Residue Committee (SRC) for these engagements. AEMO would be pleased to hear of suggestions for other forums for these.

A stakeholder group that has had only limited engagement with the detailed OFA development to date is consumer representatives[7]. AEMO would be pleased to hear if there is interest, and any suggestions for how, consumer representatives can be engaged in its work.

[7] Noting the AEMC Advisory Panel does include a Consumer Representative.

3 INITIAL ACCESS SETTLEMENT WORK

3.1 Design Interpretation

Consistent with the terms of reference, AEMO is referencing the TFR Technical Report: Optional Firm Access as the primary guidance for the algebraic direction for access settlements. Chapter 4 and sections 12.1 to 12.5 and 12.7 of that report are most relevant.

During initial consideration of the design, AEMO raised a number of design issues with the AEMC that required resolution. Practical proposals have been jointly developed, and have been incorporated into the full OFA design. They are covered in detail in the AEMC First Interim Report access settlement parameters chapter. Of specific interest to AEMO are:

- The different measurement environment of the dispatch process, which usually occurs at controllable generator unit terminals, versus the settlement process which usually occurs at connection point meters. Access settlement should operate, to the extent possible, on settlement quantities. Access Settlement uses capacity and availability figures, which are also dispatch quantities and scaling will apply. Flowgate prices will be the marginal values of binding constraints, which are dispatch quantities.
- The TFR did not specify whether the firm access is to be specified on a power station or dispatchable unit (DUID) basis. Many power stations have electrical connections that permit the units to connect to different parts of the transmission network, with individual units receiving different flowgate participation factors, so firm access cannot be specified across the station. However some stations aggregate multiple units into one DUID, or aggregate their units' outputs through a single settlement meter. A new definition, "Revenue Meter Identifier" (RMID) is proposed, being the least granular of either the DUID or settlement meter. Firm access will be specified on a RMID basis.
- The TFR did not engage with the concept of "auxiliary load" and the varied purposes to which electricity is consumed prior to the connection point, which may include activities unrelated, or partially related, to electricity generation. The matter is practically and theoretically significant because these loads will effectively be priced at a local price rather than a regional price. Grandfathering existing arrangements[8], whilst restricting new arrangements, is proposed.

Further issues have arisen which are being discussed with the AEMC presently and were not documented in their First Interim Report. These are discussed in section 3.5 below.

3.2 Testing approach

AEMO understands its tasks in testing access settlement is to:

- Assess the practicality of introducing access settlement into the existing NEM dispatch and settlement arrangements.
- Assess whether the access settlement will lead to the improved behaviours and outcomes postulated in chapter 11 of the TFR Technical Report: Optional Firm Access.

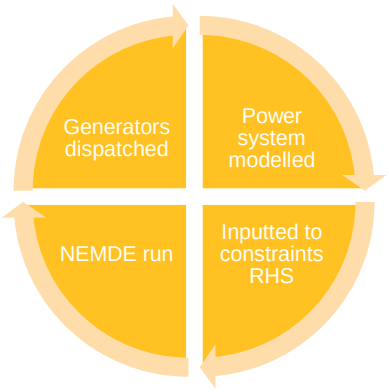
The choice of testing environments is important. At one extreme, this could be a stylised approach of the type that might be used for economic modelling, or at the other extreme a detailed technical platform. AEMO feels the skills it can bring to the task is an ability to operate access settlement in an environment as close as possible to real dispatch and settlement, i.e. a technical platform.

Such an approach has both advantages and disadvantages. This approach most comprehensively supports assessment of the practicalities of implementation, and AEMO has already identified several key design issues

[8] With the exception of mining loads drawn at parts of the network that are not electrically close to the generator.

simply through the construction of a test platform. However a technical approach tends to be less flexible, and less suited for testing behaviours over time.

AEMO has developed a test platform system which allocates access settlements, as a settlement adjustment ex-post to dispatch. This platform is fed inputs from the Dispatch and Training Simulator (DTS)[9]. The advantage of using the DTS over a simpler single-pass dispatch simulator, such as the NEMDE Queue Service, is that DTS incorporates a full electrical model of the power system that is repetitively solved following the previous NEMDE iteration. This means that constraint Right-Hand-Side (RHS) quantities that are measured from the power system can be simulated, i.e. a full closed loop process can be created in the manner shown in the diagram. It also includes auxiliary load models of power stations, and so settlement quantities can be estimated.



The DTS is a complex tool requiring considerable skill and effort to produce a repeatable output. It runs at a maximum speed of six times real-time. Therefore it is only suited to simulating specific, short events in history rather than trends over time. It can only recover a short historical period of power system conditions – approximately 15 months.

AEMO has been attempting to identify actual events of network congestion during this short historical period where access settlement is likely to have significant impact on generator behaviours. The particular period has had relatively few significant market events demonstrating behaviours primarily affected by the mispricing of constrained-off generation.

Furthermore, like any testing environment, the DTS is unable to recreate some real matters. Including:

- Price and dispatch volatility caused by fluctuations in measured inputs from the power system. As power system measurements are simulated, they are not subject to noise from real meters, caused by error or sampling time differences. This noise creates volatility in the RHS of constraints in real dispatch.
- Non-conformance of generators, i.e. failure to closely follow dispatch targets, affects real dispatch but is not readily simulated using the DTS.

When real events were back-cast without changing inputs, price volatility was observed to materially decrease. To address this issue, AEMO intends to use as base-case the backcast, rather than actual historical outcomes.

The ex-post settlement adjustments model estimates access settlement transfer payments. Following dispatch network congestion, the flowgate prices and dispatch volumes are captured and change spot market income. Modelled firm access quantities and marginal costs are entered. This allows generator profits to be calculated, and enables postulation of altered offer behaviours which can then be re-simulated to see if those altered behaviours are individually more profitable.

3.3 Temporal staging considerations

If access settlement is limited to the settlement transfers between firm and non-firm scheduled entities, it is possible to operate access settlement as standalone without involvement of network businesses. AEMO is approaching access settlement design to operate either as a standalone process or as a component of the full OFA.

AEMO is considering what supporting requirements are necessary to operate access settlement as a standalone. The principle additional areas are:

[9] The DTS is a very detailed tool developed by AEMO for the purposes of training its system controllers and to study the power system and market impacts of hypothetical actions. It provides an energy management system (EMS) and Market Management System (MMS) operating environment that is essentially the same as production with the exception that the EMS is linked to a simulated power system instead of the real system.

- Access allocations. A system is required to create initial access levels, and, if desired, re-allocate the access periodically, to take account of changes in generator registration and network capacity.
- Short-term access trading system. A two way simultaneously feasible auction would be required to support the voluntary trading of access presumably for periods shorter than any reallocation period.
- Interconnector access release. If any firm interconnector rights (FIR) are allocated based on the existing capacity of the network, there will need to be a mechanism for the purchase of this access, possibly integrated with the access trading system.

These are also all elements of the full OFA design, and as such their detailed design is being developed by the AEMC. AEMO is participating in that process, and will draw on the design of these elements for inclusion in this stand-alone access settlement assessment when they are available.

3.4 Geographical staging considerations

AEMO will consider the practicality of partial geographic implementation of the standalone access settlement design. Key technical matters that arise are:

- Existing constraints that include generators in multiple regions. This occurs between Victoria and NSW due to the looped structure of the AC ties between these regions.
- The feasibility of operating FIRs and SRAs simultaneously, in reverse directions on the same interconnector.
- Stability constraints that include more than two interconnector terms.

These will need to be further considered in AEMO's line of work, and proposals for their management included in future reports. Whilst these technical issues create challenges, our preliminary view is that options to manage them do exist.

These technical challenges do not arise with respect to timing of access settlement into Tasmania versus mainland regions due to the single direct current market network service provider (MNSP) link.

After considering these technical matters, in its final report AEMO intends to provide a general opinion of the compatability of access settlements operating in some regions whilst regional settlement operates in others.

3.5 Emergent Issues

In developing the testing platform a number of issues have arisen more recently as part of AEMO's work on access settlement. AEMO has had initial discussions with AEMC, and to allow its work to continue, is making assumptions in relation to them as described below. Clearer direction on these matters should arise in future reports.

3.5.1 Loss Factors

The Technical Report proposed making no access settlement loss factor adjustments. However as each of the generators and interconnectors within a constraint will have different loss factors, AEMO considers it is necessary to scale access quantities by the relevant loss factors to the relevant Regional Reference Node. If the AEMC accepts this proposition it will be necessary to re-specify the access settlement algebra. It is anticipated that this will be developed further in the coming months.

3.5.2 Constraint violation

Network constraint marginal prices are frequently artificially affected by violation of the constraint, and, without action, the flowgate price used in the access settlement algebra could become the constraint's violation penalty[10].

[10] For background on violation penalties, see **http://www.aemo.com.au/Electricity/Market-Operations/Dispatch/Schedule-of-Constraint-Violation-Penalty-Factors**

This would be inconsistent with the Regional Reference Price, where constraints are automatically released to avoid penalties contributing to the price.

In order to support the existing TNSP incentive scheme, AEMO publishes real-time Marginal Constraint Cost (MCC) information where the price of all binding constraints affected by violation penalties are recalculated by relaxing the violated constraints[11]. AEMO considers this a convenient source of flowgate prices and has developed the testing system to use that information for its ex-post study approach.

The MCC information table was however developed for a different purpose, and two matters would need addressing if access settlement were to use it:

- Some relaxations are performed manually over an extended time-scale. This is currently about 15 per year.
- "Soft" network outage ramping constraints (constraints priced below the market price cap) are relaxed for the MCC table but are not relaxed in the regional pricing calculation.

3.5.3 Unusual settlement pricing conditions

There are many unusual settlement pricing conditions enshrined in the current rules. In general these are applied after dispatch, leading to an inconsistency between constraint marginal prices and regional settlement. Some examples of these include:

- Administered Price Cap and floor.
- Market Price Cap over-ride during instructed load shedding.
- Market suspension.
- Price revisions due to manifestly incorrect inputs

Application of OFA pricing in these conditions will require adjustment to avoid unintended outcomes. The circumstances and objectives of each form of unusual pricing condition needs to be considered against the objectives of the OFA. This logic will need to be developed to support the full OFA with involvement from both AEMO and AEMC, and may also require intricate consideration of system design and rule wording. AEMO intends to undertake work on this intricate area in the latter part of the project.

3.5.4 Five-thirty considerations

Existing regional settlements are complicated by the mixture of five-minute and half-hour metered and calculated quantities, which are known to create anomalous outcomes. Resolving this matter is outside the scope of the OFA, however access settlements will also be complicated by it. Section 12.4 of the Technical Report: Optional Firm Access proposes calculating access settlement on a half-hourly basis, i.e. the averages of five-minute quantities are used to adjust half-hourly meter measurements. AEMO's test platform is built on this basis. Learnings from implementing this approach are:

- The approach created design challenges for the test platform due to the need to accumulate dispatch quantities and apply one settlement adjustment.
- It is conceptually complex to understand a half-hour settlement as the actual congestion occurs on a five-minute basis.
- Some outcomes are anomalous, such as constraints that bind for only one dispatch interval (DI) affecting all settlements across a half-hour.

An alternative would have been to calculate in OFA settlements in each five minutes, such as is currently done for the Frequency Control Ancillary Services (FCAS), and where necessary interpolate 30 minute measurements. This would give different outcomes and, because half-hourly regional settlement would remain, would likely produce different anomalies.

[11] For an explanation of the MCC_Constraintsolution table, see Pg. 626 of the MMS data model found here: http://www.aemo.com.au/AEMO%20Home/About%20the%20Industry/Information%20Systems/Data%20Interchange#MMS Data Model

AEMO is not currently intending to study a five-minute OFA settlement alternative.

3.6 Interim Observations

AEMO considers that part of its analysis should seek to test the hypothesis that access settlement will encourage generator offers during network congestion closer to marginal cost and a resulting improvement in dispatch efficiency. These incentives are discussed in sections 11.5 to 11.9 of the Technical Report: Optional Firm Access. AEMO has not yet completed hypothetical re-running of dispatch cases, and details on outcomes will be provided in our next report.

The dispatch benefits attributed to access settlement alone[12] relate to reducing the instances of:

- Inefficient dispatch and underuse of network capability due to generators offering away from marginal cost.
- Volatile positive and negative spot pricing outcomes unrelated to true system marginal cost.
- Low and counter-price interconnector flows.

These instances are frequently ascribed to the "regional pricing incentive", in that by settling generators at regional rather than local prices, a generator has an incentive to offer away from cost in order to optimise its operation with respect to the regional, rather than local, price.

However it is important to understand that the regional pricing incentive that access settlement intends to address is only one of many reasons why offers away from costs occur. In developing the model and reviewing recent events, AEMO can make qualitative observations listed below.

3.6.1 Flowgate generators

Most of the TFR discussion on these matters considers the incentives on discrete generators who are constrained-off from the regional price in the existing arrangements. The incentive is then to offer at the market price floor, or to use some other bidding parameter, in order to maximise output whilst the network congestion remains.

AEMO has been reviewing events of recent years where a material volume of offers has been moved away from marginal cost, in order to test whether access settlement would have changed this incentive. This has proved a more challenging task than anticipated. There have been many examples of significant offering away from cost and resulting material dispatch inefficiencies, however all recent material events studied to date have been substantially affected by one or more of the issues listed below, which are outside the scope of access settlement to address.

3.6.2 Flowgate support generators

Access settlement does not directly encourage flowgate support generators (usually described as "constrained-on generators") to offer closer to marginal cost. The OFA reform addresses the current incentive to withdraw flowgate support generation by encouraging TNSPs to enter network support agreements with such generators in order to maximise the provision of access to other firm generators.

Whilst it is hoped this mechanism will improve dispatch efficiency in the context of the full OFA, a flowgate support mechanism does not operate in a stage one of standalone access settlement, so it will not form part of AEMO's assessment.

Some of the more material events in recent years relate to congestion:

- On the Calvale – Stanwell (855–871 line) in Queensland in early 2013.
- On the Mt Piper – Wallerawang (70–71 line) in NSW in 2009–10.

A key contributor to these events was the withdrawal or price rebidding of critical constrained-on generation. These cases are therefore unlikely to illustrate efficiency benefits from access settlement incentives.

[12] I.e. absent of the broader parts of the OFA reform

3.6.3 Portfolio bidding

Very material network congestion events are typically characterised by looped constraints, with inefficient dispatch outcomes magnified by the relative participation factors of constrained generators. For example, a generator with a unity factor can, through tactical bidding, constrain-off a competing interconnector by a ratio of up to 14 to one.

Access settlement is designed to address the incentive to offer away from marginal cost by such congested generation, by pricing a constrained generator, at the margin, at its local price that would become negative in this circumstance. This presumes that the generator acts unilaterally. The most material recent events described above involved portfolio generators spread around a loop. In such scenarios the disbenefit of a negative local price can be overwhelmed by the very high prices received in other parts of the loop.

This incentive is also known to exist in fully locational marginal priced markets where portfolios exist around loops. Such events are therefore unlikely to illustrate access settlement benefits.

3.6.4 Five-Thirty rebidding

The basis difference between five-minute dispatch and half-hourly settlement creates its own incentives upon generators to offer away from marginal cost. This is most typically in situations where a very high dispatch price has occurred early in a settlement period, and generators rapidly re-bid in order to increase output for the remainder of the settlement period. The outcome is often observable by a very high positive dispatch price early in the period, followed by a series of low and sometimes negative prices. There are large energy flow changes, with interconnectors reducing flow and often reversing before then end of the settlement period.

This behavioural distortion is unrelated to the regional pricing incentive and outside the scope of OFA to address. However the circumstance that leads to the initial high dispatch price is frequently triggered by network congestion, and generator responses to it are very similar to the behaviour that occurs when plant is constrained off. As a result it is very difficult to distinguish behaviours driven by the five-thirty distortion, or by regional pricing. This greatly complicates AEMO's ability to identify access settlement dispatch efficiency benefits.

3.6.5 Last-minute rebidding

There have been a number of high price events in Queensland in early 2014 which are affected by a combination of network congestion and rebidding of volume to high prices late in a trading interval. The rebidding incentive appears to be the lack of available competitive response to an unforecast supply change in one dispatch interval. This behaviour is also affected by the five-thirty distortion: the rebidding generator's loss of settlement volume to the high price is attenuated by half-hour settlement.

Whilst network congestion is a contributing factor, the behaviour appears unrelated to the regional pricing incentive and therefore access settlement would be unlikely to affect it.

3.6.6 Non-scheduled generation

The NEM has registered over 3,000 MW of non-scheduled generation, of which approximately half is large-scale windfarms registered prior to the introduction of the semi-scheduled category.

Access settlements is to only apply to scheduled and semi-scheduled generators, scheduled network services and directional interconnectors. Under OFA, non-scheduled generation would receive the equivalent of an automatic fully firm access right equal to its current output. The output of these units however contributes to network congestion as per any other generator. Variations in non-scheduled generation lead to variations in the RHS of constraints that constrain scheduled generators.

As a result, RHS volatility can frequently occur with wind variations. This in turn can complicate the interpretation of events when simulated for access settlement.

Of the non-wind non-scheduled generation, much of this is price responsive, fast-start plant. In the smaller regions of Tasmania and South Australia, it contributes a material level of supply. By not being part of the scheduling process, it inadvertently adds to price volatility. As the NEMDE is unaware of their ability to supply, it can set a dispatch interval price well in excess of their marginal price, followed by over-supply and a low price in the following dispatch interval.

Inefficient dispatch and price volatility caused by the operation of non-scheduled generation outside the scope of access settlements, and further complicates the ability to assess its dispatch benefits.

3.6.7 Observations on recent events

AEMO has been reviewing events in recent years with material price volatility, interconnector congestion and counter-price flows and events of obvious widespread offering away from costs. All of the major events analysed so far were either dominated by, or significantly affected by, one of the drivers outside of the scope of access settlement. Therefore it is likely that access settlement, had it been introduced alone, may have changed, but would not have entirely eliminated these outcomes.

AEMO would be pleased to hear suggestions of any candidate events unaffected by these complexities that could be studied, or suggestions of how to separate the impact of these unrelated distortions from the access settlement incentives.

GLOSSARY

Definitions

Many of the listed terms are already defined in the National Electricity Rules (NER), version 54.[13]

Term	Definition
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
access settlement	A new settlement process in the model through which access-long generators receive payments and access-short generators make payments.
administered price cap	A temporary market price cap applied during administered pricing under clause 3.14 of the National Electricity Rules
availability	For a conventional generator, the offered availability; for an intermittent generator, the Unconstrained Intermittent Generation Forecast
congestion residue	A settlement surplus that accrues when electricity is transported across a priced network constraint. Distinguised from loss factor residue.
constrained off	(For a generator) dispatched below its preferred output.
constraint	A mathematical representation in NEMDE of a power system limit.
constraint RHS	Constraint Right-Hand-Side, the static part of the constraint equation
dispatch	The real-time process of determining the optimal pattern of generation to meet demand.
DTS	Dispatch and training simulator
firm interconnector	An interconnector for which AEMO holds some agreed access in trust.
firm interconnector right (FIR)	A right to receive a specified proportion of the IRSR proceeds of a firm interconnector.
flowgate	A point of potential congestion on the transmission network; the notional location on a transmission network represented in NEMDE by a transmission constraint
flowgate support generator	(With respect to a flowgate) a generator with a participation factor less than zero.
hedging	The use of financial derivatives to reduce commercial risks caused by spot market volatility.
hedging risks	Risk of the derivative position being unmatched to the physical due to being unable to transact the physical commodity.
interconnector	A notional entity that is dispatched by NEMDE to transfer power from one RRN to a neighbouring RRN across a regulated interconnector.
inter-regional access	Network access provided to a directed interconnector, from the RRN in the exporting region to the RRN in the importing region.
inter-regional settlement residue (IRSR)	The fund, held in trust by AEMO, into which, or from which, settlement payments relating to directed interconnectors are paid.

13 An electronic copy of the latest version of the NER can be obtained from http://www.aemc.gov.au/rules.php.

Intra-regional loss factor residue	The loss factor residue that emerges due to flows and pricing of losses within a region.
issuance	The process by which access rights are released.
local price	The marginal value that a generator at a node provides to economic dispatch; the locational marginal price
looped constraint	A constraint managing a meshed part of the network, characterised by different participation factors.
loss factor pricing	Adjustment of the geographical price of electricity according to marginal loss factors.
loss factor residue	The settlement surplus that emerges due to the pricing of marginal loss factors. Distinguished from congestion residue.
manifestly incorrect inputs	A situation where prices may be rejected due to a suspicion of manifestly incorrect inputs as described in clause 3.9.2B of the National Electricity Rules.
marginal loss factor (MLF)	A multiplier used to describe the marginal electrical energy loss for electricity used or transmitted.
market price cap (MPC)	A price cap on regional reference prices as described in clause 3.9.4 of the National Electricity Rules.
market suspension	The application of an administered price in the circumstance described in clause 3.14 of the National Electricity Rules.
mispricing	(In the current NEM design) a generator being settled at a price different to its local price
NEM participant fees	The fees collected by AEMO from NEM participants to cover its own costs of operating the NEM
NEMDE	National Electricity Market Dispatch Engine: The computer system through which AEMO dispatches scheduled plant in the NEM and sets market prices.
NEMDE Queue	An offline version of the NEMDE which can be used to simulate NEMDE outputs, using fixed power system inputs.
network congestion	When a transmission network cannot accommodate the dispatch of the least-cost combination of available generation to meet demand.
network support agreement (NSA)	An agreement between a network service provider and a market participant or any other person providing network support services to improve network capability by providing a non-network alternative to a network augmentation.
non-scheduled generator	A generator in respect of which any generating unit is classified as a non-scheduled generating unit in accordance with Chapter 2 of the National Electricity Rules. Unlike scheduled generators, these generators are not dispatched by NEMDE.
participation factor	The coefficient of a variable in a constraint equation
pre-dispatch	Forecast of dispatch performed one day before the trading day on which dispatch is scheduled to occur.
region	An area determined by the AEMC in accordance with Chapter 2A (of the NER), being an area served by a particular part of the transmission network containing one or more major load centres or generation centres or both.
regional reference price (RRP)	The price paid to a dispatched generator in regional settlement
regional reference node (RRN)	The node where the regional reference price is set.
scheduled generator	A generator in respect of which any generating unit is classified as a scheduled generating unit in accordance with Chapter 2 of the National Electricity Rules.
semi-scheduled generator	A generator in respect of which any generating unit is classified as a semi-scheduled generating unit in accordance with Chapter 2 of the National Electricity Rules.
settlement residue auction (SRA)	The auction through which AEMO sells SRA rights.

settlement residue committee	The committee tasked with overseeing the design of the settlement residue auction
simultaneously feasible auction	An auction of access rights incorporating constraints representing the limits of the power system such that the total sale is simultaneously supportable by the physical power system.
spot market	The physical market for electricity, as operated by AEMO. Distinguished from the financial markets for electricity derivatives.
SRA right	The right to receive a specified proportion of the inter-regional settlement residue for a specified directed interconnector
stability constraint	A power system limit that is not a thermal constraint and cannot be linked to a specific asset
thermal constraint	A power system limit controlling the maximum current flow on a specific network asset
transitional access	A level of firm access service that is allocated to existing generators at the commencement of the optional firm access regime and for which no access charge is payable