Congestion management Technical Working Group

Working paper – Preliminary thinking on alternate models

1. Purpose of paper

The purpose of this paper is to set out for discussion a preliminary staff view on:

- Which models should be taken forward in the detailed design process and the reasons why,
- The key outstanding questions and challenges to be resolved for each of the remaining models in order to take them to the next stage of development.

2. Background

Based on stakeholder feedback (including that of the TWG), the ESB has decided to progress parallel models together, with a decision on the best model made later – these models would include at least one stakeholder alternate model alongside the CMM. The virtual seminar and technical working group processes have identified the strengths and challenges associated with the various alternative options. Our approach has been to look at all alternate models and take the best ideas from all of them.

The models have been classified into those that meet the access objectives in (1) operational timeframes and (2) investment timeframes. Some models (including the CMM and transmission queue model) have needed to be split into their investment and operational components. We do not propose to progress the alternative models which were only indirectly related to access reform, although at least one of the models merits further consideration as part of a separate process.

3. Preliminary ESB staff view on models to be taken forward

The team has worked with the TWG to narrow down the remaining options and consider the following are the best models to progress.

Table 1 - Alternate models for progression to detailed design phase

Operational timeframes	Investment timeframes
CMM with universal rebates[1] Single, combined-bid energy and congestion market using a system of charges and rebates - Sub-option: Allocate access to rebates using methodology derived from queue order	**Connection fees /congestion zones** Establish a system of incentives/disincentives that reflect forecast congestion at a given network location. - Sub-option: The incentives/ disincentives take the form of connection fees.
Congestion relief market Separate energy and congestion ancillary co-optimised-bid markets - Sub-option: Reflect queue order in initial process to establish who buys and who sells congestion relief.	**Transmission queue** Establish a transmission queue that confers priority rights. Priority rights are allocated to incumbents and thereafter on a first come first served basis (if the network has spare capacity) or via auction if it is over-subscribed.

[1] We have renamed "vanilla CMM" in response to feedback that the previous name was unclear.

We consider that it is feasible to mix and match the operational and investment timeframe models, subject to the caveat that the transmission queue option would need to be applied in conjunction with one of the blue shaded operational timeframe sub-options.

4. Discussion of alternative models selected for further development

4.1 Operational timeframes

CMM with universal rebates

The CMM with universal rebates (previously known as "vanilla CMM") differs from the CMM-REZ in that all generators, both incumbent and new entrant, receive congestion rebates.

Feature	Model proposal
Efficient dispatch outcomes How does the model dispatch the cheapest available combination of resources to securely meet demand?	When congestion occurs, market participants are subject to a congestion charge that reflect the marginal cost of congestion at their location.
Signals for congestion relief How does the model create incentives for demand side and two way technologies to help to alleviate congestion?	When congestion occurs, two way and demand side participants are able to access lower prices (equivalent to a negative congestion charge). Storage providers will benefit from greater spreads in congested locations.
Managing inter-regional flows How does the model ensure efficient use of the transmission system when inter regional flows are affected by congestion?	This model removes the need for clamping in the event of counter-price flows, because generators affected by congestion receive the LMP + the congestion rebate. The settlement residues flowing into of the pool of rebates reflect the RRP where the energy is consumed.
Allocating the value arising from regional pricing How does the model allocate the value arising from the use of regional pricing?	Depends on rebate allocation metric. Options include: status quo (winner takes all), pro rata access sharing, inferred economic dispatch, or potentially based on a queue.

A key advantage of this model is that it is relatively straightforward and low cost to implement. It also results in simple bidding arrangements, since market participants need only submit one bid, rather than separate bids for the energy and congestion markets.

Going forward, a key outstanding matter for consideration is the allocation metric used to determine each generator's share of the congestion rebates. Generators require clarity on this feature of the CMM so that they can assess how the model affects them. There is a range of options for the allocation metric, which can be tailored to meet various objectives, such as:

- Maintain status quo outcomes. This option would give outcomes similar to the congestion relief market (except that it would occur automatically rather than via a separate ancillary services market).
- Improve on status quo outcomes. For example, we could elect to move away from "winner takes all" outcomes, where tiny differences in participation factors have a large bearing on the profits of individual generators on a looped flow. Instead, the costs of congestion could be shared among affected generators.
- Provide revenue certainty. For example, we could reflect queue status (as established via the transmission queue model) in the allocation of rebates.

The key objective for the allocation metric is to not distort efficient bidding incentives. Any allocation metric should therefore be independent of dispatch outcomes.

There are also some refinements that could be made to the allocation metric, particularly with respect to out of merit order generators. In its simplest version, the CMM allocates rebates on the basis of availability regardless of whether the generator would have wanted to be dispatched at the prevailing RRP (i.e., even where RRP is less than generator cost). High marginal cost plant (ie peaking plant) would receive a windfall gain at the expense of low variable cost plant. This is because the low marginal cost generators are obliged to share their rebates with generators who would not normally have been dispatched in that interval.

To avoid this outcome, we could preclude out of merit order generators from receiving a share of the settlement residue if the RRP is low; e.g. by precluding peaking plant from receiving a rebate if the RRP is less than $300 MWh. However, this refinement has the potential to become complex, particularly as we can't use generator bids to determine merit order (because to do so would resurrect the incentives for disorderly bidding that we're trying to eliminate).

Key questions

- What metric should we use to allocate rebates between generators?
  - Should we remove the "winner takes all" characteristics implicit in the current specification?
- What are the consequences of the congestion management model in terms of bidding incentives?
- Should we adapt the model to preclude peaking generators from receiving rebates when the RRP is low?

Congestion relief market

Feature	Model proposal
Efficient dispatch outcomes How does the model dispatch the cheapest available combination of resources to securely meet demand?	When congestion occurs, market participants can buy/sell congestion relief.
Signals for congestion relief How does the model create incentives for demand side and two way technologies to help to alleviate congestion?	Storage, demand response providers, and parties that benefit from disorderly bidding have the opportunity to sell congestion relief to curtailed generators.
Managing inter-regional flows How does the model ensure efficient use of the transmission system when inter regional flows are affected by congestion?	Our initial view is that trading in CRM is expected to reduce incidences of counter-price flows, however, further work required to examine this issue.
Allocating the value arising from regional pricing How does the model allocate the value arising from the use of regional pricing?	Initial dispatch run establishes buyers and sellers of congestion relief: retains status quo allocation of value (including winner takes all).

The congestion relief market has a number of features that are attractive to market participants:

- It gives market participants autonomy over whether they choose to participate,
- It transparently rewards parties who alleviate congestion, and
- It provides a clear path for developing supporting contractual arrangements.

However, there are a number of outstanding questions requiring further consideration, which could affect whether this model is workable or not. As we resolve the outstanding issues, we will attempt to retain the features that make it attractive to market participants.

A key matter for further consideration is implementation costs. As it requires changes to dispatch, the ESB considers that the congestion relief market is likely to be substantially more expensive to implement than the congestion management model (at least in terms of systems costs). Further work is underway to explore options for how the congestion relief market could be implemented, which will help to consolidate our view of the expected implementation costs. Being more expensive does not necessarily preclude a model from being taken forward, however, the ESB would expect to see commensurately higher benefits relative to the alternative options.

Key questions

- Does the existing model require material alteration to ensure that the dispatch algorithm is able to solve?
    - If these alterations are made, does the model still retain the features that made it attractive to market participants in the first place?
- What implementation costs are involved – both for AEMO and market participants?
- Should we adapt the model to remove the "winner takes all" characteristics implicit in the current specification?
- What are the consequences of the congestion relief market in terms of bidding incentives?
- Should we adapt the model to preclude peaking generators from selling congestion relief when the RRP is low?

4.2 Investment timeframes

Connection fees model/congestion zones

Feature	Model proposal
Nature of incentive How does the model incentivise efficient investment decisions/ disincentivise inefficient investment decisions?	New generators are charged a locational fee based on an alignment with the ISP and/or a forecast of congestion. Generators are incentivised to locate in areas of lower expected congestion because they are charged a lower (or no) fee.
Identifying efficient connection locations How does the model determine which parts of the network should be subject to incentives/ disincentives to connect?	Efficient connection locations are determined in accordance with the transmission planning framework (as supplemented by government policy). Network is split into zones based on level of current/forecast congestion. Information regarding status of different network zones is made publicly available.
Approach to managing new connections How does the model deal with different proponents seeking connection at different times?	Incentives/disincentives are applied in a way that encourage generation investment that aligns with planned transmission investment. If multiple projects are competing for limited transmission capacity, a batching process could come into effect.

Treatment of pre-existing generators How does the model treat existing generators? What is the balance between new entrants and incumbents?	Incumbents are not subject to the incentives/disincentives (as they have already made their location decision).
Efficient retirement decisions How does the model framework encourage efficient retirement decisions for end-of-life generators?	Once a generator reaches a pre-determined age, they could be excluded from the transmission planning studies that decide zone status. I.e. connection fees could be set at lower levels in proximity to end of life generators.
Maximising hosting capacity of available transmission How does the model maximise the potential hosting capacity of the network by encouraging investments that enhance hosting capacity?	The model allows for design options where discounts/waivers on connection fees (or other incentive mechanism) could be made available to parties that agree to fund measures that increase hosting capacity or to operate in ways that reduce congestion risk for neighbouring generators.
Signals for congestion relief How does the model create incentives for demand side and two way technologies to locate where they provide the most benefits to the system?	Parties that provide congestion relief could be exempted from any disincentives that apply to new generators in congested zones. Given that storage can both worsen or alleviate congestion, depending on whether it charges or discharges, it would be necessary to accompany these arrangements with efficient incentives in operational timeframes.

Under this model, we establish a framework that signals to prospective investors which parts of the network are:

1. available for further development,
2. reaching capacity, and
3. already full.

A key design question is what mechanism is used to deter investment in locations that are already full.

The ESB considers that connection fees would provide straightforward and scaleable locational signal. Under this variant, new entrant generators would commit to pay a charge that reflects the long run marginal cost of congestion at their chosen network location. These charges would be administratively determined via the regulatory framework – for instance by the TNSPs (and approved by the AER) as part of their transmission charging methodology, using inputs derived from the ISP. [2] This model would be straightforward to apply in conjunction with jurisdictional schemes as the connection fees could be set at levels to encourage/discourage investment in line with jurisdictional schemes.

[2] For clarity, this model is different from the type of connection fees proposed by Shell, which we do not support because it involves a physical access regime – i.e. a do no harm regime expanded to all types of constraints.

Key questions

- What is the nature of the incentive used to influence generator location decisions?
- What methodology is used to calculate the efficient hosting capacity of the network for each zone?
  - How does this methodology reflect differences in the output profiles of different generator types?
- What happens when multiple generators seek access to the same part of the network?
- Who is responsible for administering various aspects of the framework?
- Under the connection fee model, how are connection fees calculated?
  - What is the correct balance between accuracy and simplicity/transparency?
- Under the connection fee model, what happens to revenue paid by generators? For instance, is it used to:
  - offset transmission use of service fees paid by customers?
  - accelerate transmission investment in accordance with the ISP?
- Can queue positions can be traded?

Transmission queue

Feature	Model proposal
Nature of incentive How does the model incentivise efficient investment decisions/ disincentivise inefficient investment decisions?	Congested generators with tied bids are dispatched in order of marginal cost (subject to ramp rates, minimum generation requirements) and then queue order. In the presence of a loop, dispatch reverts to the status quo, with generators being dispatched in order of participation factor by the dispatch engine.
Identifying efficient connection locations How does the model determine which parts of the network should be subject to incentives/ disincentives to connect?	The model applies to existing and future transmission networks as per the ISP. Efficient connection locations are identified based on the Tx capacity available.
Approach to managing new connections How does the model deal with different proponents seeking connection at different times?	If expressions of interest are less than the Tx capacity, first come first served is applied. If EOIs are greater than Tx capacity, an auction is held and proponents assessed based on price.
Treatment of pre-existing generators How does the model treat existing generators? What is the balance between new entrants and incumbents?	Incumbent generators are treated as equal first in the connection queue (or pro-rated according to current rules if incumbent generation exceeds Tx capacity).
Efficient retirement decisions How does the model framework encourage efficient retirement decisions for end-of-life generators?	Model is accompanied by proposed rule change to tied priced bids whereby RE generators are always dispatched before thermal generators where consistent with system security requirements. Refer to 'new tie breaker rules' section 5.1.
Maximising hosting capacity of available transmission How does the model maximise the potential hosting capacity of the network by encouraging investments that enhance hosting capacity?	Option for new generators to fund investment to increase transmission hosting capacity in return for an improved position in the queue.
Signals for congestion relief	Opportunity for generators to improve their position in the queue through transmission charges (to augment local Tx capacity or

How does the model create incentives for demand side and two way technologies to locate where they provide the most benefits to the system?	install storage and seek the right to dispatch during periods when there is no shortage of Tx capacity). Energy storage is subject to same queuing terms as generators.

Under this proposal, we would establish a transmission queue, with generators being dispatched in queue order when the tie-breaker rules would otherwise apply. Under this model, incumbent generators and generators locating in parts of the network where spare capacity is available would receive a queue number that makes them joint first in the queue. Thereafter generators would receive their queue number on a first come first served basis (if the network has spare capacity) or via auction if it is over-subscribed.

We consider that the concept of generators receiving a form of priority right based on either the timing of their connection or the outcome of an auction is sound. However, as currently specified, we consider that the transmission queue model is unlikely to be an effective tool for managing access risk. This is due to the impact of generation coefficients[3], which means that the tie-breaker rules rarely come into play. Instead, race to the floor bidding, combined with generator constraint coefficients, gives rise to winner takes all outcomes. This issue is discussed further in the TWG paper on winner takes all dispatch in the NEM.

These could be resolved by adjustments to how a generator's queue status is reflected in operational timeframes. For instance, queue status could be incorporated into:

- the metric used to allocate congestion rebates between generators under the CMM or
- the initial process to establish who buys and who sells congestion relief.

Resolving this issue will be key to the viability of this model.

Key questions

- How does a generator's queue position manifest in operational timeframes?
- What methodology is used to calculate the efficient hosting capacity of the network (for the purposes of establishing whether initial queue positions are available)?
  - How does this methodology reflect differences in the output profiles of different generator types?
- Who is responsible for administering various aspects of the framework?
- Can queue positions can be traded?
- Should energy storage be subject to the same queuing terms as generators?
- How does the model framework encourage efficient retirement decisions for end-of-life generators?

[3] Each generator or interconnector affected by a constraint has a coefficient allocated to it within the constraint equation, which reflects the impact it has on the constrained transmission line. For example, if a one MW reduction in output of a generator decreases flow on the constrained line by one MW, the coefficient is +1. The further away a generator or interconnector is located from the constrained line, the greater the change in output required to achieve a one MW change in flow over the constrained line. This is reflected by a smaller coefficient.

5. Discussion of alternative models not selected for further development

5.1 Operational timeframes

New tie breaker rules

Feature	Model proposal
Efficient dispatch outcomes How does the model dispatch the cheapest available combination of resources to securely meet demand?	Lower cost generators (RE and energy storage) are dispatched before higher cost generators (thermal) when both have bid the same price and transmission capacity is constrained. When constraint applies to generators with equal marginal cost (eg a group of VRE generators) dispatch priority is based on commissioning date/queue order.
Signals for congestion relief How does the model create incentives for demand side and two way technologies to help to alleviate congestion?	Requires further consideration.
Managing inter-regional flows How does the model ensure efficient use of the transmission system when inter regional flows are affected by congestion?	Requires further consideration.[4]
Allocating the value arising from regional pricing How does the model allocate the value arising from the use of regional pricing?	Dispatched generators receive RRP. Dispatch determined in accordance with amended tie breaker rules.

New tie breaker rules would entrench race to the floor bidding in the presence of congestion, and then rely on the regulatory framework (rather than the market) to determine dispatch order.

The approach involves categorising different generator types – e.g. VRE versus non-VRE – and dispatching them in a certain order (subject to meeting system security and operational needs). There is potential for this approach to deliver a marginal improvement in the efficiency of dispatch relative to the status quo, but it would be less accurate and less dynamic than a market-based approach. It also has the potential to be contentious. Given the models that rely on new tie-breaker rules lack widespread support, we think it is more fruitful to focus on the options that perform more strongly against our objective of dispatch efficiency.

However, the concept of using rules to provide more investor certainty to generators with greater incumbency than its competitors can be translated into how the allocation metric can be altered from ‘winner takes all’ to more preferable for those with a higher queue position. This idea of ‘access protection’ is a concept provided in multiple key industry body submissions. There is also scope to adapt the congestion relief market to incorporate this principle.

[4] EnergyAustralia’s submission included a separate proposal for dealing with interconnectors which would change the way that interconnectors are treated in the constraint formulation guidelines.

5.2 Investment timeframes

REZ adaptation part of CMM

Feature	Model proposal
Nature of incentive How does the model incentivise efficient investment decisions/ disincentivise inefficient investment decisions?	Generators receive/do not receive a congestion rebate. Rebates are available to incumbents, REZ generators, and in other locations where spare hosting capacity is available or proposed.
Identifying efficient connection locations How does the model determine which parts of the network should be subject to incentives/ disincentives to connect?	Rebates are made available for locations identified via an enhanced transmission planning framework. The rebates allocation is aligned to AEMO's ISP including the development of REZs and non-REZ transmission network planning.
Approach to managing new connections How does the model deal with different proponents seeking connection at different times?	Rebates are made available via some form of tender process – either a REZ tender, or a system-wide tender to allocate any remaining hosting capacity.
Treatment of pre-existing generators How does the model treat existing generators? What is the balance between new entrants and incumbents?	Incumbent generators receive rebates. The definition of incumbents will form part of future detailed design work.
Efficient retirement decisions How does the model framework encourage efficient retirement decisions for end-of-life generators?	The model allows for design options regarding the grandfathering of rebates to incumbent generators. For example, after a pre-determined period, incumbent generators could be excluded for the purposes of deciding where new rebates are available. Incumbents would still receive rebates but the rebate revenue would be distilled with new connecting generators.
Maximising hosting capacity of available transmission How does the model maximise the potential hosting capacity of the network by encouraging investments that enhance hosting capacity?	The model allows for design options where rebates are made available above planned levels to parties that agree to fund measures that increase hosting capacity.
Signals for congestion relief How does the model create incentives for demand side and two way technologies to locate where they provide the most benefits to the system?	Demand-side and two-way technologies benefit from lower prices in the presence of congestion. For batteries, this means they can access greater price spreads by storing energy until the congestion has passed.

Based on stakeholder feedback, the team proposes to take the REZ adaption, as previously recommended in the Post 2025 review, off the table, and instead focus on developing a connection fee based model.

The primary driver of stakeholder opposition to the CMM-REZ was concern about what would happen to generators who are ineligible to receive a rebate. Further, of the stakeholders that supported some form of CMM, several (including ECA and ENA) expressed a preference for CMM plus connection fee over CMM-REZ.

Under CMM with universal rebates, all generators – both incumbents and new entrants – receive rebates. This approach does, however, necessitate an alternative solution in investment timeframes. A connection fees model has the advantage of providing up front clarity to investors. Staff note that the CMM + connection fees model was the ESB's second ranked model during the Post 2025 process. A model that utilises connection fees could equally be applied in combination with the congestion relief market.

We note that CMM-REZ shares many core features with the investment timeframe models that remain on the table. The key difference is the nature of the incentive.

Physical access rights given effect via locational connection fees

Feature	Model proposal
Nature of incentive How does the model incentivise efficient investment decisions/ disincentivise inefficient investment decisions?	New connecting generators are required to "do low harm" to pre-existing generators. New entrants are incentivised to locate in areas of low forecast congestion in order to minimise their locational connection fees and/or their operational behaviours.
Identifying efficient connection locations How does the model determine which parts of the network should be subject to incentives/ disincentives to connect?	The model applies to the full NEM including actionable ISP projects. The "do low harm" assessment conducted during connection process determines the connection cost. A revised RIT-T approach allocates costs to customers, existing generators and new entrants.
Approach to managing new connections How does the model deal with different proponents seeking connection at different times?	A queuing mechanism determines the order in which "harm" is assessed.
Treatment of pre-existing generators How does the model treat existing generators? What is the balance between new entrants and incumbents?	Incumbent generators have already connected and hence do not pay connection fees. Incumbent generators have confidence that their access will not be materially constrained in future by new entrants.
Efficient retirement decisions How does the model framework encourage efficient retirement decisions for end-of-life generators?	A new entrant could enter into commercial contracts under which existing generators could agree to being 'harmed' under specific circumstances.
Maximising hosting capacity of available transmission How does the model maximise the potential hosting capacity of the network by encouraging investments that enhance hosting capacity?	New entrants can negotiate the level of connection firmness with the TNSP including the level of curtailment, operational behaviours and costs of physical augmentation.
Signals for congestion relief How does the model create incentives for demand side and two way technologies to locate where they provide the most benefits to the system?	Generators will assess congestion relief solutions to identify the most effective / least cost in order to minimise locational connection fees. It requires measures to ensure that parties behave as intended in operational timeframes.

Our preliminary view is that physical access models do not meet the required objectives in either the investment or operational timeframes:

- In the investment timeframe, similar models – such as in the WA and previously in FERC – have all been determined to be inefficient and unworkable. Several of these jurisdictions either have or are looking to move away from such physical access models either to LMP or open access models.
- In the operational timeframe, implementation of these models would require movement away from economic dispatch to ensure the physical access rights are honoured. That is, the objective function of dispatch is no longer the lowest cost but honouring the physical access rights.

These issues are discussed in more detail in the TWG paper on physical access.

However, certain ideas from the locational connection fees model may be suitable for further progression. In particular, the idea that new entrants can negotiate with TNSPs to explore options to mitigate their impact on the broader system (at their own cost) could potentially form the basis of a mechanism to maximise the hosting capacity of available transmission. Further work is required to establish how this concept might be applied. For instance, generators who wish to connect in congested parts of the system, and have proposals for how they can mitigate their impact on congestion, could have an option to negotiate a lower connection fee, or a lower queue number.

5.3 Other models

As per previous TWG discussions, we also propose to take the following models off the table on grounds that they do not directly contemplate access reform: dual price floors, shaped MLFs and the PIAC model.