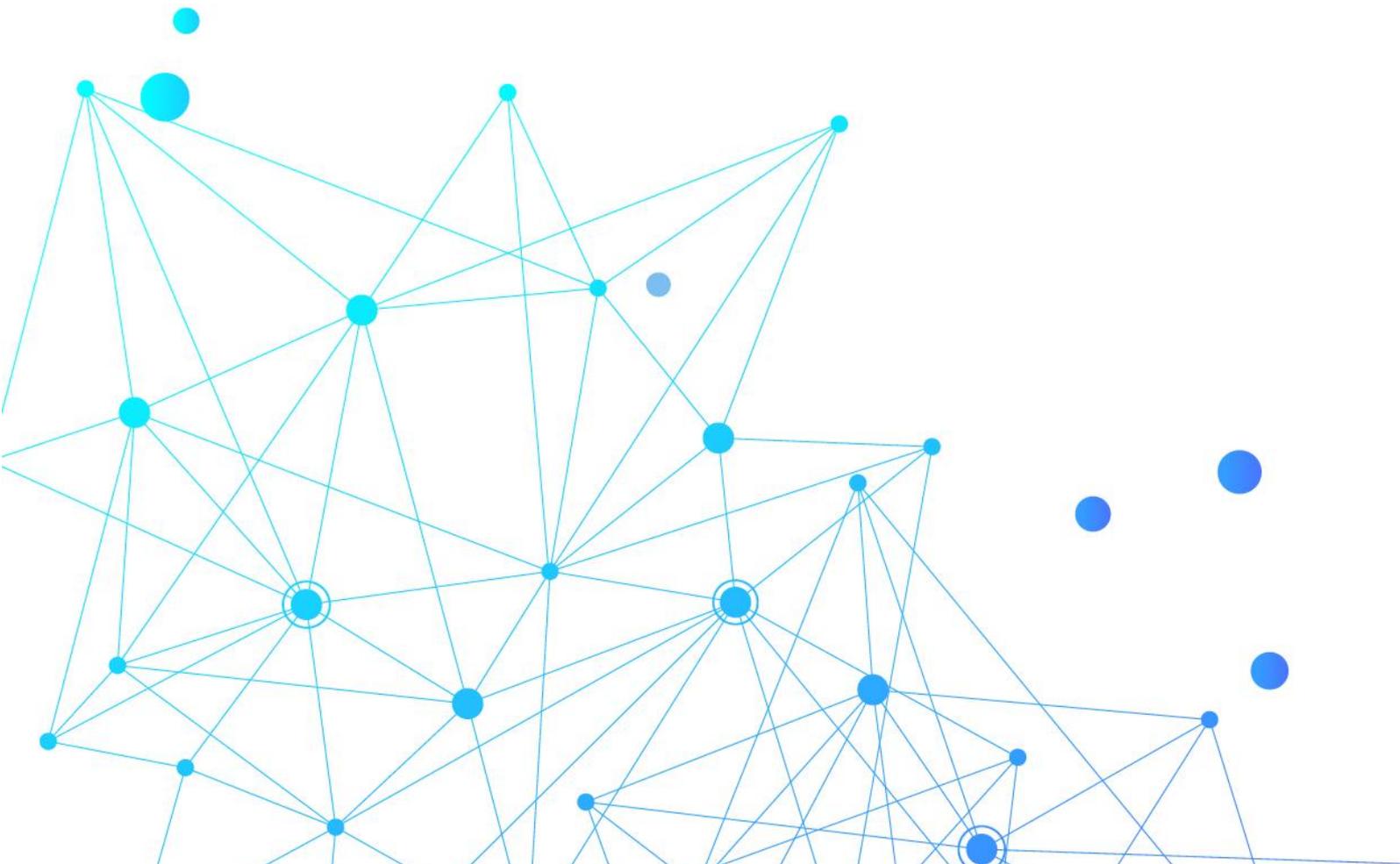




Energy Transformation Taskforce



Governance Framework for Constraint Equations

Information paper

August 2019

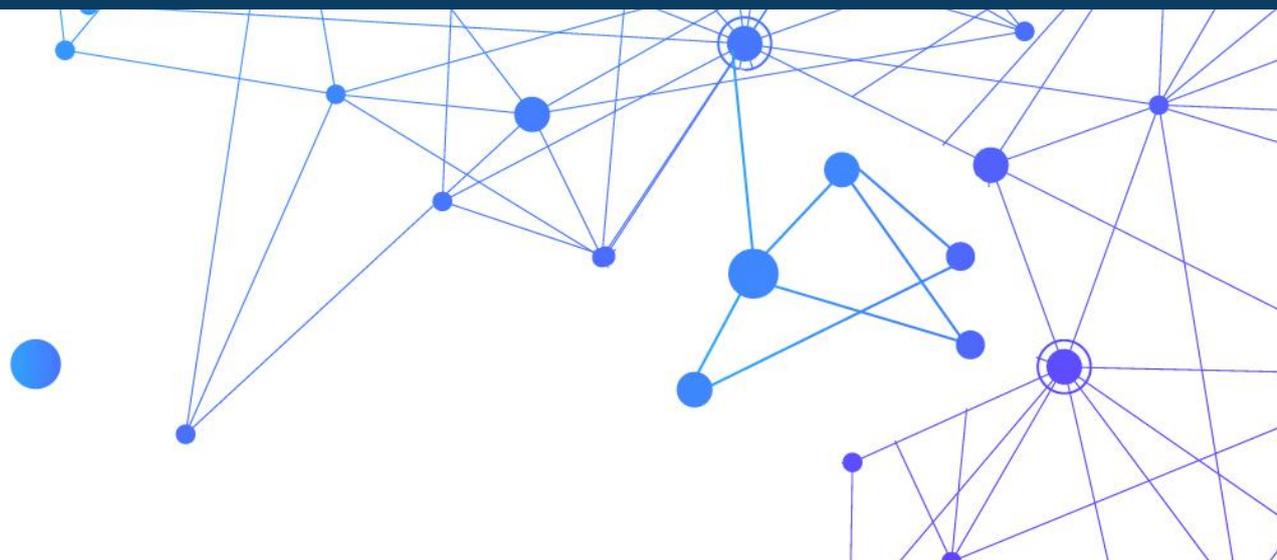


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1. Purpose

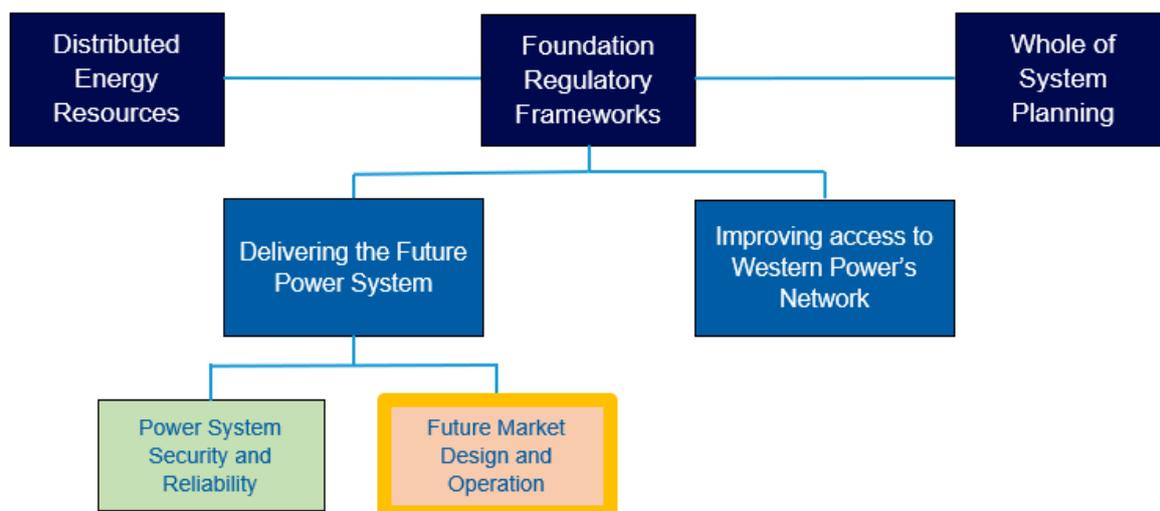
1.1 The Energy Transformation Strategy

This paper forms part of the work to deliver the Energy Transformation Strategy (Strategy). This is the Western Australian Government's strategy to respond to the energy transformation underway and to plan for the future of our power system. The delivery of the Strategy is being overseen by the Energy Transformation Taskforce (Taskforce), which was established on 20 May 2019. The Taskforce is being supported by the Energy Transformation Implementation Unit (ETIU), a dedicated unit within the Department of Treasury.

More information on the Strategy, Taskforce, and ETIU can be found on the Energy Transformation website at <http://www.treasury.wa.gov.au/Energy-Transformation>.

This paper is prepared as part of the *Future Market Design and Operation* project (highlighted in **Figure 1**) within the Foundation Regulatory Frameworks work stream of the Strategy.

Figure 1: Energy Transformation Strategy work streams



The Future Market Design and Operation project is undertaking improvements to the design and functioning of the Wholesale Electricity Market (WEM):

- modernising WEM arrangements to implement a Security-Constrained Economic Dispatch (SCED) market design that optimises the benefits of the introduction of constrained network access for Western Power's network; and
- implementing a new framework for acquiring and providing Essential System Services.

1.2 The purpose of this paper

This paper is one of a series covering design elements of the new WEM. These changes are crucial to support the continuing security of the power system and the efficient operation of the WEM in an environment of rapidly changing technology and consumer demand.

The purpose of this paper is to outline the framework that will govern the development, use and regulation of constraint equations that are required for the new network access and SCED arrangements planned to be implemented in the WEM from 1 October 2022.

2. Introduction to constraint equations

2.1 Overview of constraint equations

The SCED engine will perform a constrained optimisation calculation that produces a dispatch outcome subject to technical constraints of the power system and the network. This requires a set of ‘constraint equations’ to reflect the limits of the network.

Constraint equations are mathematical representations that the Australian Energy Market Operator (AEMO) uses to manage power system limitations and Essential System Services requirements.¹ Constraint equations are formulated based on network limits that affect how energy can flow through the network.

There are two types of network limits: thermal and non-thermal. These are mathematically defined as limit equations and are inputs to constraint equations.

- A thermal limit is the maximum energy that can be transmitted through a piece of network infrastructure (for example, equipment ratings). For example, if too much energy is transmitted through a line it can overheat, causing it to sag, melt and potentially break. A thermal limit is in place to define the boundaries within which infrastructure should be operated.
- A non-thermal limit describes system security and stability limitations. It is required to maintain network stability or for frequency control services, or to enact network control services. For example, electrical equipment operating at voltages outside of normal operation for too long will be damaged. Non-thermal limits are in place so this does not occur.

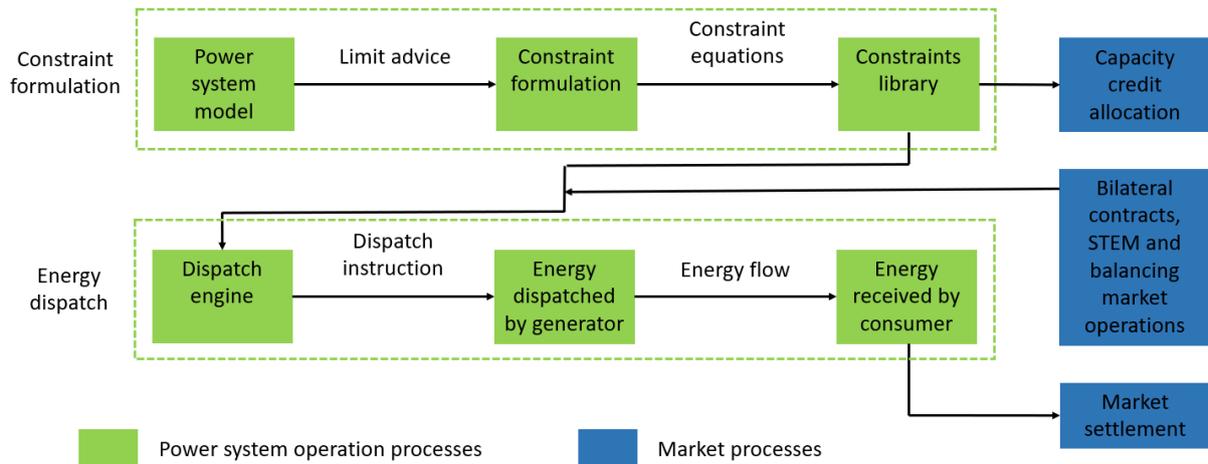
Constraint equations form an input into constrained-optimisation linear-programming calculations in the dispatch engine.

Constraint equations will also be used to inform the allocation of capacity credits to certified facilities. Capacity will not be issued beyond the physical limitations of the transmission network in the new constrained access model. Some facilities may not receive Capacity Credits for their maximum generation, where that generation may not be available at peak times due to the network being congested. Constraint equations will be used to determine congestion and the maximum capacity credits that can be allocated within an area of the network.

The process to formulate constraint equations and use them in energy dispatch is summarised in **Figure 2**. It shows that power system limits are used to formulate constraint equations.

¹ AEMO, *Constraint Formulation Guidelines*, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Congestion-Information/2016/Constraint_Formulation_Guidelines_v10_1.pdf

Figure 2: Process to develop and use constraints



2.2 Structure of this document

The remainder of this document is set out as follows.

- Section 3 sets-out the organisations that will be responsible for defining the limit equations and formulating the constraint equations.
- Section 4 outlines the technical processes for constraint equation development and use that must be specified, and the documents these must be specified in.
- Section 5 outlines the organisation responsible for ensuring compliance with regulatory obligations, and how it will undertake these functions.
- Section 6 outlines the information that must be published.
- Section 7 outlines how AEMO, Western Power and the Economic Regulation Authority (ERA) will recover the costs of constraint-related activities.

3. Responsibility for limit equations and constraint equation formulation

The governance framework must identify the organisation(s) responsible for developing limit equations and formulating constraint equations. The organisation(s) must have appropriate knowledge, expertise and access to information to perform these functions. The governance framework must also ensure that the organisations will define limit equations and formulate constraint equations in a way that balances the need to operate infrastructure safely and securely, but also promotes the efficient use of the network for the benefit of customers.

The governance framework must ensure that the organisation(s) responsible for developing limit equations and formulating constraint equations are legally responsible and accountable for the accuracy of information supplied. This is to provide sufficient incentive for the organisation(s) to undertake their functions with due care, giving regard to good electricity industry practice. This practice should also reflect the best interests of the market and consumers.

Approach

Western Power will be responsible for defining limit equations and providing these equations and supporting information (together, referred to as limit advice) to AEMO. AEMO will be responsible for using the limit advice to formulate constraint equations.

Western Power, as the Network Operator, is best placed to define the limits associated with its infrastructure. This includes both thermal limits (including equipment ratings) and non-thermal limits related to system security and stability that depend on infrastructure specifications (for example, voltage ratings) and network configuration.

AEMO, in performing its system management functions, will use that limit advice, together with other power system information it collects and maintains, and security constraints, to formulate constraint equations for the secure and reliable operation of the SWIS.

Placing responsibilities on entities that are best able to provide information related to their infrastructure and existing functions will be the most cost-effective option.

This approach is also consistent with other jurisdictions. For example, in the National Electricity Market (NEM) and Singapore, the network operator is required to provide limit advice to the system operator to inform the formulation of constraint equations.

Western Power and AEMO will be subject to the existing legal framework providing sufficient incentives and accountability for the quality of information (limits advice and constraint equations) provided. The framework includes the civil penalties outlined in:

- Part 5 Division 3 and Schedule 1 of the WEM Regulations; and
- Section 126 of the *Electricity Industry Act 2004*.

The maximum liability for an act or omission undertaken in good faith under these instruments is capped at \$100,000.² Western Power will be legally responsible (and therefore liable) for the limit advice, and AEMO will be legally responsible (and therefore liable) for the constraint equations (except to the extent an error in a constraint equation is attributable to an error in limit advice).

Alternatives considered

Two alternatives were considered:

1. One organisation (either AEMO or Western Power) being responsible for both defining the limit advice and formulating constraint equations.
2. A third party being responsible for defining the limit advice and formulating constraint equations.

The first option was not selected by the Taskforce as Western Power is not well-placed to formulate constraint equations as it does not have the same knowledge of system operation as AEMO. Additionally, Western Power is not responsible for overall power system security. Similarly, AEMO is not well-placed to define limit advice as it does not have the same knowledge of Western Power's infrastructure. This would require the other organisation to provide support to the organisation responsible for defining limit advice and formulating constraint equations, which would result in duplication of effort and consequently be more expensive than the preferred option.

The second option was not selected by the Taskforce as a third party will not have the same knowledge, expertise and access to information as AEMO and Western Power. As in option one, this will result in duplication of effort and likely higher costs.

Western Power will be responsible for defining thermal and non-thermal limit advice.

AEMO will be responsible for formulating constraint equations.

Western Power and AEMO will be subject to the existing legal liability and penalty framework relating to the quality of limit advice and constraint equations.

² As per the provisions of the *Electricity Industry Act 2004*.

4. Specification of technical processes for constraint equation development and use

There are many technical processes supporting the development and use of constraint equations. These range from the processes for applying a risk margin to limit advice to AEMO's ability to intervene if the dispatch engine cannot produce a feasible solution in the presence of constraints.

Some of these processes will require prescriptive detail to be documented to ensure their application is consistent and robust. The governance framework must outline the extent to which such technical processes should be outlined in the WEM Rules, or other documents including WEM Procedures or guidelines.

Approach

The WEM Rules will require the development of WEM Procedures that outline:

- the process to transfer information between Western Power and AEMO, including limit advice;
- a description of the process and assumptions Western Power uses to define limit advice, including the application of a risk margin;
- a description of the process and assumptions AEMO uses to formulate constraint equations, including the application of an operating margin;
- the constraint relaxation procedure (a procedure whereby AEMO can resolve dispatch when the dispatch engine is unable to produce a feasible solution); and
- any other processes needed to give effect to the development and use of constraint equations.

Specifying these technical parameters and processes in WEM Procedures will provide flexibility to change them as needed, whilst also providing assurance to Market Participants that the technical processes will be developed, documented and consulted on to maintain robust, consistent and transparent decision-making.

AEMO will be responsible for developing these Procedures. AEMO will be required to engage with Western Power, and consult with industry as outlined in the procedure change process in the WEM Rules. Both AEMO and Western Power will be required to comply with these Procedures.

Technical processes relating to constraints information will be specified in WEM Procedures developed by AEMO.

5. Compliance

The governance framework for limits advice must include appropriate regulation of the development and use of, and compliance with, constraint equations. This is important to ensure effective operation of SCED, appropriate reserve capacity allocation and prudent and efficient use of network infrastructure. For example, if a generator is dispatched contrary to a constraint then the constrained line is at risk of being overloaded and damaged. This risks the operation of the network and additional costs being incurred.

Organisations responsible for developing limit advice or constraint equations may have incentives to achieve an outcome that, although prudent for the efficient use of their infrastructure or operation of the system, may not be economically efficient for the market. For example, a risk or operating margin applied to limit advice or constraint equations could be too conservative. This may place unnecessary costs on Market Participants through inefficient market outcomes or additional network investment to alleviate perceived constraints.

Regulation of constraints will include:

- how Western Power defines the limit advice, including whether an appropriate risk margin has been applied;
- how AEMO formulates the constraint equations, including whether an appropriate operating margin has been applied;
- how AEMO applies constraint equations; and
- whether information about constraints is published as required.

In addition, assessment of whether Market Participants comply with binding constraints (that will be issued through Dispatch Instructions) will be undertaken by AEMO and the ERA's existing activities to monitor compliance with Dispatch Instructions.

Approach

The ERA's existing monitoring and compliance functions provided under clause 2.13.2 of the WEM Rules will apply to constraints. The ERA is required to monitor Rule Participants³ compliance with the WEM Rules and Procedures. In the future, this will include all of the constraints related functions and obligations outlined in the WEM Rules and Procedures (as described in Section 4 of this paper) .

The ERA is well-placed to undertake this regulatory role because of its current expertise in – and processes in place for – the monitoring and compliance functions for the WEM. This is also likely the most cost-effective option, although it is acknowledged the ERA may require additional resources to discharge these functions.

Market Participants will also have the ability to raise concerns with the ERA about limit advice and constraint equations and seek an additional level of assurance that limit advice and constraint equations are fit for purpose.

³ Rule Participants include Western Power, AEMO and Market Participants.

The ERA will have discretion about the frequency and manner in which it undertakes these activities, including how it investigates concerns raised by Market Participants (for example, not investigating frivolous or vexatious matters). This includes that it can decide to review all constraint equations or audit a sample. It can also choose to monitor the appropriateness of risk margins applied to constraint equations through its annual review of WEM effectiveness.

The intent of providing discretion is to ensure that the ERA is able to take a risk-based approach to its regulatory role so that costs of the monitoring and compliance framework for constraints are no more than the most efficient costs needed to ensure effective WEM operation.

The ERA will outline its approach to monitoring and compliance in its Compliance Framework and Strategy.⁴

The development of constraint equations for reserve capacity allocation will be required prior to the implementation of rule and regulation changes giving effect to the ERA's monitoring and compliance functions (which will commence from October 2022). As such, the initial set of limit advice and constraint equations being prepared to apply to SCED from October 2022 will not be captured under the new monitoring and compliance framework. Therefore, an interim arrangement to provide assurance on the accuracy and appropriateness of the initial set of limit advice and constraint equations is required. An appropriately-empowered party will review the limit advice and constraint equations formulated prior to commencement of new market arrangements on 1 October 2022.

The existing dispute mechanism in the WEM Rules will also be available and applicable to constraint-related matters.

The ERA will regulate development, use and compliance with constraint equations, and publication of associated documents.

Alternative considered

An alternative considered was constituting a technical panel, separate from the ERA, to perform regulatory functions. For example, a technical panel can be convened on an as-needs basis to include specialist expertise for this function. However, finding suitably-qualified, senior technical specialists willing to be engaged on an as-needs basis for similar functions in the WEM has been challenging in the past. Also, a temporary technical panel constituted to only scrutinise limit advice and constraint equations (and not other aspects such as dispatch non-compliance) would be inefficient and potentially expensive as it would create an additional entity with potential duplication of some of the ERA's existing processes and its own administration needs.

⁴ ERA, *Compliance Framework and Strategy*, <https://www.erawa.com.au/electricity/wholesale-electricity-market/compliance-framework-and-strategy>

6. Publication of information

The governance framework should outline the constraint-related information that is to be published, which stakeholders this is available to and how these stakeholders can access the information. This will provide stakeholders certainty about the information they have access to, and place obligations on AEMO and Western Power to make certain constraints-related information available.

Approach

Transparency should be maximised, whilst respecting the need to maintain confidentiality of specific types of commercial information.

The WEM Rules will require the following constraint information to be publicly available:

- Limit advice.
- Constraint equations.
- Information on binding constraints.

This information will be regularly published on the AEMO website, similar to its NEM congestion information resource.⁵ Information on binding constraints will also be available to Market Participants in near real time through the Market Management System.

In addition, the WEM Rules will require publication by AEMO of an annual document outlining the current and expected areas of congestion. This publication will be accessible to a wide range of stakeholders such as industry to assist with investment decisions on location of new generation or augmentation of congested parts of the network, as well as academia and other interested parties to study patterns and trends of interest.

⁵ AEMO, *Congestion Information Resource*, <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Congestion-information>

7. Cost recovery for constraint-related functions

The governance framework must outline the funding arrangements for constraint-related functions. Funding is required for the initial work undertaken prior to commencement of the new market arrangements on 1 October 2022, and ongoing functions undertaken following market commencement.

Some constraint-related functions will be new, conferred on AEMO and Western Power by amendments to the WEM Rules. Other constraint-related functions will be an extension of existing functions and may not need specific WEM Rule changes, for example the extension of the ERA's monitoring and compliance functions.

Approach

Constraint-related functions will be funded as follows.

- For AEMO and the ERA, through market and regulator fees respectively.
- For Western Power, through charges to access its infrastructure.

The cost of the development, use, and regulation of constraints are indirect costs to provide electricity to consumers, and therefore should be recovered through the market.

Existing regulatory processes will determine the costs AEMO, Western Power and the ERA can recover. The constraint-related functions for these organisations will be conferred through the WEM Rules and Procedures to support these regulatory processes.

- The ERA determines the allowable revenue and forecast capital expenditure AEMO can recover through fees charged to Market Participants for its services. On 14 June 2019, the ERA published its final allowable revenue and forecast capital expenditure determination for the period 2019-2020 to 2021-22. This included approval for \$13.75 million for transitional functions outlined in clause 1.20 of the WEM Rules, which AEMO identified as including constraint-related work. It is expected AEMO will seek funding for ongoing constraint-related work through future allowable revenue determinations. The amendments to the WEM Rules to give effect to the governance framework for constraints will enable AEMO to recover costs for its ongoing constraint-related activities.
- The ERA approves Western Power's non-capital costs (amongst other items) through its five-yearly access arrangement. The Access Code will be amended to include constraint-related costs as a non-capital cost, and identify these as being recoverable for activities undertaken prior to market start. It is expected Western Power will seek recovery of its constraints-related costs (both those incurred prior to and following market start) through its access arrangement. The amendments to the Access Code will specifically enable this.
- The ERA is able to recover costs of its WEM-related functions from regulator fees defined in the WEM Rules. Where the ERA determines a need for additional resources to perform constraint-related functions, it will be able to seek these through existing government budget processes.

Constraint-related functions will be funded by:

- **market and regulator fees under the WEM Rules, for AEMO and the ERA, respectively; and**
- **charges to access infrastructure under the Access Code, for Western Power.**