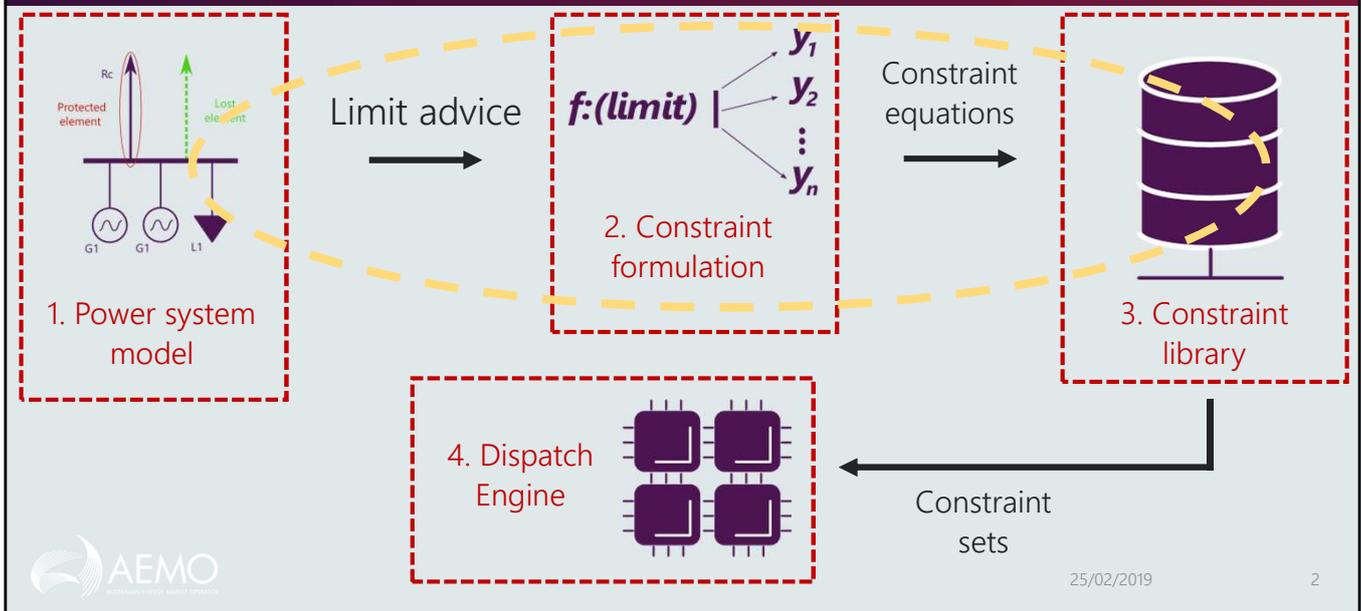




WEM Reform: Constraint Development Responsibilities

PSO-WG Meeting 3
February 2019

Constraint technical framework



In the November working group, we introduced the “technical framework”: a breakdown of the PSO aspects into more manageable “components” (and an introduction of key terminology taken from the NEM / NEMDE implementation)

The overall objective of the PSO-WG is to flesh-out the framework such that it enables the PUO to make informed decisions as to what aspects of system constraints should be codified in the WEM Rules.

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The power system model component describes the conversion of physical equipment limits into “Limit Advice”. It prompted market design questions such as:

- how should reasonable levels of risk and performance be balanced in setting operational margins?

At the end of the WG, AEMO resolved to engage with Western Power to develop this interface.

Today’s presentation aims to share this information with the WG, and show how it progresses into the formulation of constraint equations, and publishing of constraint data via the library.

Constraint responsibilities

Deliverable	TNSP	AEMO
Line Rating (thermal)	✓	
Develop Stability Limit (non thermal)	✓	
Due diligence of Stability Limits		✓
Develop Thermal Constraint Equations		✓
Develop Stability Constraint Equations		✓
Ancillary Services Constraint Equations		✓



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Prior to any engagement, WP proposed the following breakdown of constraint development responsibilities, noting that this model largely follows the NEM structure

(LK comment: also implicit NEMDE-like implementation i.e. FCAS equations implemented naturally through NEMDE's 'generalised constraint' solver).

Specific meanings "develop" vs. "due diligence" are critical parts of the framework.

Note that in the NEM, there is very limited technical specification of constraint development at the rule level. For example, there is no definition of a thermal vs. stability, only that the dispatch process must ensure system security.

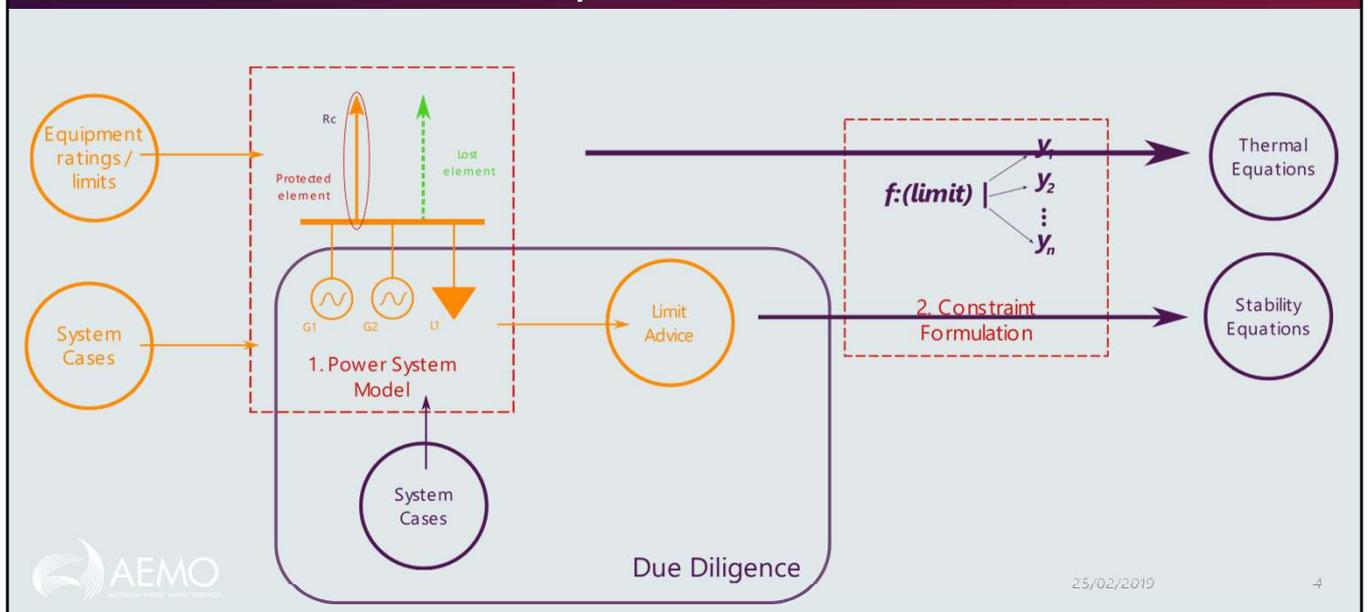
Similarly, there is no specification of responsibility and/or liability for their operation.

This may reflect a desire to allow flexibility in the implementation; may also reflect an interconnection of many TNSPs with differing risk profiles (and accountability to independent state governments).

The balance between flexibility and certainty in the market is a non-obvious problem, something the rule framing / drafting can influence, and a key output from this working group.

Notwithstanding however, this broadly follows AEMO's expectation of the final allocation of responsibilities.

Thermal vs Stability Limits



The separation of responsibility in thermal and stability equations reflects the level of complexity in their development.

With a proper power system model (including accurate equipment limits), it is relatively straight-forward to formulate a Thermal Constraint Equation and no “Limit Advice” is necessary (will we discuss in more detail in a moment)

In this diagram, orange and purple show the responsibility breakdown between WP / AEMO respectively.

In this model (i.e. current breakdown) WP build and own the transmission assets; they also own and maintain the power system model, including the equipment limits / ratings. This includes detail of limits that may vary with:

- summer / winter
- overload / emergency
- dynamic conditions

WP supplies a version of the model directly to AEMO; this is sufficient to formulate co-optimisable thermal equations.

By contrast, stability limits (e.g. voltage and/or dynamic) require additional engineering

insight and effort to both identify and solve.

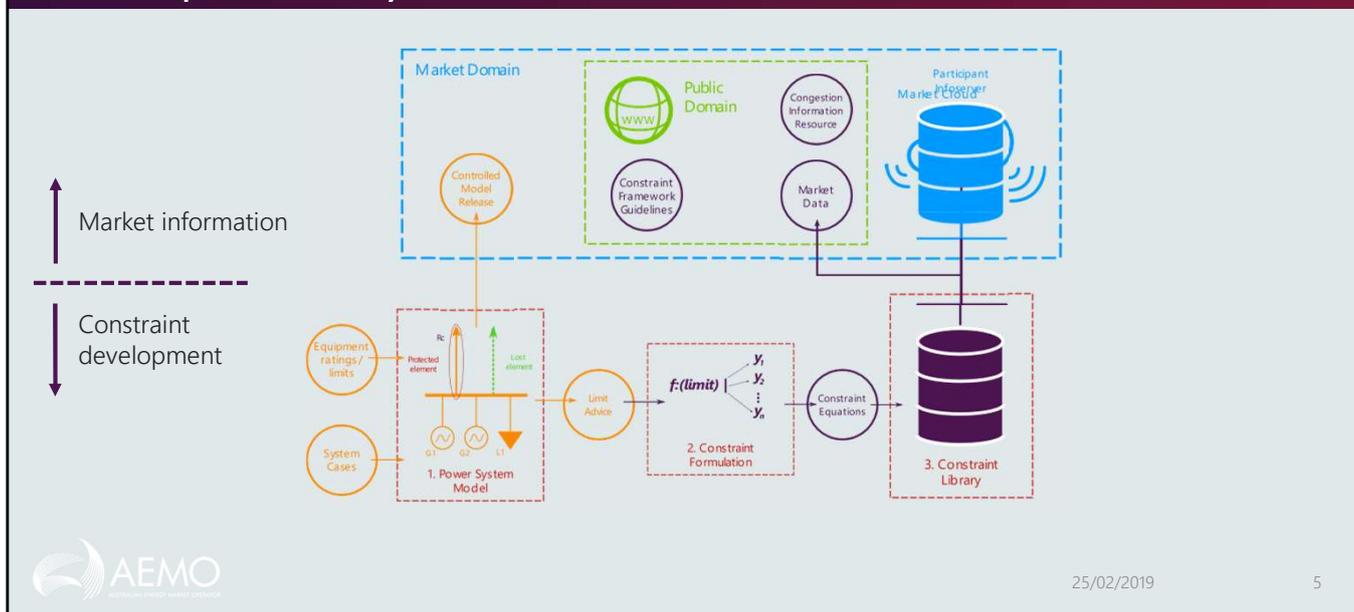
Under this arrangement, WP has primary responsibility for identifying and solving these limits.

For example, the Limit Advice for Victoria is available on the AEMO website (<https://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Congestion-information/Limits-advice>). This follows from AEMO's delegation as the system planner for the Victorian transmission network. Other TNSPs do not publish information to this level of detail (show VIC stability advice as for context), e.g. only publish the "limit equation", and no detail as to the inputs, assumptions, approach etc.

In any case, prior to formulating any constraints, AEMO first tests the advice using the power system model and its own set of selected inputs – this is the so-called "due diligence" process.

PROPOSED HANDOVER TO WESTERN POWER PRESENTATION

Constraint Formulation Transparency



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Reasonable to assert that SCED has some fundamental complexity both in concept and implementation detail, but all for naught if it cannot be communicated to the market and/or public to enable commercial decisions.

Recall the WG objective is to enable (the PUO to make) informed decisions as to what aspects of system constraints should be codified in the WEM Rules.

We believe the NEM experience may be appropriate as a base for WEM / SWIS, adjusted for learning and more modern information and comms technology.

The NEM was started in 2005: a specific amendment was introduced in 2009 to obligate AEMO to create and maintain the congestion information resource (3.7A & 11.30)

Available to this day as a section on the AEMO public website
<https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Congestion-information>

“ The objective of the *congestion information resource* is to provide information in a cost effective manner to *Registered Participants* to enable them to understand patterns of *network* congestion and make projections of *market* outcomes in the presence of *network* congestion (the *congestion information resource objective*).

”

There are also obligations on TNSPs to supply the data necessary to maintain the resource.

The information resource might be a reasonable way to communicate general information to the public. However the real value AEMO can provide to the market is a direct API to the market database: in the east, this already available through the “infoserver”: a replication of AEMO’s market database available to market participants. The infoserver has an identical schema, includes dispatch but also PASA and pre-dispatch (another source of market and operations insight). It has real-time bidding information stripped, but all information is released the day after trading.

AEMO maintains the database and provides a service to assist participants with setup, but then leaves commercial analysis up to the market players. In the east, an industry exists for supplying professional grade real-time analysis software for participants with an infoserver.

Also of note is NEMDE Queue (<https://www.aemo.com.au/Electricity/IT-Systems/NEM/NEMDE-Queue-Service>): AEMO provides a similar level of limited support to setup an offline dispatch engine, allowing sophisticated participants to edit an input file and investigate “what-if” scenarios.

While we’re not committed to any specific technology / implementation at this point, we would aim for the same / similar concept for the WEM going forward.

AEMO also publishes NEM information to the public website: we have seen significant academic and open-source initiatives make use of this.

We have also discussed the possibility of a releasable version of the Western Power dynamic (powerfactory) model, for e.g. use by consultants in the connection process.

The NER also explicitly obligates AEMO to publish the “Constraint Formulation Guidelines” [3.8.10 Network constraints (c)], however under the general information framework, AEMO provides a suite of processes, policies and other training material (including a recurring training course). Not presupposing any format of the rule drafting, in this context we propose the “Constraint Framework Guidelines”

Constraint Framework Guidelines



- High-level description following the component breakdown:
 - Power System Model
 - Technical constraint development
 - WP interface
 - Constraint Formulation
 - Description of the conversion process
 - Constraint Library
 - Constrained Dispatch
- Envisaged "official" location of decided settings / tunings
 - operating margins
 - constraint intervention / overwriting

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The guideline presents an overview of the full lifecycle of a dispatch constraint in the Wholesale Energy Market (WEM).

It is intended to serve both as an introduction to the constraint system for market participants, as well as capture and illustrate the broad principles and design of the system. It does not cover all complex edge-cases of constraint development and deployment; where this document does not contain specification detail, it points to where further information can be found.

Follows the component framework currently being presented to you now, i.e. we package this up as both documentation of the development rationale, and to serve as a future reference

Current set of content to include (will pick some examples to discuss in the presentation):

Power System Model

- i.e. as discussed in the last two WG updates

Constraint formulation

- Translation of limit advice to equations
- Why does a limit need to be reformatted?
 - Brief discussion of DE function + characteristics, optimisation that require special formatting
 - Terminology, e.g. LHS / RHS stuff, coefficients + normalisation
 - Negative vs positive coefficient implications
- Operational margins
- Naming
- Intro (brief) to dispatch
 - Merit order
 - Co-optimisation
 - Illustration of principle
 - Pre-dispatch

Constraint Library:

- Mechanics of operationalisation, book-keeping:
- Intro to the constraint library
 - Maybe some stats?
 - Concepts of Inactive / Active:
 - Outages
- Interface with Dispatch Engine
- Public (or non-public?) interface

Dispatch

- Set scene for normal operation:
 - Number of constraints
 - Active vs Binding
 - Typical figures for frequency and length of binding
- Example equation condition scenarios:
 - Normal (binding / non-binding)
 - Outage
- Intro to Market and settlement
 - How is a binding constraint resolved?
 - How does this translate into \$\$
 - Brief discussion of market information provided by constraints + action
 - Intro to congestion:
 - How can a generator react / possibly influence constraint action?
 - Mostly a jump-point for “where to learn more”

Constraints: Next Steps

- Dispatch Engine
- Transitional Arrangements
- Participant thoughts / questions?



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Currently, AEMO's next focus is the dispatch engine: we are at the point where the development of many WEM features hinges on the design and implementation of the engine.

The current dispatch system is fundamentally tied to the existing market design.

Key example: 30 minute dispatch cycle. Although DIs are sent out at 10 minute increments, the collection of data and solution process must all be ready some time before this. The engine was never designed to allow the sort of near-realtime correction that the future system will require e.g. response to PV (let alone control of DER).

This impacts the formulation and structuring of the constraint library, hence from the component perspective, we will probably start to work backwards.

AEMO will also focus on planning for transitional arrangements: in particular, how the initial development of constraints will be managed/resourced, with mind to the first reserve capacity cycle lead-timing to hit a 2022 deadline. We note the PUO have appointed a project resource; AEMO will work with them in regard to this and the future timeline (for the WG project and more generally).

Finally, an opportunity for general participant questions / thoughts related to the constraint project.