WORKING ON A STRATEGIC RESERVE FOR RELIABLE POWER

AEMO'S REQUEST TO ENHANCE THE RELIABILITY & EMERGENCY RESERVE TRADER

STAKEHOLDER FORUM
12 NOVEMBER 2018

AEMC

Agenda

1.	Welcome and agenda
2.	Background and context
3.	Appropriateness of the reliability standard
4.	Options paper
5.	Appropriateness of the reliability standard – implications
6.	Questions and answers
7.	Roundtable discussions

BACKGROUND AND CONTEXT

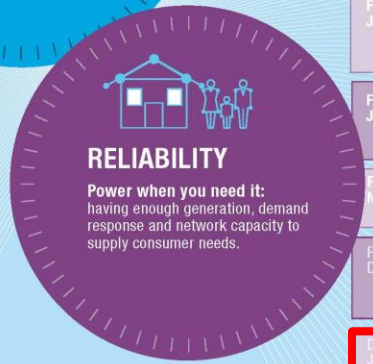
VICTORIA MOLLARD
12 NOVEMBER 2018

AEMC

AUSTRALIAN ENERGY MARKET COMMISSION

AEMC SYSTEM SECURITY AND RELIABILITY ACTION PLAN

Updated 8 November 2018



Final: Mar 2017 ✓ — **Emergency frequency control scheme rules**
Enhanced schemes to act as a last line of defence in an emergency

Final: Jun 2017 ✓ — **System security market frameworks review**
Recommendations to deliver a stronger and more resilient system with better frequency control as the generation mix changes

Final: Sep 2017 ✓ — **Managing the rate of change of power system frequency rule**
Makes networks provide minimum levels of inertia

Final: Sep 2017 ✓ — **Managing power system fault levels rule**
Makes networks provide services necessary to meet minimum levels of system strength

Final: Sep 2017 ✓ — **Generating system model guidelines rule**
Requires detailed information on how generators and networks perform

Stage one final: Nov 2017 ✓ — **Reliability Panel review of frequency operating standards**
Assessing whether the existing standard is appropriate to maintain a secure power system as the generation mix changes

Final: Feb 2018 ✓ — **Inertia ancillary service market rule**
The potential for a market mechanism for power system inertia was assessed through the Frequency control frameworks review.

Final: Jul 2018 ✓ — **Frequency control frameworks review**
Looking at ways to integrate new technologies and demand response to help keep the system secure

Final: Sep 2018 ✓ — **Register of distributed energy resources rule**
Setting up a national register of distributed energy like small-scale battery systems and rooftop solar to help AEMO better manage the power system

Final: Sep 2018 ✓ — **Generator technical performance standards rule**
Updating the technical performance standards for connecting generators and the process for negotiating them

Pending AER review — **Review of the system black event in South Australia**
The AER is conducting a compliance investigation which will recommend possible changes to regulatory frameworks. When complete the AEMC will consider this, and AEMO's investigation, for possible changes to the regulatory frameworks.

Final: Apr 2018 ✓ — **Reliability Panel review of reliability standard and settings 2018**
Assessing whether the standard and settings are appropriate to guide efficient investment to meet consumer demand

Final: May 2018 ✓ — **Reporting on aggregate generation capacity for MT PASA rule**
Improves the information AEMO provides to signal whether electricity supply is projected to meet demand in the medium-term

Final: Jun 2018 ✓ — **Reinstatement of long-notice RERT) rule**
Enables AEMO to contract for electricity reserves up to nine months ahead of a projected shortfall under the RERT, the strategic reserve mechanism

Final: Jul 2018 ✓ — **Making the AER responsible for calculating values of customer reliability (VCR) rule**
Requires the Australian Energy Regulator to calculate and update values of customer reliability, used to develop reliability standards

Final: Jul 2018 ✓ — **Reliability frameworks review**
Looking at lowest cost ways to make enough energy available for consumers when they need it, the need for a strategic reserve, the suitability of a 'day ahead' market, and demand response mechanisms

Final: Nov 2018 ✓ — **Generator three-year notice of closure rule**
Requires large generators to give at least three years' notice before closing

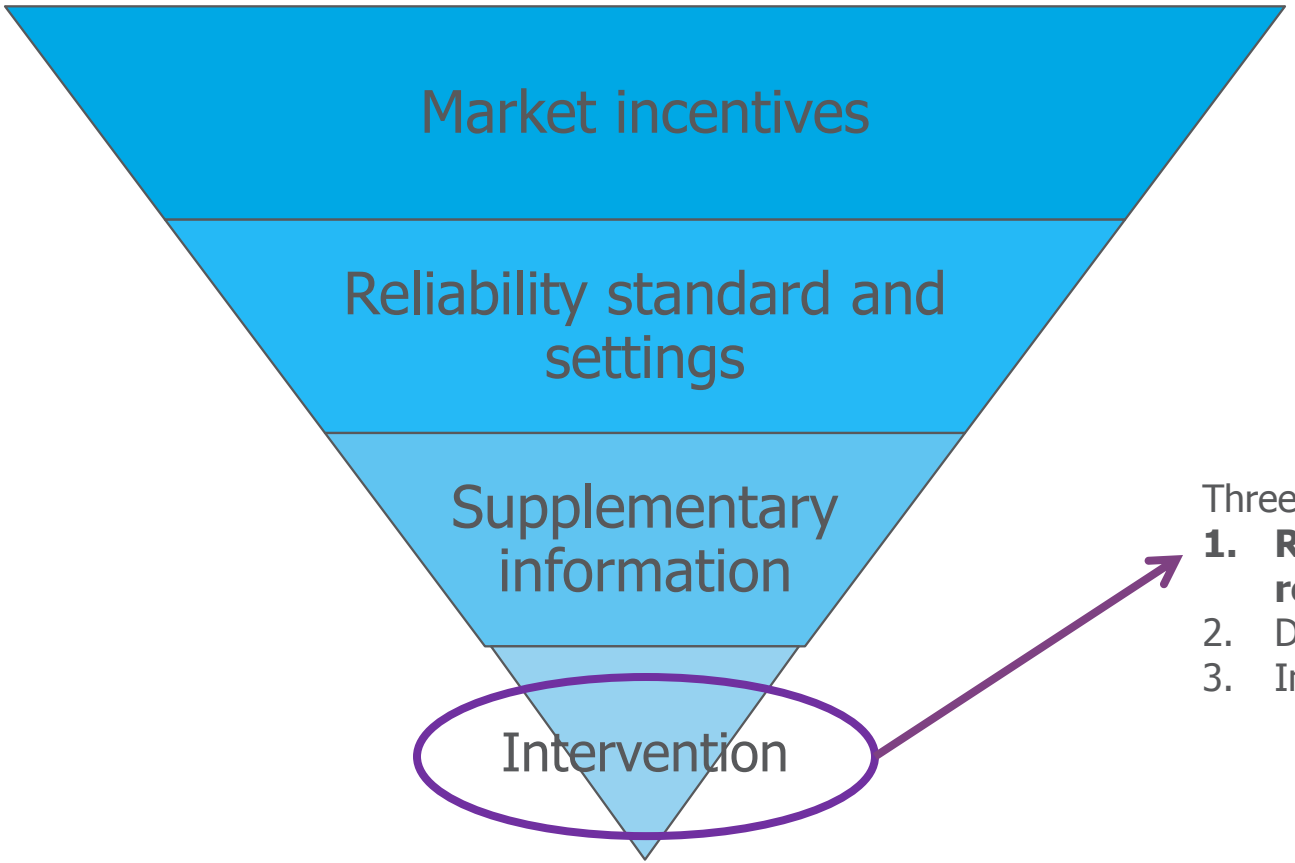
Final: Dec 2018 — **Coordination of generation and transmission investment review**
Options to make AEMO's integrated system plan actionable; and ways to improve the coordination of generation and transmission investment

Draft: Jan 2019 — **Enhancement to the RERT rule**
AEMO request for broader changes to the RERT framework

Final: Jun 2019 — **Reliability Panel review of annual market performance**
Review of the performance of the national electricity market in terms of security, reliability and safety over 2016-2017

This rule change forms part of our reliability work program

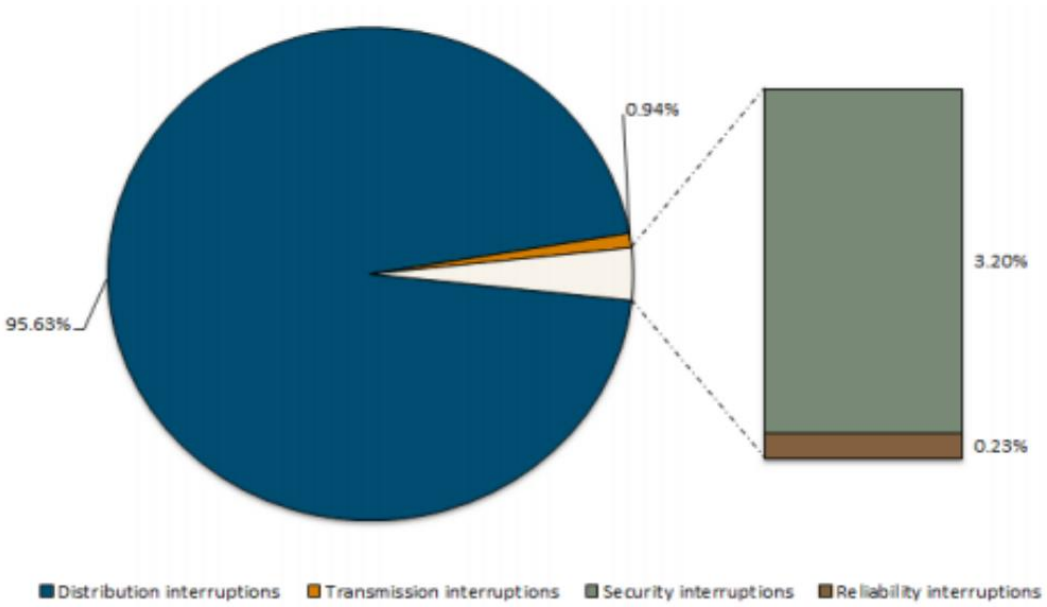
Current reliability framework has an escalating series of interventions



Three key intervention mechanisms:

1. **Reliability and emergency reserve trader (RERT)**
2. Directions
3. Instructions

What are the causes of supply interruptions in the NEM?

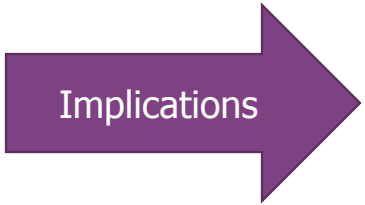


Reliability-related supply interruptions account for a small fraction of interruptions to customers

What is the reliability and emergency reserve trader (RERT)?

The RERT is a strategic reserve to guard against blackouts:

- **Intervention mechanism –** allowing AEMO to contract for additional reserves such as generation or demand response that are not otherwise available in the market
- **Important safety net that underpins reliable electricity supply** – allowing AEMO to use it as a last resort when a supply shortfall is forecast, or, where practicable to maintain power system security



It does carry direct and indirect costs:

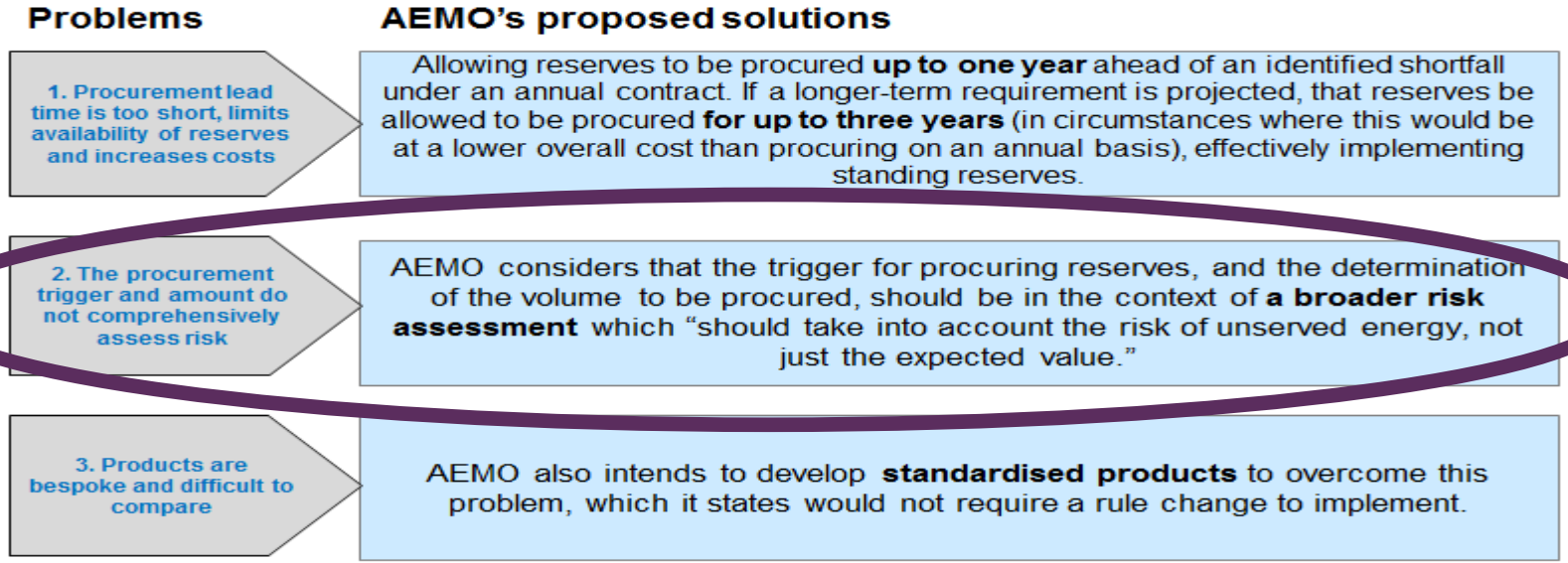
- **Direct** costs of the RERT last summer amounted to $52.0 million
- **Indirect** costs are due to the distortionary effects the RERT can have on market outcomes

Recent history of enhancing the RERT

AEMO's views on strategic reserves	•August 2017: AEMO set up an expert advisory panel to design a strategic reserve mechanism
AEMO submits two rule changes	•9 March 2018: Reinstatement of the long notice RERT •9 March 2018: Enhancement to the RERT
Reinstatement of the long-notice RERT	•21 June 2018: Commission makes an urgent final rule, to assist with summer readiness, increasing the lead time available for AEMO to procure reserves to nine months ahead of a projected shortfall
Enhancement to the RERT	•21 June 2018: Commission starts consultation on AEMO's proposal to enhance the RERT to help manage the risk of shortfalls •18 October 2018: Commission publishes options paper •8 November 2018: Additional information from AEMO in support of the Enhancement to the RERT rule change request
Increased use of the RERT	•Summer 2017/18: AEMO dispatched RERT twice. Previously, it had never been dispatched. •Summer 2018/19: AEMO currently in the process of procuring reserve contracts.

Issues raised in the enhanced RERT rule change request

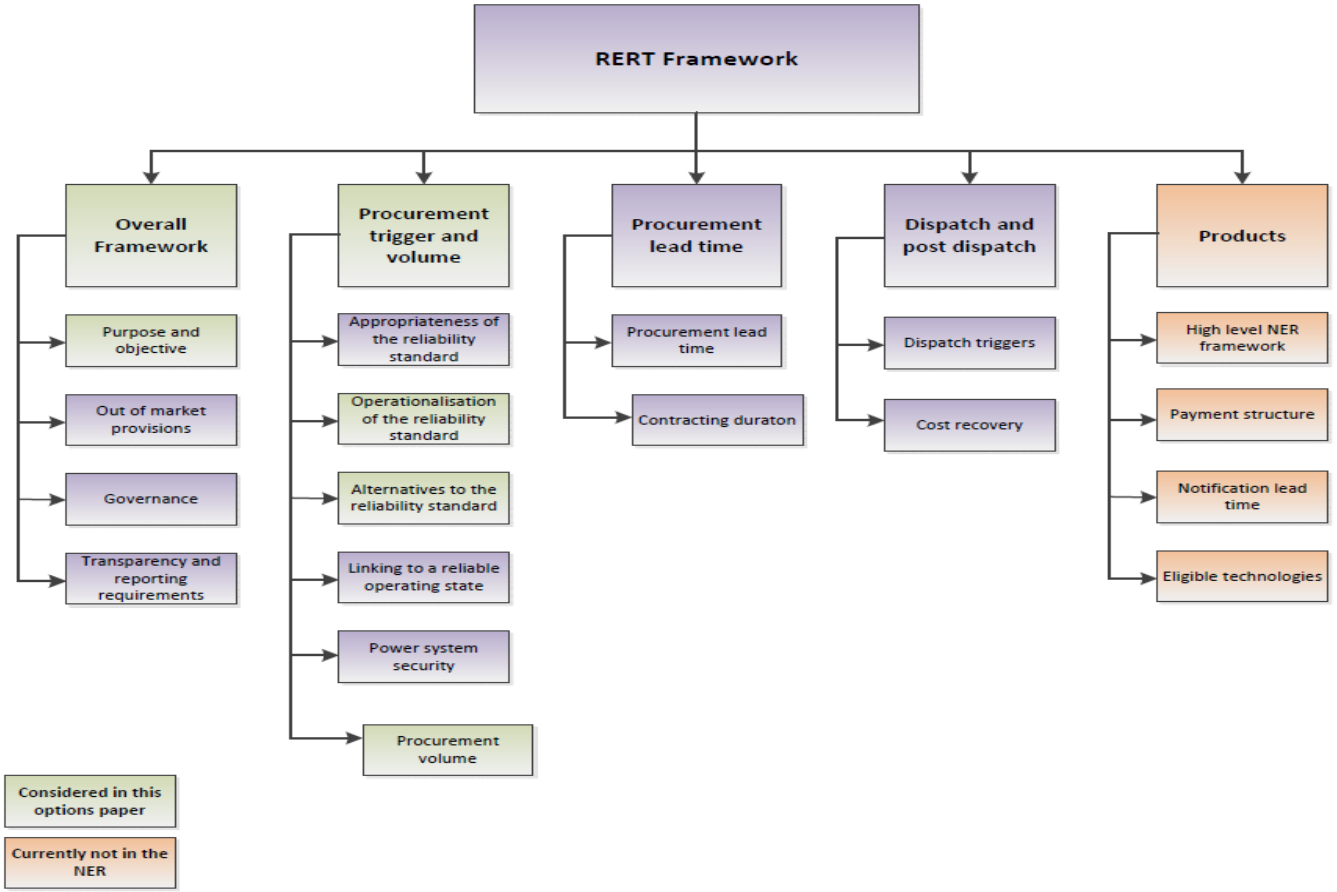
- AEMO raised three main issues in its rule change request, summarised here.



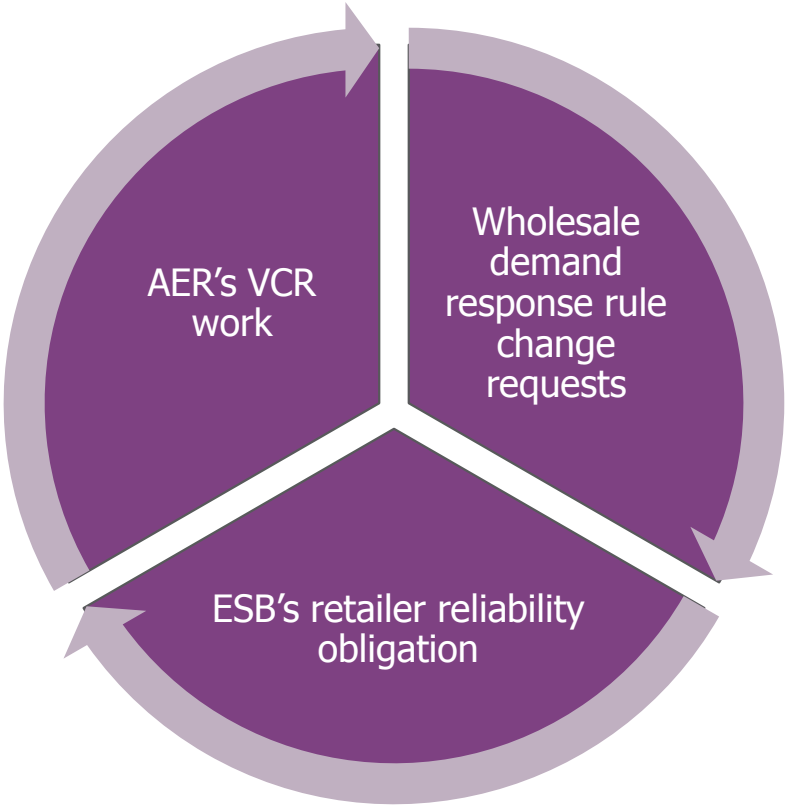
Options paper

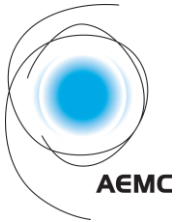
- In addition, AEMO also provided a **high-level design for an enhanced RERT**, which includes proposed design changes that go beyond the three issues areas identified above.

Scope of the rule change request and options paper



Interaction with other reliability work projects





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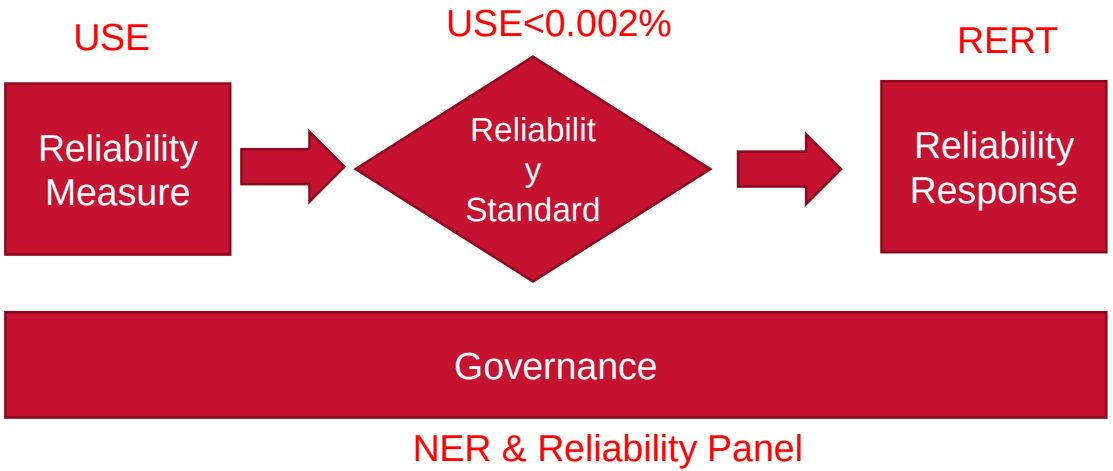
Reliability Framework Discussion

12th November 2018

Reliability Framework

Reliability Framework

The standard framework comprises a number of elements:



- **Reliability Measure** - quantifies the reliability of the system.
- **Reliability Standard** – articulates the acceptable level of reliability.
- **Reliability Response** – actions that are incentivised through the framework e.g. in a capacity market the framework determines the amount of capacity that must be procured to meet the standard.
- **Governance** – how the framework is managed and the settings changed.

Measuring Reliability

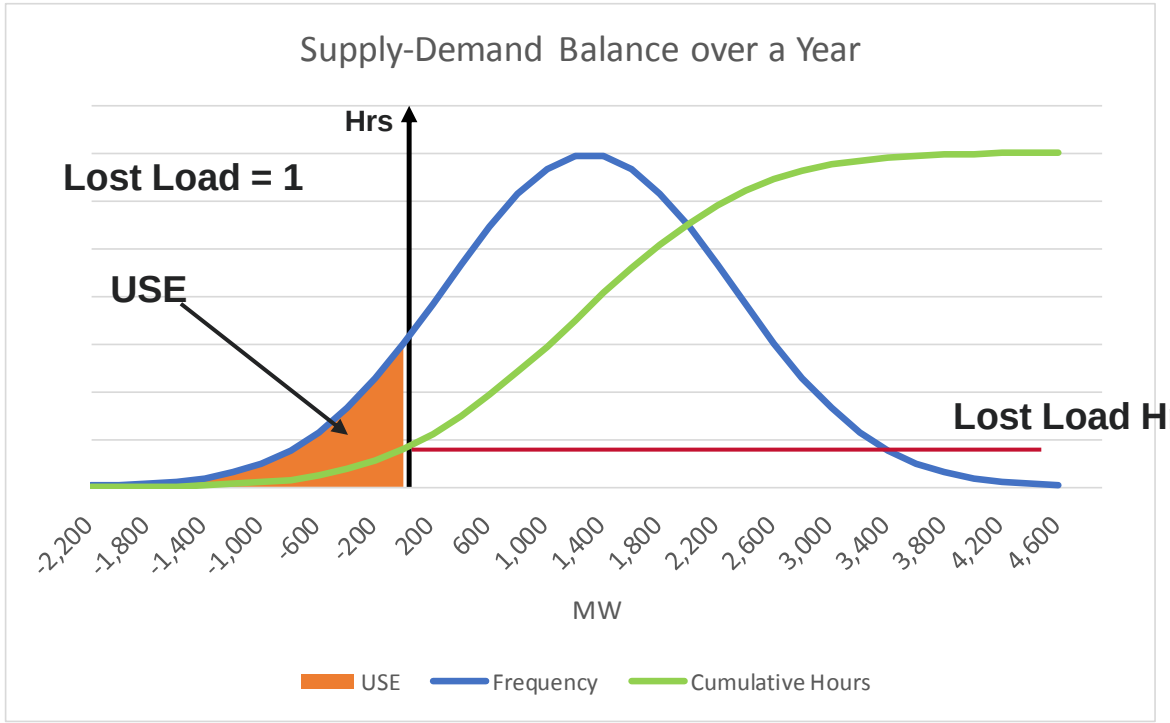
Reliability is measured *ex-ante* using forecasts of the supply-demand balance over a year.

Each simulation produces:

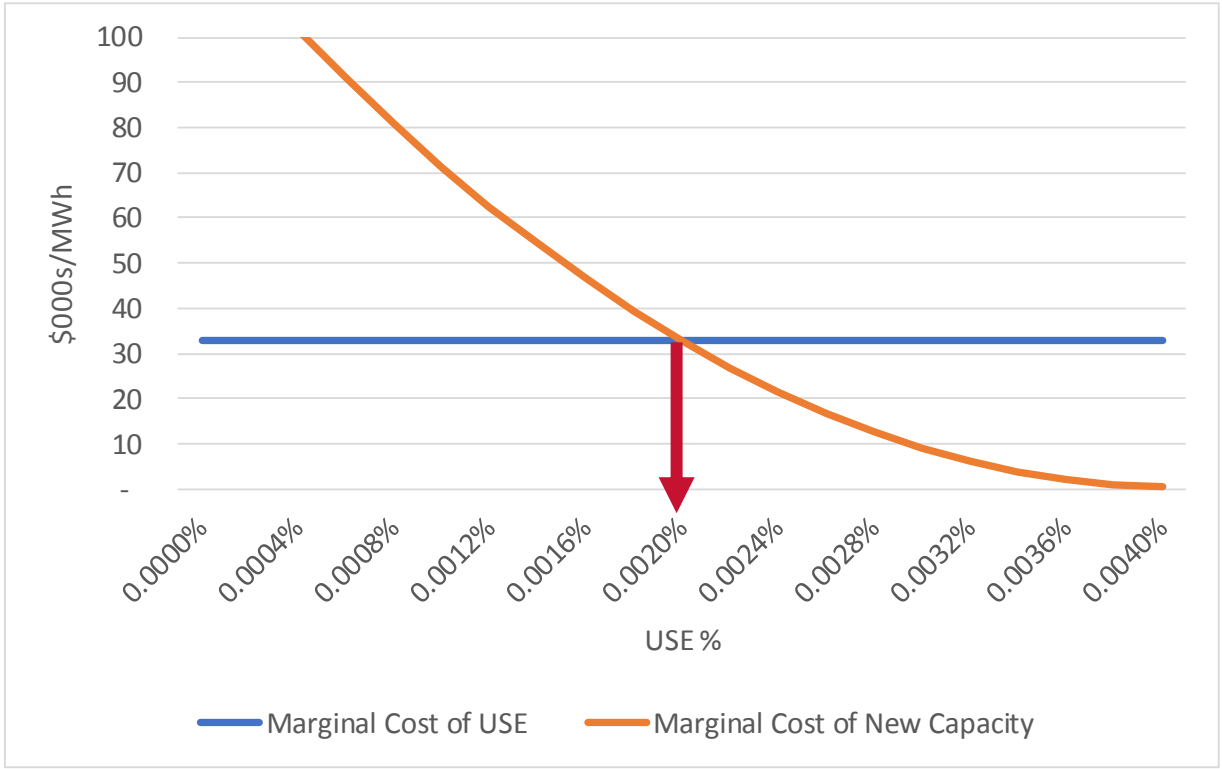
- **Unserved Energy** (USE) in MWh.
- **Lost Load Outcome** = 1 if lost load, 0 if not.
- **Lost Load Hrs** over a year.

Key metrics are averaged across all simulations:

- 1 in 10 Loss of Load Expectation (**LOLE**) = average lost load hours during P10 events.
- **USE** = Average USE across all simulations.
- **LOLP** Loss of Load Probability = average of all lost load outcomes.



Setting the Reliability Standard



The theoretical approach to setting the reliability standard involves finding the optimal trade off between:

- The cost of USE i.e. cost of blackout, and
- The cost of providing additional capacity to avoid blackouts.
- The intersection of the marginal cost curves is used to identify the optimal level of reliability.

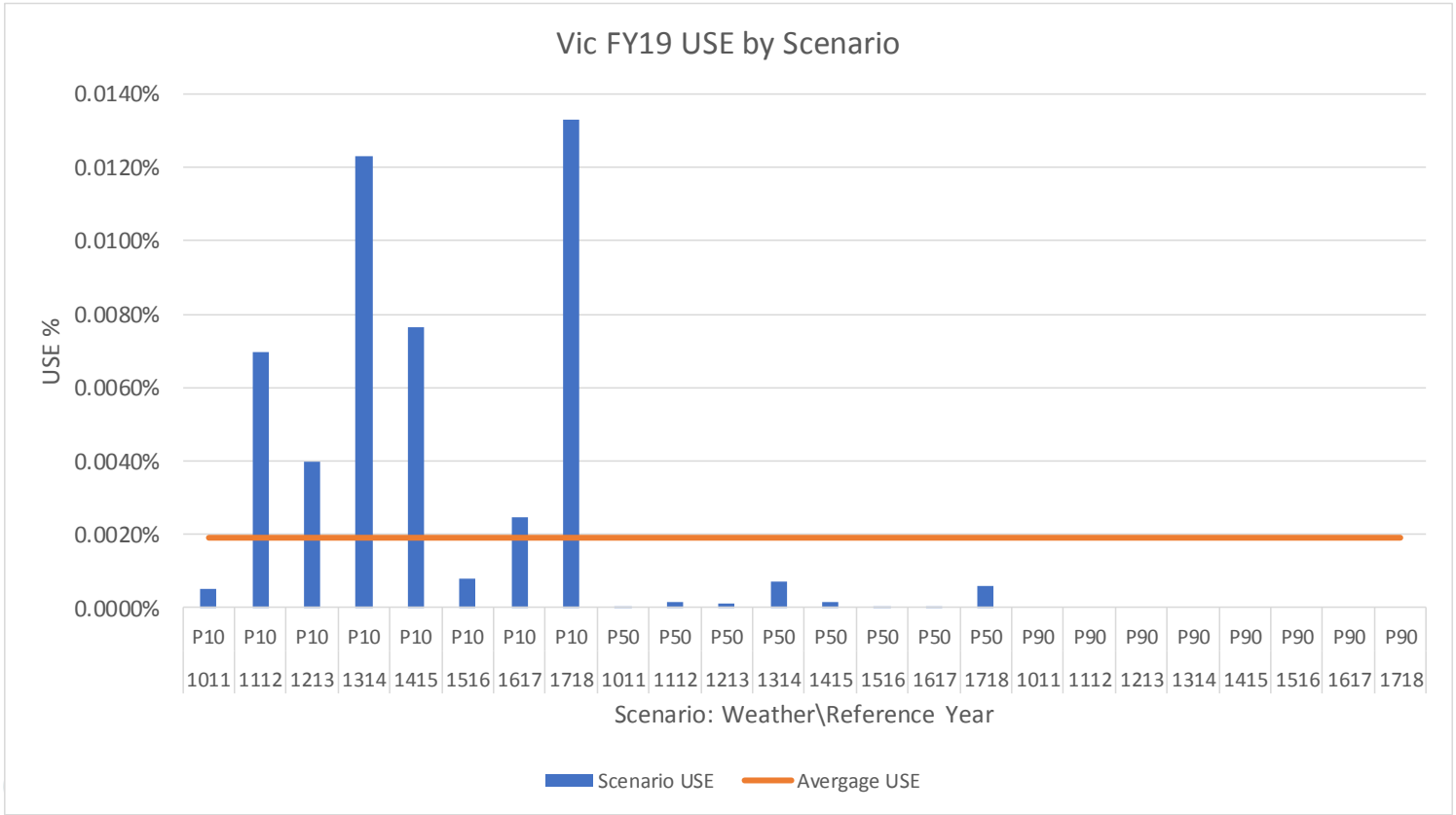
International Comparison

Metric	Annual Standard	Jurisdiction	Supplementary Requirement	Market Type
USE	0.002 %	WEM (Aus)	Reserve margin = greater of 7.6% or largest unit	Capacity
		NEM (Aus)		Energy only
	300 MWh (0.0005%)	AESO (Alberta, Canada)		Energy only
1 in 10 LOLE	2.4 hours	NY-ISO, PJM, ISO-NE (US)		Capacity
		ERCOT (Texas)	Non-binding 13.75% reserve margin[1]	Energy only
	3 hours	National Grid (GB)	Sufficient capacity for a 1 in 10 year winter peak	Capacity
	3 hours	RTE (France), Elia (Belgium)	< 20 h lost load 95% of the time	Capacity
	8 hours	EirGrid (Ireland), Portugal	Index of load served > threshold 95% of the time	Energy only
LOLP	4 %	NWPCC (US)		Capacity
	15 %	OCCTO (Japan)	Based on 0.3 days/month LOLP during peak periods	Energy only
No formal requirement		Germany, Nord Pool, CAISO (US)	Various bespoke metrics.	Capacity

[1]Ercot are moving towards calculating economically optimum and market equilibrium reserve margins in lieu of reserve margins based on 1-in-10-year LOLE .

USE is a tail risk in the NEM

USE forecast is built up from scenarios

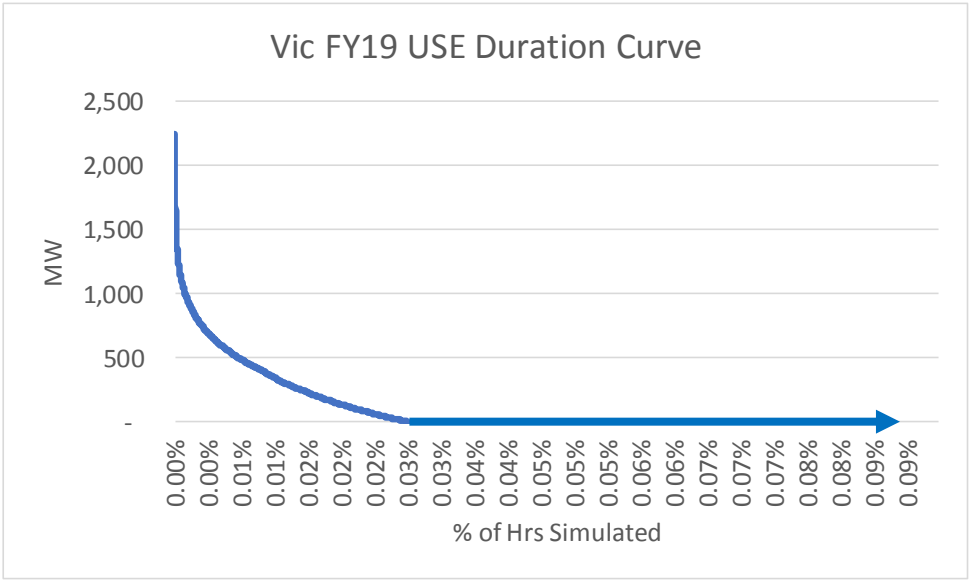


- AEMO forecasts the distribution of USE using 100 simulations for each of 3 weather types and 8 reference years.
- ESOO Vic USE % of **0.0019%** is close to the standard.
- The distribution of USE is highly *skewed* to the P10 weather scenarios.

<u>Other Metrics</u>

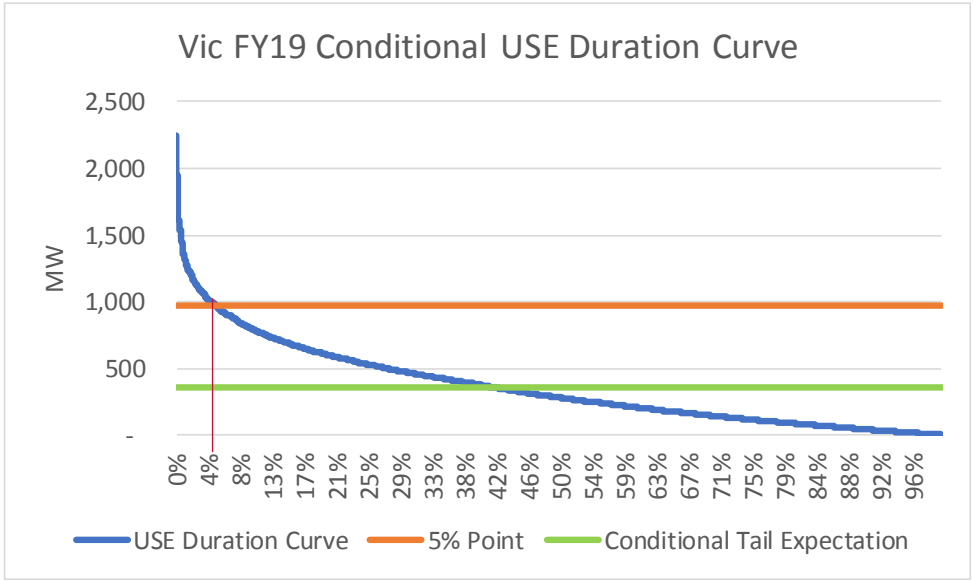
- LOLP = **31%**
- 1 in 10 LOLE = **7.22** hrs

Combining all scenarios and simulations gives the full USE curve



- Combining all scenarios and simulations results in a USE duration curve with a very sharp tail but a very low probability (only 0.029% of simulated hours have USE).
- The most extreme outcomes are the result of coincident high demand and multiple outages.
- Compared to LOLP and LOLE, the USE metric is preferred as it provides some information on the magnitude of lost load.
- However, USE does not provide information on the shape of the tail. i.e. a flat profile of lost load could result in the same USE as a highly skewed profile.

Describing USE

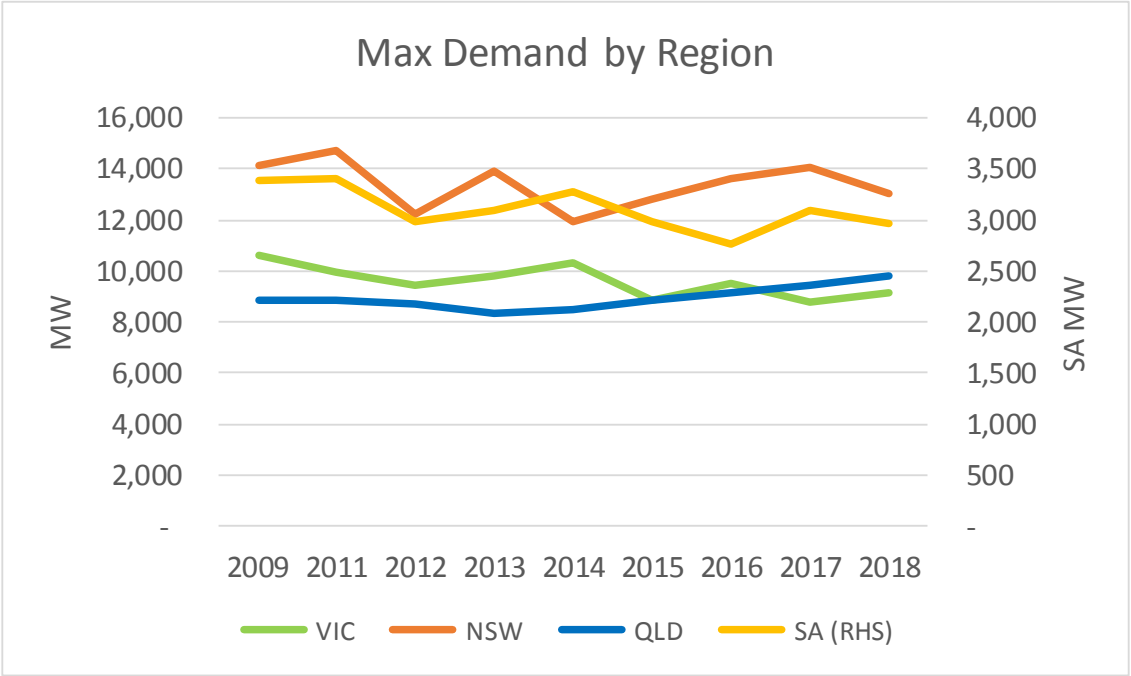


- Alternative statistics can provide more insight into the size and shape of the USE tail e.g:
  - **Conditional Tail Expectation** = average level of USE given that some USE occurs = 363 MW.
  - **USE at Risk** = 5% point of USE distribution (i.e. only 5% of USE outcomes, if they occur, are worse) = 977 MW.
- Note that the average USE metric can be split by size and likelihood.
  - **Average USE in MWh = Conditional Tail Expectation (MW) * LOLE (hrs)**

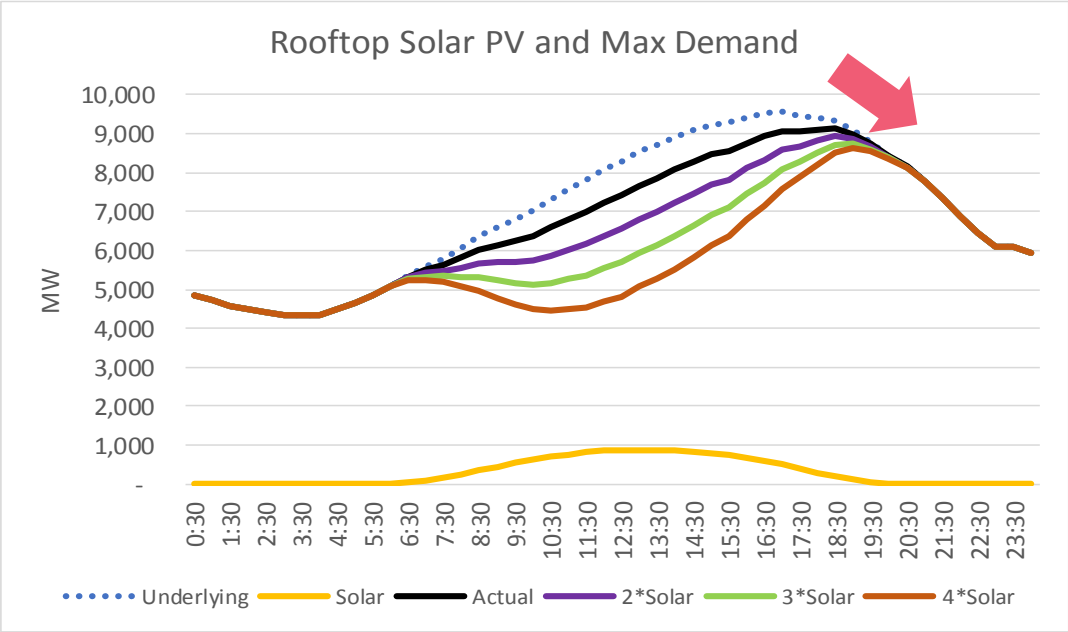
Why haven’t we seen much USE ?

Maximum demands have generally been falling

This has coincided with general over-supply.



Rooftop PV has been reducing max demands

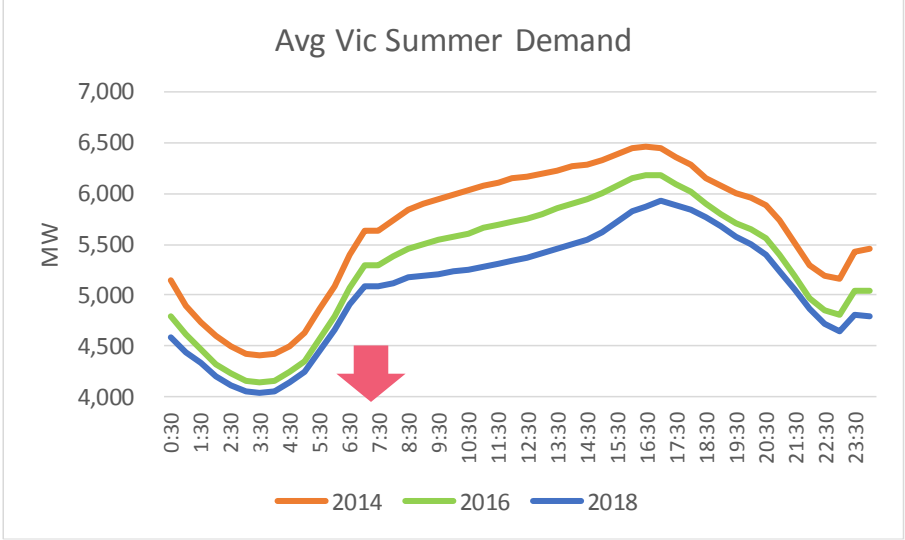


Actual = actual operational demand for 18/1/2018 in Vic.
Solar = reported rooftop solar PV output.
Underlying = underlying demand adding back rooftop solar PV.
2*Solar = Operational Demand adjusted for twice as much solar.
3*Solar = Operational Demand adjusted for 3 times as much solar.

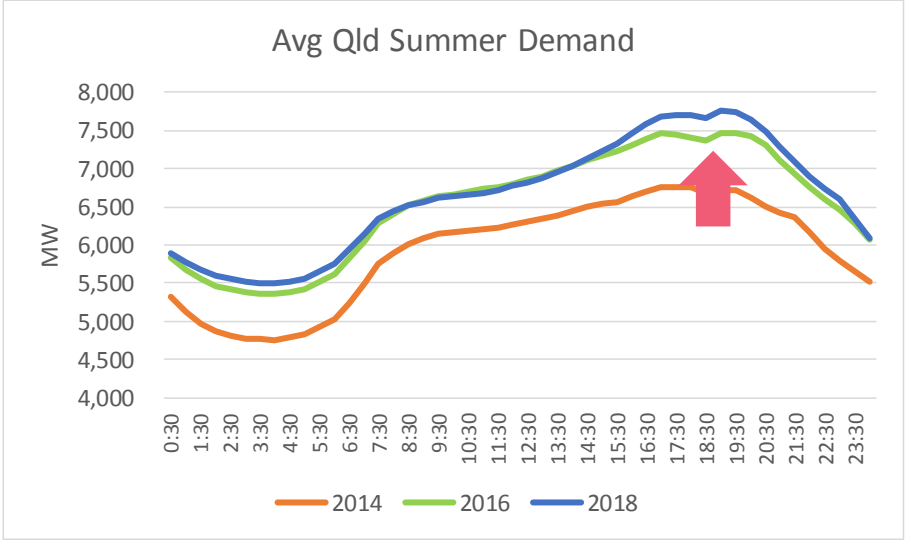
- Increasing rooftop PV has been one of the key drivers of generally lower maximum demands across all regions.
- Initially, rooftop PV has the effect of *lowering* the max demand.
- The *timing* of the maximum demand is shifted from the late afternoon into the evening.
- However, as the maximum demand is shifted later in the day further additions of rooftop PV have less impact on max demand.
- The flipside to this trend is that there is more risk to the maximum demand if the hot conditions are accompanied by cloud cover.

Impact of industrial loads

Large industrial load changes are a key driver of max demands.

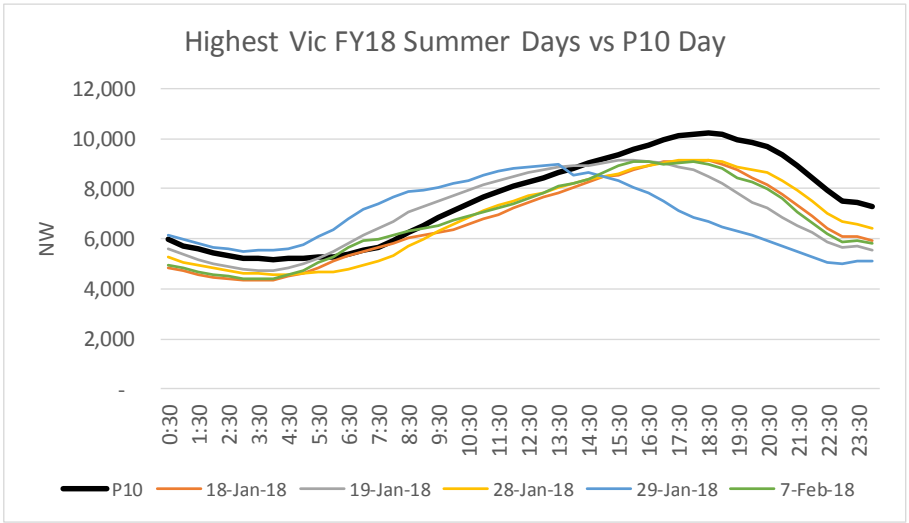


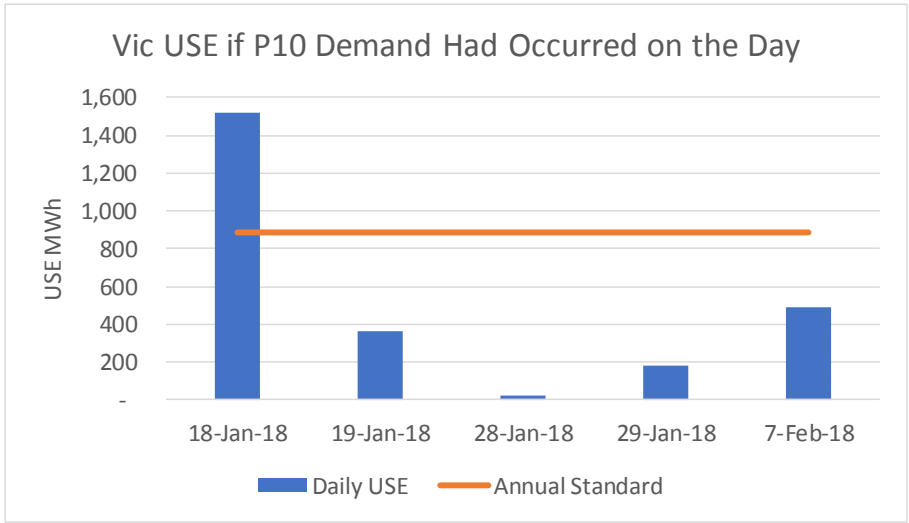
- Point Henry smelter closed in August 2014 removing ~200 MW.



- LNG demand has been the key driver of the increase in Qld max demands.

Recent weather patterns have been favourable



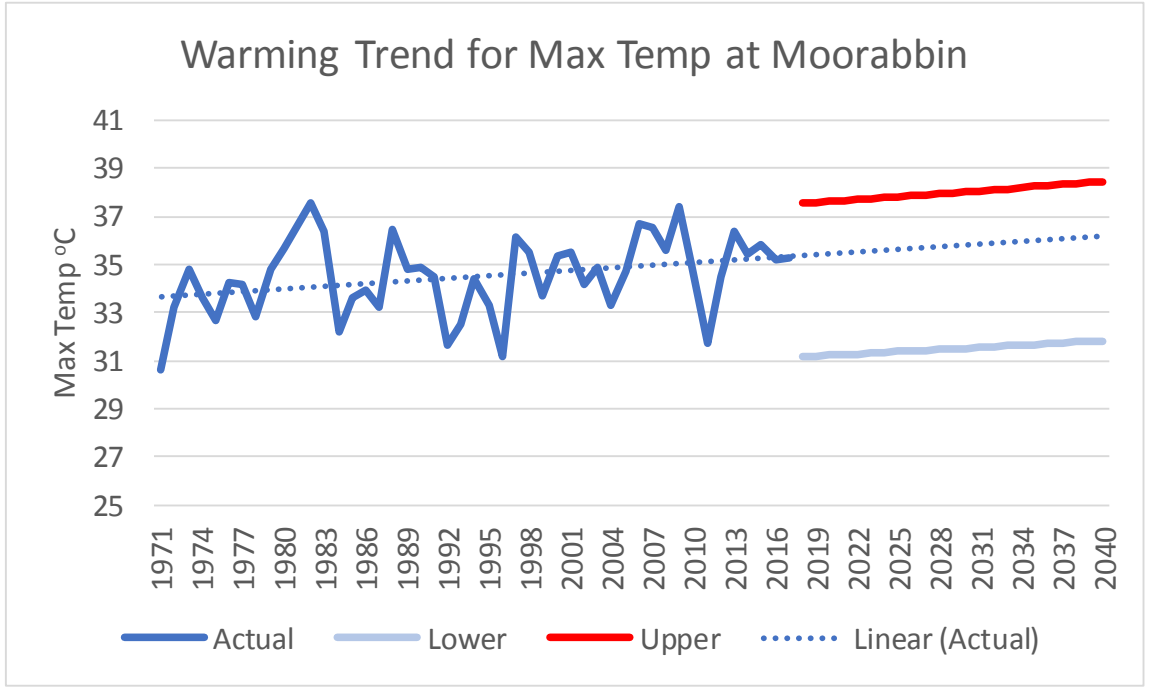


- Vic avoided USE during summer of 2017-18 but RERT was required on 2 occasions.
- The highest demand reached 9,153 MW which is below the P10 operational demand of 10,239 MW due to max temps on the 5 highest demand days peaking at 40.3^{o}C compared to ~43.5^{o}C for a P10 day. (the highest temp of 41.7^{o}C fell on Saturday Jan 6th before the return of industry).
- If the demand had reached P10 on any of the 5 highest demand days then there would have been USE. The USE of either 18 or 19 Jan would have breached the annual standard.

Increasing tail risks

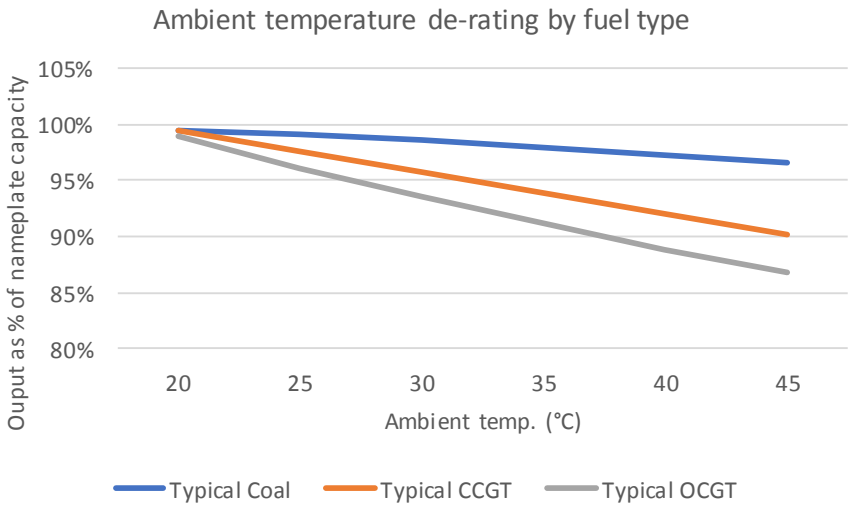
Temperatures in the NEM are increasing

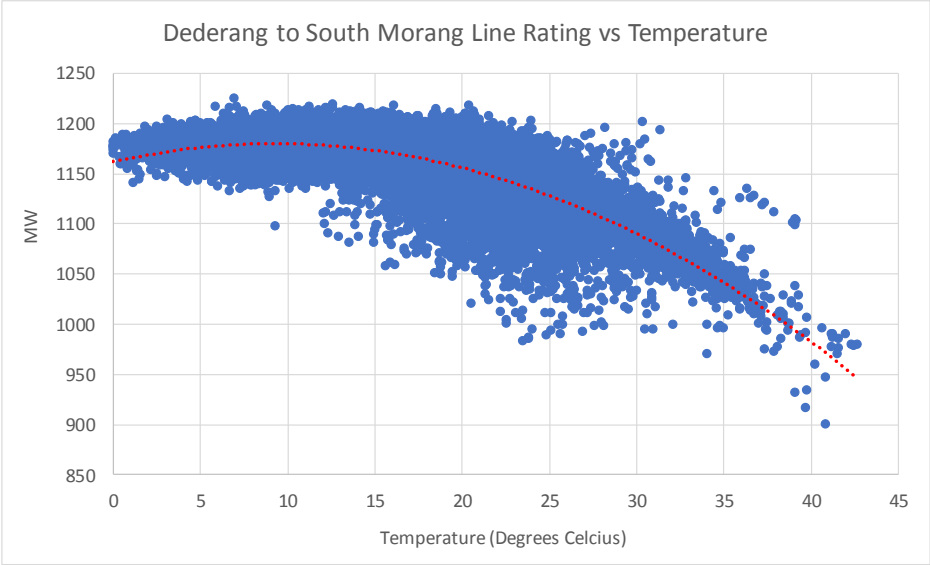
ESOO forecasts build in some warming and a range of outcomes but is this enough ?



Average of top 5% of max temperature

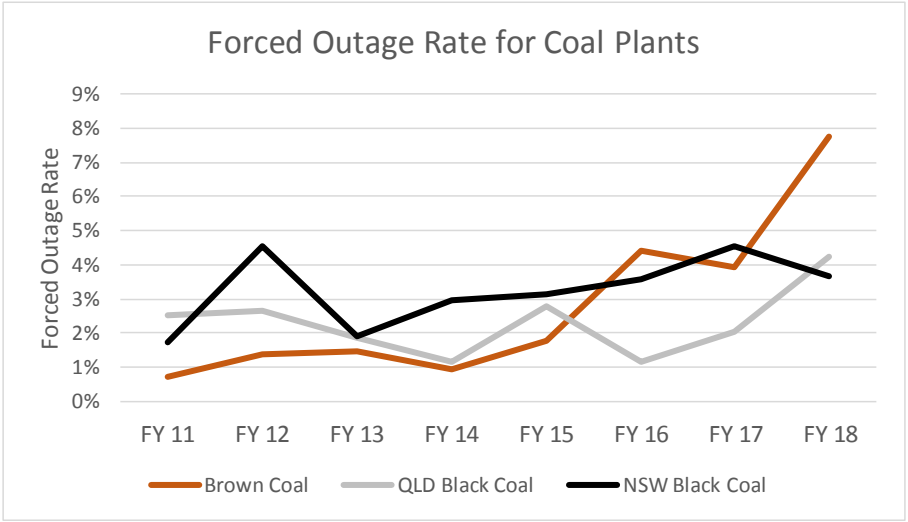
Higher temperatures reduce supply

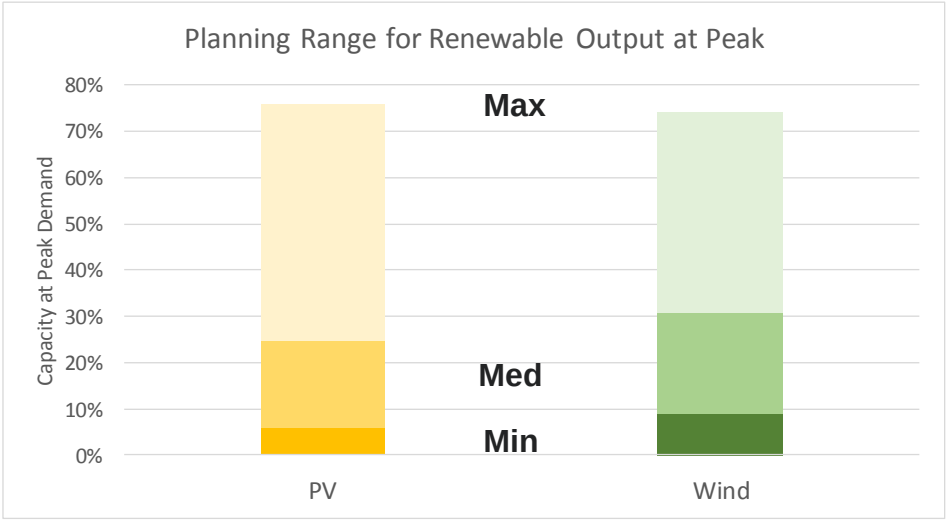




- Both generation output and transmission line capacities fall with increasing temperatures affecting system resilience.
- The type of generation that is most affected by de-rating is peaking plant.
- Temporary diesels are even more prone to de-rating e.g. SA diesels de-rate by up to 25%.
- High temperatures can lead to discrete reductions in supply e.g. control scheme fully de-rates Basslink when Georgetown in Tasmania is above 36ºC.
- In Victoria summer ratings for generators are 500 MW lower than winter ratings.

Generation at peak is becoming more uncertain

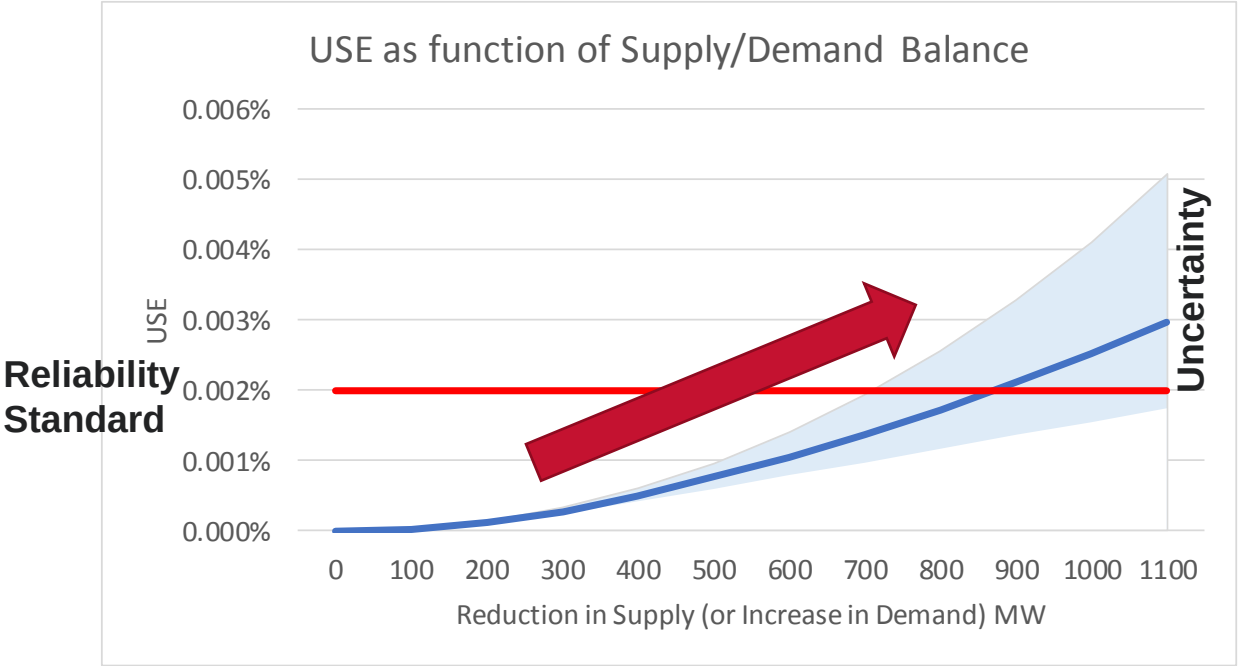




- Recent years have shown an increasing trend in forced outages.
- Solar capacity at peak is falling as the max demand shifts to later hours.
- There is limited historic data on the performance of wind and solar at peak demand times and so the range of uncertainty in the forecasts is extremely wide.

Tail risks increase as the supply-demand balance tightens

Generator retirements have tightened the supply-demand balance



- As the supply-demand balance tightens both the amount of USE and the range of USE outcomes increases *non-linearly*.
- This can result in moving quickly from a position of zero USE to a level of USE that breaches the standard.
- Uncertainty of inputs is magnified in the range of USE outcomes.

Managing tail risks

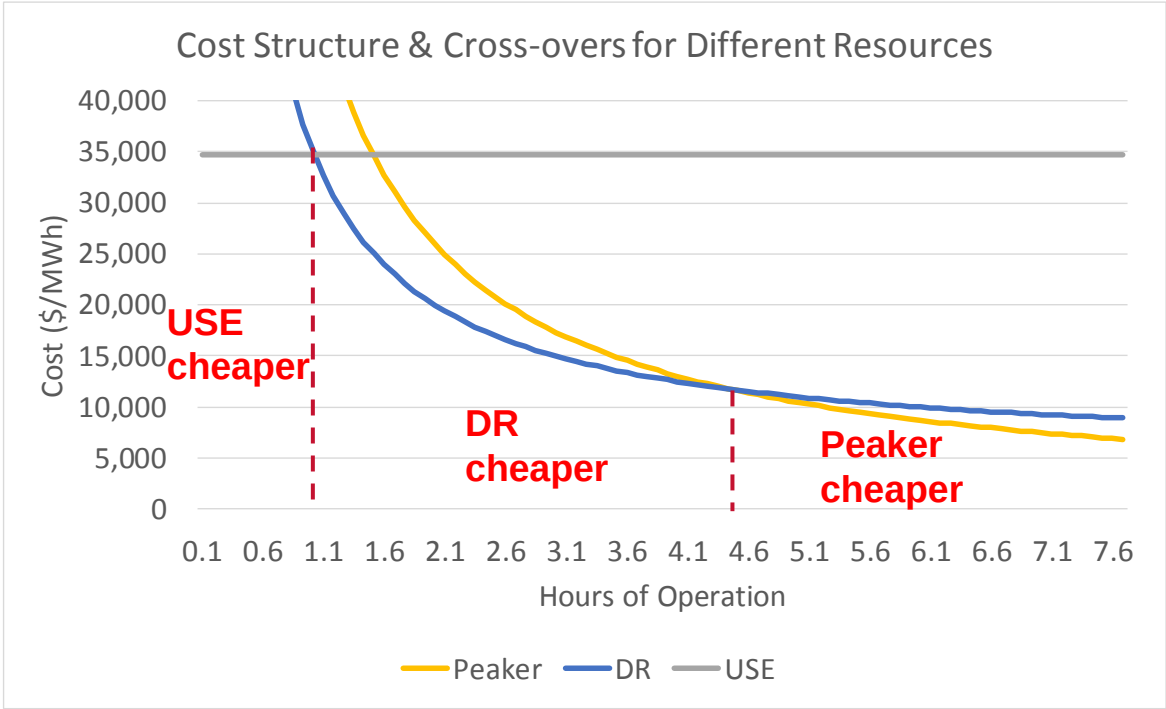
Tolerance for Load shedding

- Managing tail risk invariably means accepting some level of load shedding but how much is acceptable these days when we are ever more dependent on technology powered by electricity ?
- Traditionally, the tolerance for load shedding has been expressed as a single cost **Value of Customer Reliability.** AEMO's 2014 study of VCR found an aggregate VCR of **~$33k/MWh** with differences across different types of customers, time of occurrence, regions and seasons.
- The AER is beginning a process to update the VCR but AEMO considers that additional stakeholder views should be sought on non-cost inputs such as the maximum acceptable limits for how long people can be without power during extreme heat.
- Tail risks are normally managed via procuring **insurance** which reflects inherent **risk aversion** in society and the desire to avoid exposure to extreme outcomes.

Cost structure of resources drives the optimal mix

Cross-overs are determined by relative fixed and variable costs for each resource.

Shape of USE duration curve is also a key driver.



Note: Illustrative numbers

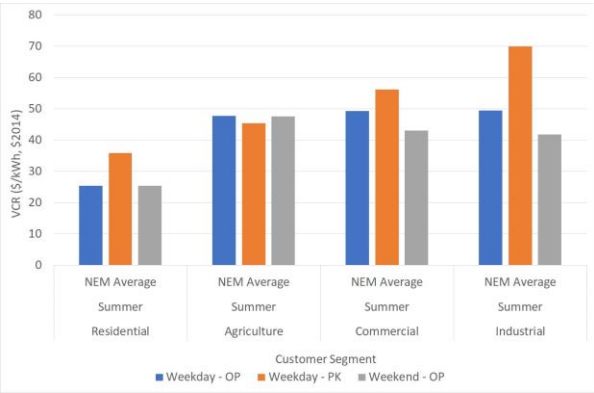
Appropriateness of the Reliability Standard

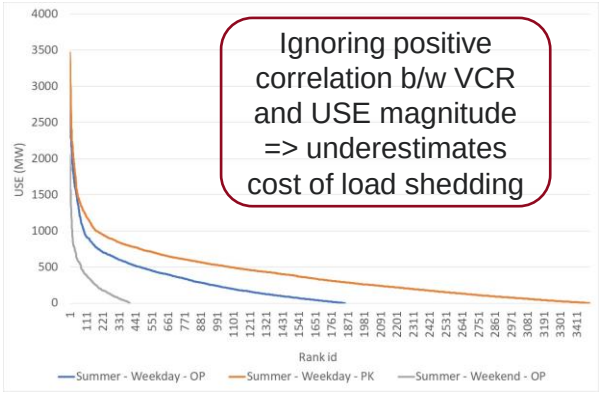
Appropriateness of the current reliability standard

The current standard is not fit for purpose as it:

- Assumes a single cost for VCR – underestimates the cost of load shedding, leading to inefficient level of USE.
- Ignores value of insurance and risk mitigation – leading to inefficient level of volatility in USE outcome and extreme events.

Impact of cost structure of VCR





Ignoring positive correlation b/w VCR and USE magnitude => underestimates cost of load shedding

Impact of risk and uncertainty

- Average USE metric does not reflect volatility and extreme events – hence the trade-off does not value insurance and risk mitigation.
- Inconsistent with risk aversion in economics and prevalence of insurance products in real-life.
- Even in the NEM participants pay contract premium over *expected pool prices* for certainty.
- The standard/framework should have a risk management dimension.

Enhancing the RERT

- In its Enhanced RERT rule submission AEMO proposed:
  - Delinking RERT procurement from the reliability standard.
  - Standardisation of RERT products to lower costs and improve operational dispatch.
  - Procurement of RERT over longer time periods to lower costs.
- Our review of the reliability framework supports these views:
  - AEMO considers the current reliability standard does not reflect the true efficient level of reliability and questions its role in the overall reliability framework.
  - Triggering RERT based on a single year's comparison against the current standard can lead to an inefficient resource mix to manage reliability and lead to on-again, off-again procurement which will lead to higher costs.
  - RERT procurement should be delinked from the standard, but set to fill the gap between the market outcome and the efficient reliability level – taking account of both the level and risk of USE.
  - RERT should be considered as a form of insurance and there should be a standing reserve with its level determined based on the risk of USE and the costs of mitigation.

Findings and recommendations

Risk of USE is increasing due to:

- Tightening of the supply-demand balance following retirement of thermal plant.
- Increasing maximum temperatures driving higher demand and lower supply.
- Increasing variability due to renewables and forced outages.

NEM reliability standard is not suited to managing risk and should be delinked from RERT procurement

- It assumes a constant VCR, which does not consider the cost structure of USE or risk averseness.
- Leads to on-again, off-again RERT procurement which leads to higher costs.
- Hence, RERT procurement should be delinked from the current standard

Reliability framework should incentivise the optimal resource mix to manage tail risks

- Optimal mix depends on shape of tail and cost structures of resources including DR and DER.
- Both in-market and the RERT mechanism should be used to procure the optimal mix, but a few barriers exist.
- There should be a standing reserve to provide insurance against tail risk.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OPTIONS PAPER

SARAH-JANE DERBY
12 NOVEMBER 2018

AEMC

Scope of the options paper

- The options paper considers:
  - how we will consider the appropriateness of the reliability standard
  - how the RERT procurement trigger could be designed
  - how the RERT procurement volume could be set
- We note that the other design features of the RERT, such as the procurement lead time, will be considered and consulted upon separately through the draft determination.
- For the purpose of these options, we assume that the level and form of the reliability standard remains the same.

The Commission has presented three options for the RERT procurement trigger and procurement volumes for stakeholders' consideration.

Approach to considering the appropriateness of the reliability standard

The options paper sets out the approach the Commission is taking to considering this issue:

1. Seek technical input, including from the Panel and AEMO

2. Review and discuss

3. Consider input and feedback

This will be incorporated into the draft determination

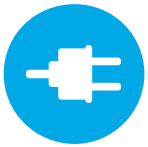
Appropriateness of the reliability standard – Reliability Panel advice

The Panel's advice on the reliability standard was largely informed by its recent work on the *2018 Reliability standard and settings review.* The Panel emphasised the following points:

- The form of the reliability standard should be retained as unserved energy.

- The Panel did not review the level of the reliability standard but received submissions suggesting the current level was appropriate.

- Modelling indicated that the system will provide a better level of reliability than the reliability standard.

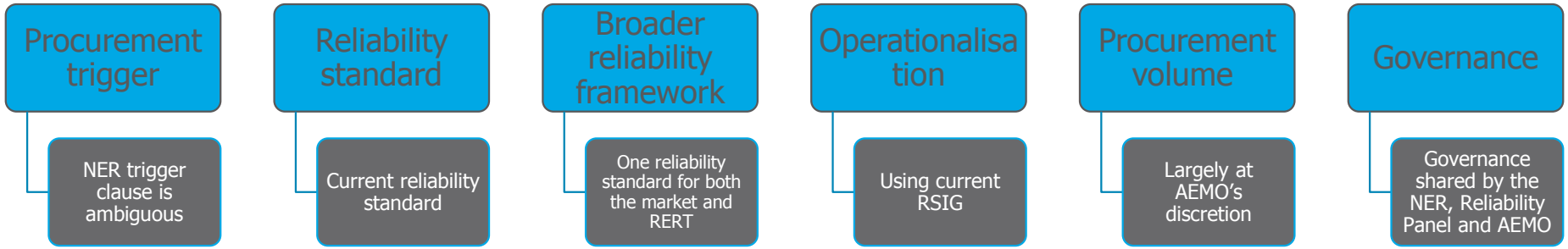


- Modelling indicated that costs of moving to zero expected unserved energy would be significant.

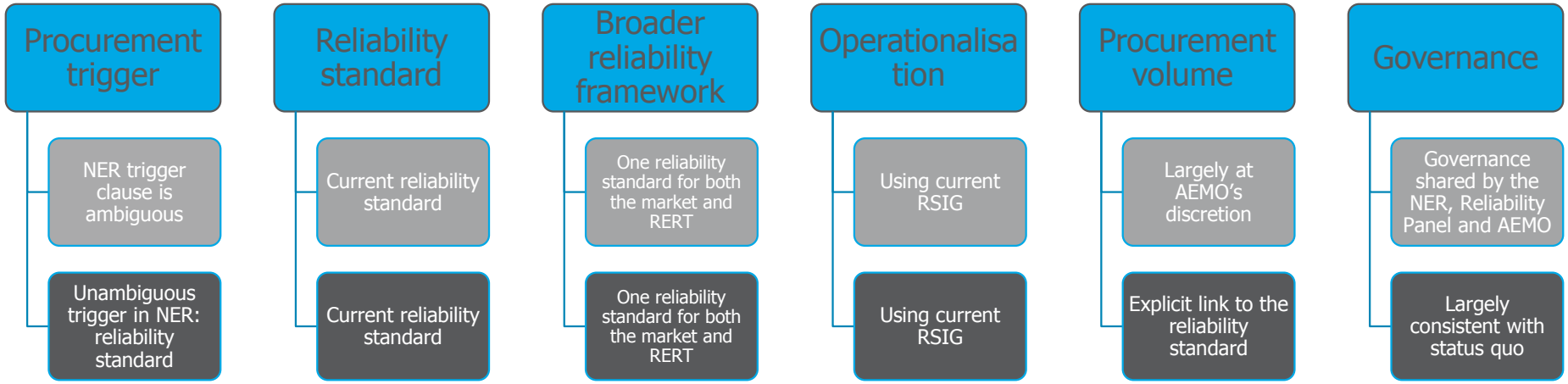
- The RERT's procurement trigger should be linked to the reliability standard – at least for long-notice RERT.

- It is less clear whether or not the procurement of the reserves should be linked to the reliability standard for short-notice RERT.

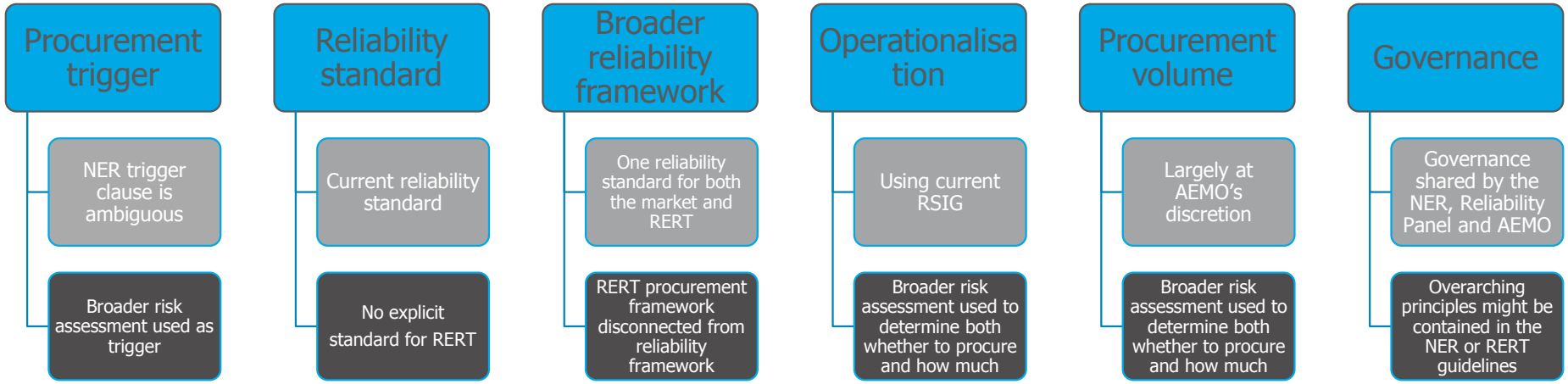
Current arrangements: procurement trigger and volume



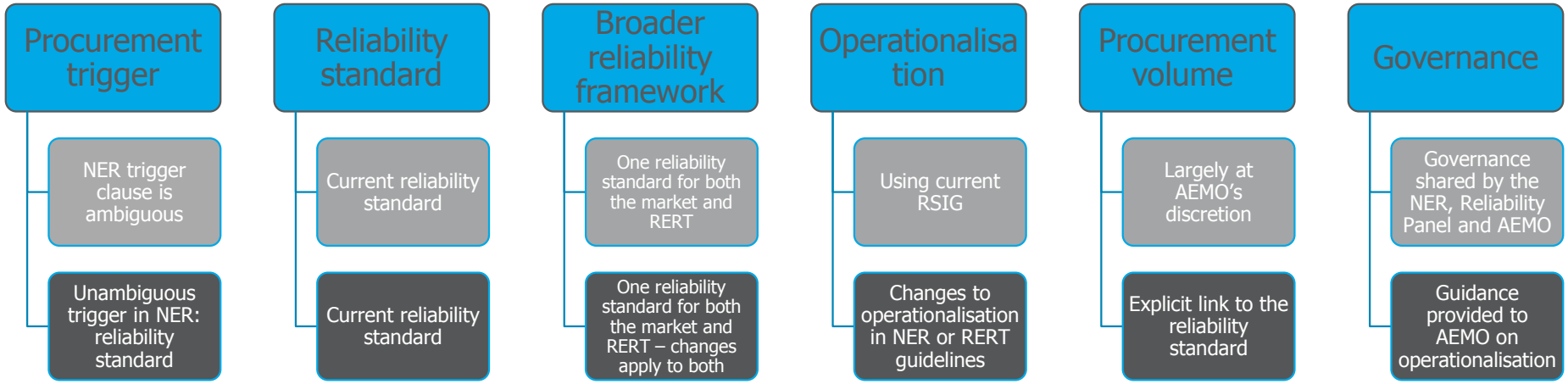
Option 1: Reliability standard determines procurement trigger and volume

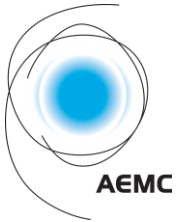


Option 2: Broader risk assessment framework of procurement trigger and volume



Option 3: Changes to the operationalisation of the reliability standard





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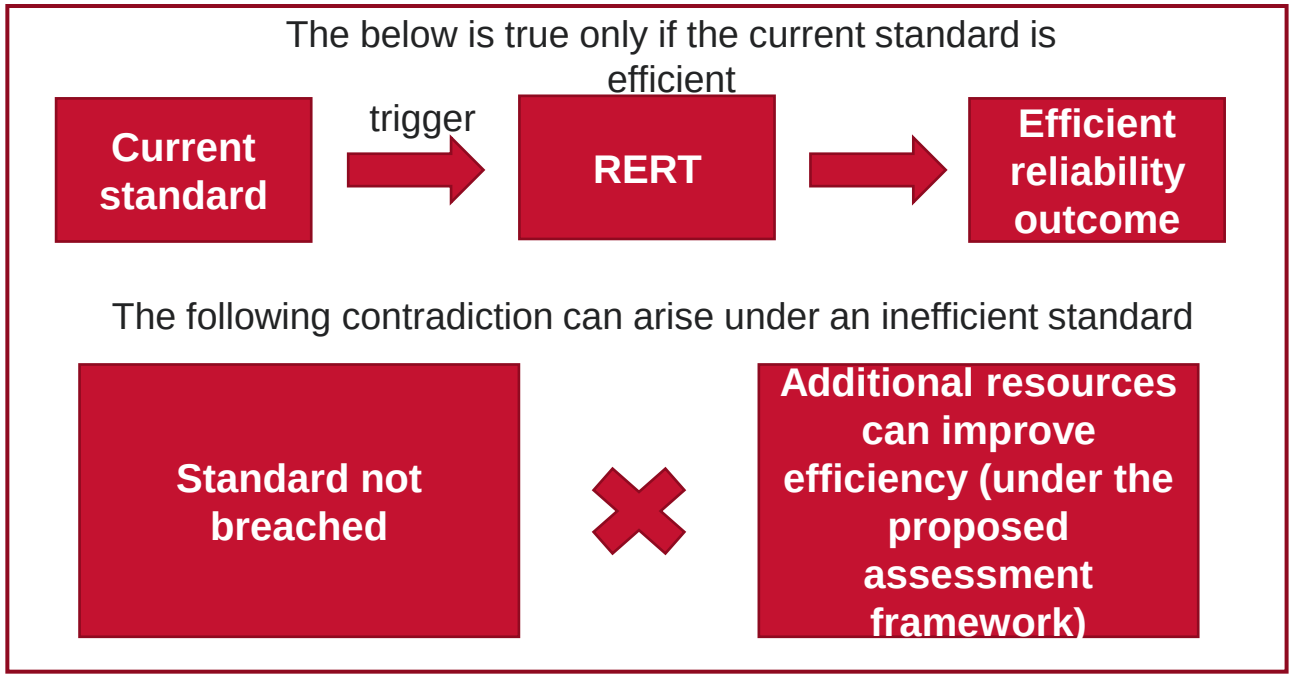
RERT Procurement Option

12th November 2018

Delinking RERT procurement from the current reliability standard

If the current standard does not lead to an optimal level of reliability, linking RERT to the standard cannot be efficient.

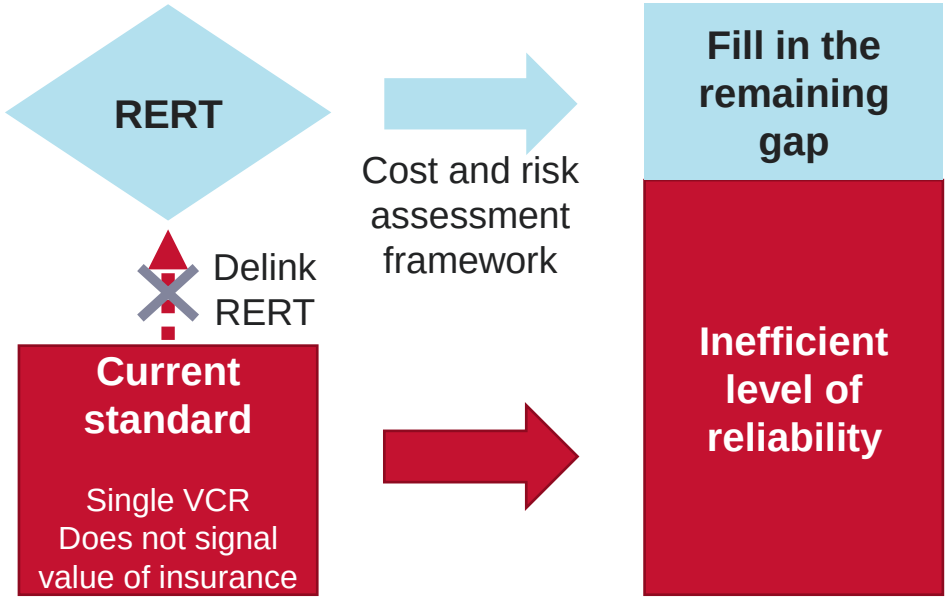
- AEMO's view is that the existing reliability framework is not suitable in the current NEM because
  - The average USE metric of the reliability standard assumes a constant VCR, which does not consider the cost structure of USE or risk averseness.
  - Leads to on-again, off-again RERT procurement which leads to higher costs.
- Linking RERT procurement to an inefficient standard means potentially cost-effective resources are not utilised to manage reliability outcomes.



Delinking RERT procurement from the current reliability standard

If the current standard does not lead to an optimal level of reliability, linking RERT to the standard cannot be efficient.

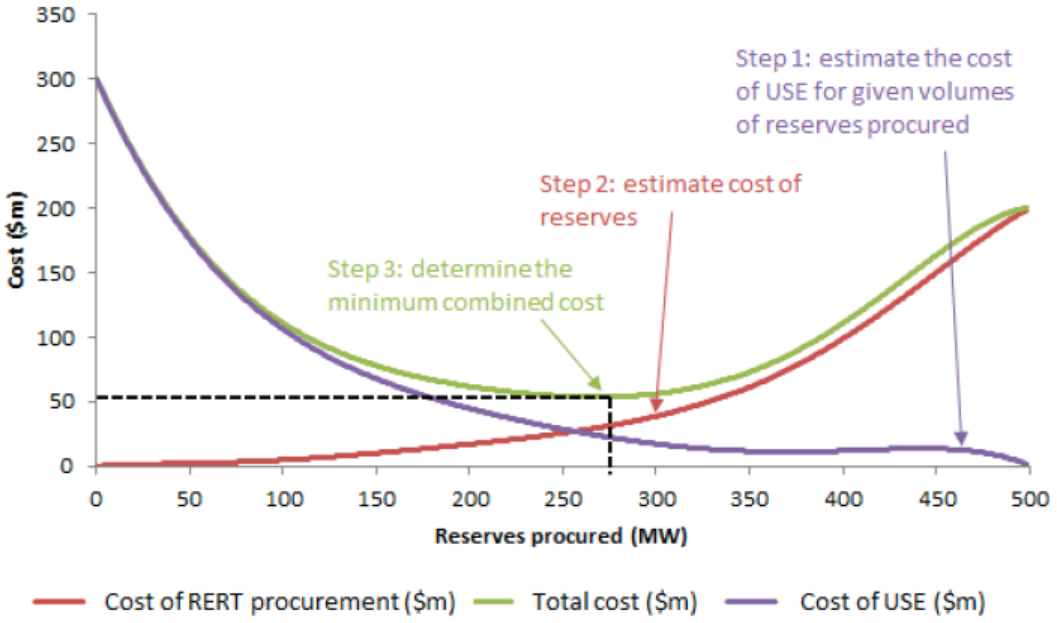
RERT can be linked back to an efficient standard (or set of standards) if they are designed in the future.



- Through delinking from the current standard, RERT will:
  - Ensure the optimal resource mix is available to deliver the efficient reliability outcome.
  - Provide insurance and risk mitigation against USE risk.
- The assessment framework would be redundant if RERT can be linked back to an efficient set of standards.

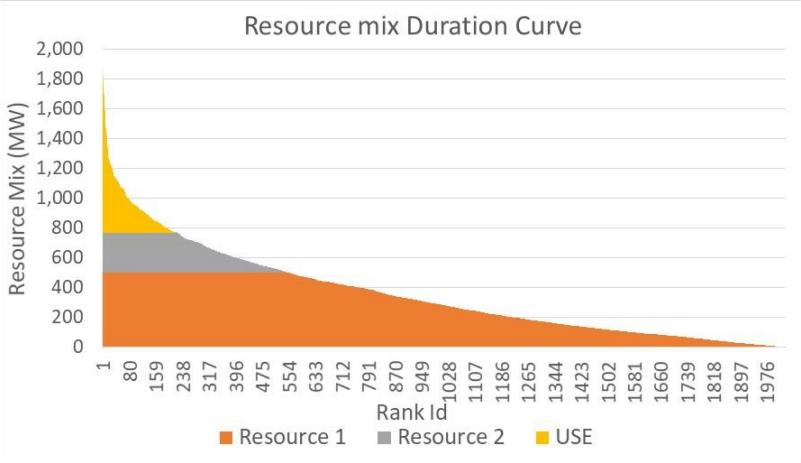
Broad cost and risk assessment framework

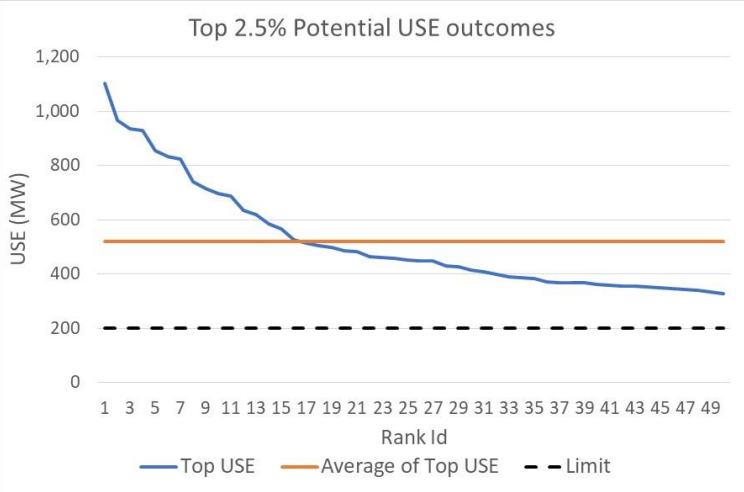
Seek to minimise total economic (resource + USE) cost while taking into account the risk appetite of the community.

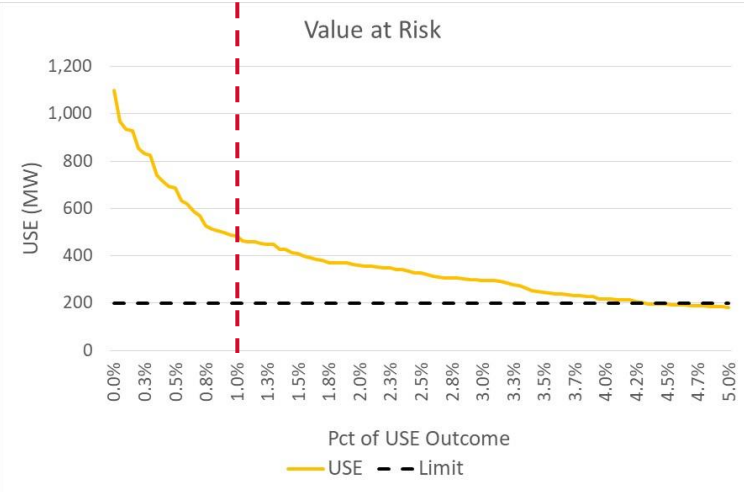


- The above describes the main trade-off in minimising total cost (after adjusting for resource operating constraints).
- In addition, the framework should also limit USE risk under some “tolerable threshold”. Some examples are:
  - Average USE under top x% of USE outcome is less than y MW
  - Probability of USE being more than x MW is less than y%
- AEMO will continue to work with stakeholders and the AEMC on the appropriate form and level of the risk metrics.

Example of incorporating risk

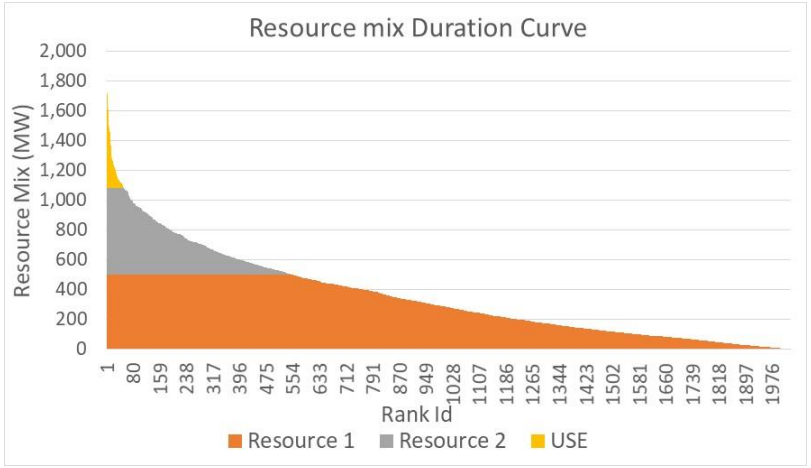




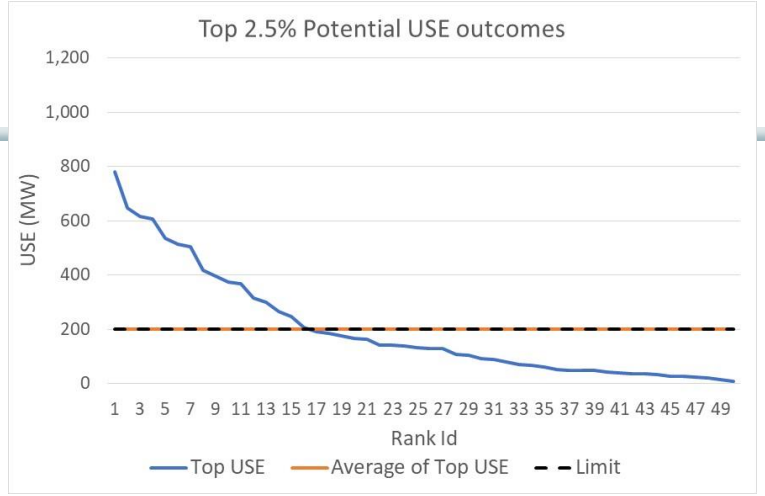


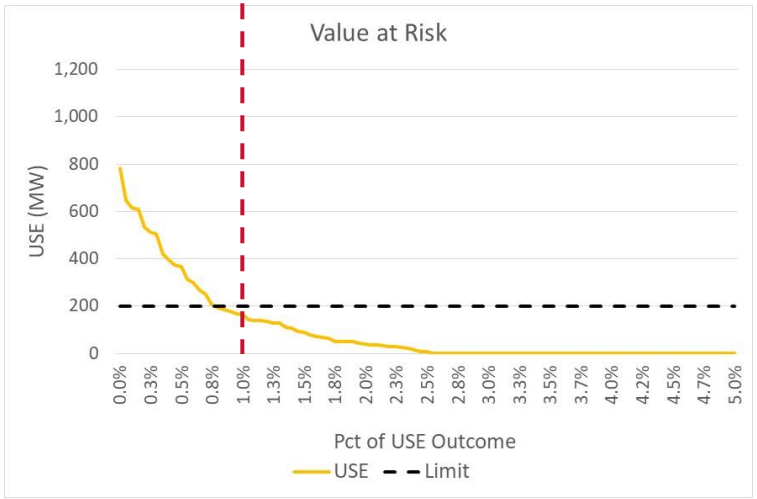
- A total of 764 MW of RERT procured to minimise economic cost only, risk not taken into account.
- But the (illustrative) risk metrics are not satisfied. For example:
  - The average of top 2.5% USE outcome has 520 MW of USE, not 200 MW
  - The probability of USE > 200 MW is more than 4%, not 1%.

Example of incorporating risk



- A total of 1083 MW of RERT procured at minimum economic cost, subject to satisfying the risk metrics.



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DISCUSSION
Q&A

Discussion
Q&A

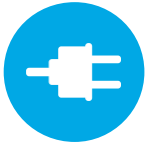
ROUNDTABLE DISCUSSIONS

Roundtable topics

- Is RERT insurance or is it an out-of-market market?

- Appropriateness of the reliability standard

- Governance and transparency



- Procurement lead time and contracting duration

- VCR, reliability and RERT

- Minimising market distortions

NEXT STEPS

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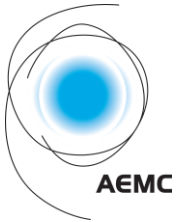
NEXT STEPS

Table 1: Project milestones

KEY MILESTONES	DATE
Project initiated (same day as the publication of the long-notice RERT final determination) and **consultation paper published**	21 June 2018
Technical working group, meeting #1 held	4 September 2018
Publication of options paper	**18 October 2018**
Stakeholder workshop	12 November 2018
Technical working group meeting #2	20 November 2018
Close of submissions on options paper	29 November 2018
Draft rule determination	**31 January 2019**
Final rule determination	**25 April 2019**



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