# Review of the System Restart Standard

## Draft Determination

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# Background – The AEMC Reliability Panel

- The Reliability Panel defines the power system security and reliability standards necessary to provide a reliable and secure electricity market.
- The current members of the Panel (appointed by the AEMC) are:

| | |
|---|---|
| Neville Henderson | Panel Chair and AEMC Commissioner |
| Trevor Armstrong | Acting Chief Executive Officer, Ausgrid |
| Lance Balcombe | Chief Executive Officer, TasNetworks |
| Murray Chapman | Executive Officer Corporate Development, AEMO |
| Mark Collette | Executive Energy, EnergyAustralia |
| Royce De Sousa | General Manager - Energy & Sustainability, Visy |
| Gavin Dufty | Manager Policy and Research, St Vincent de Paul Society, Victoria |
| Miles George | Managing Director, Infigen Energy Ltd |
| Chris Murphy | Strategic Advisor, Meridian Energy and<br>General Manager - Energy Market Interfaces, Telstra |
| Richard Wrightson | General Manager Energy Portfolio Management, AGL Energy |

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# What is the System Restart Standard?

**Neville Henderson**
Chairman, Reliability Panel - Commissioner, AEMC

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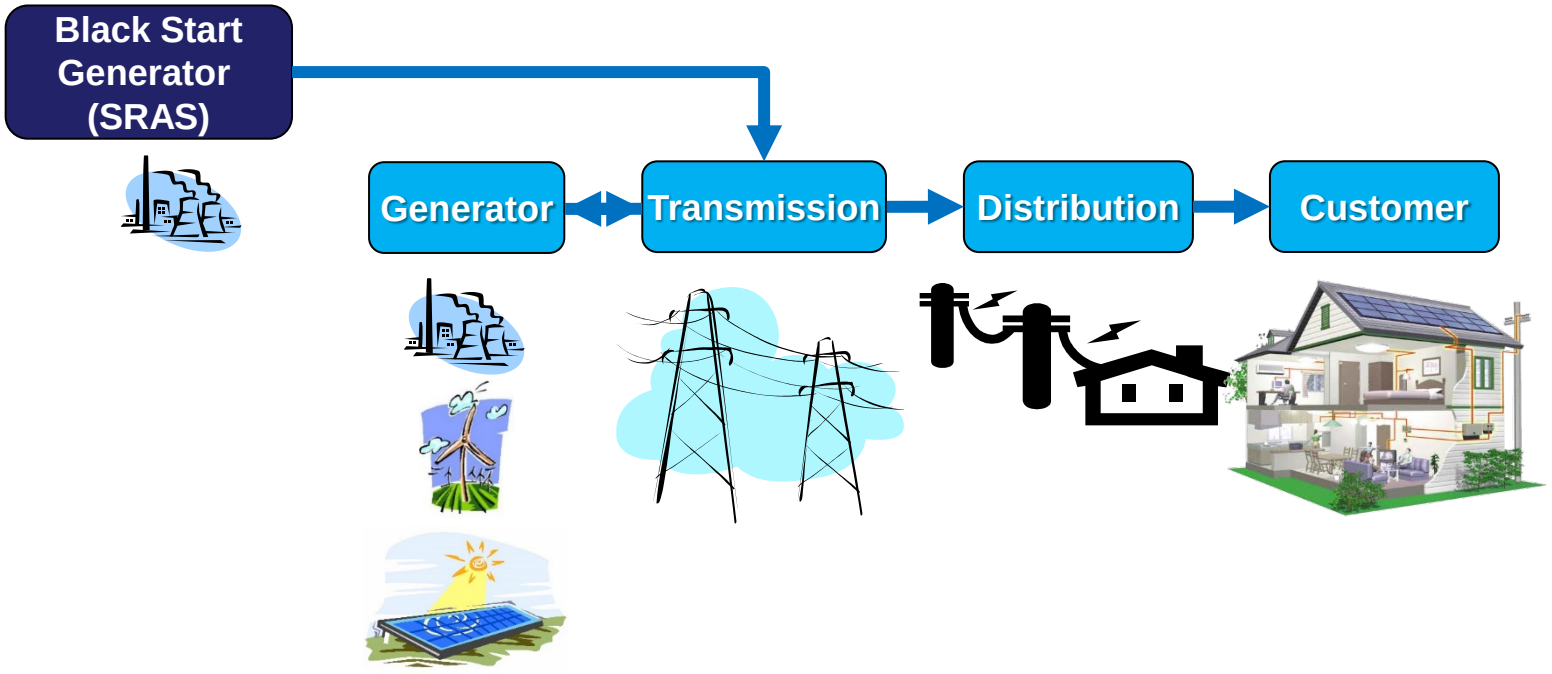
# Background

- The Reliability Panel (Panel) commenced this review of the System Restart Standard in November 2015.
- On 25th August 2016, the Panel published the following documents:
  - Draft Determination
  - Draft System Restart Standard
  - Economic Assessment of SRAS in the NEM (Deloitte Access Economics)
- Submission to the Draft Determination are open until 6 October 2016

# What is the System Restart Standard?

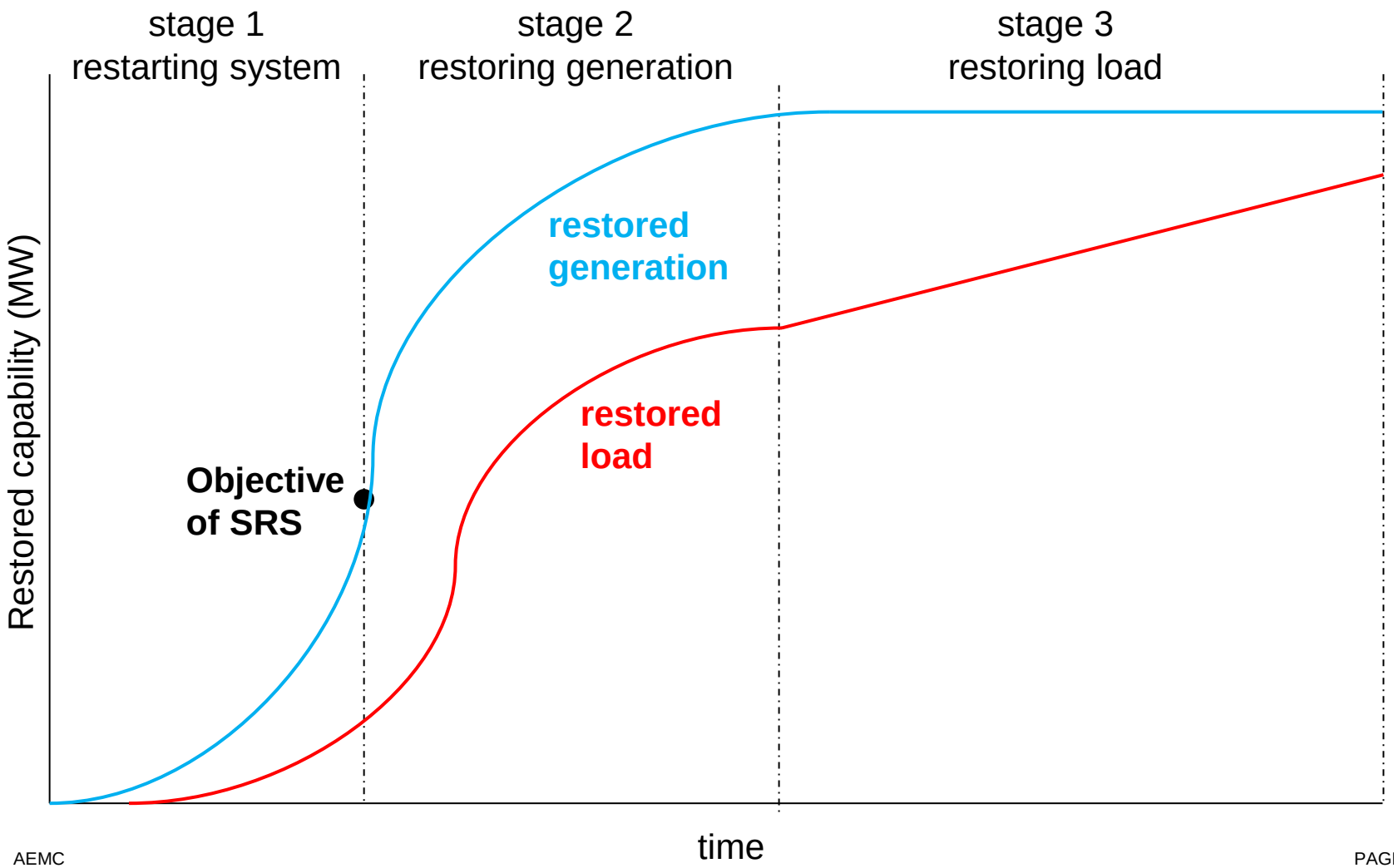
- The Standard defines a target for AEMO's procurement of SRAS, it is not an operational standard for actual restoration performance. The Standard:
  - specifies the time, level and aggregate reliability for restoring generation and transmission system capability following a major supply disruption
  - provides guidelines for AEMO's determination of electrical sub-networks
  - defines the diversity requirements for SRAS
- The Standard does not specify the level of load (consumer consumption) that needs to be restored in a given time following a major supply disruption.

# Background -
# System Restart Ancillary Services (SRAS)




- SRAS provides an emergency restart capability for the NEM, to help restore the transmission and generation network following a black system event

# The Standard sets a target for stage 1 of the restoration process



# Relevant changes to the requirements following on from the 2015 SRAS Rule Change

- SRAS for each electrical sub-network shall be procured under the assumption that supply (other than that provided under a system restart ancillary services agreement acquired by AEMO for that electrical sub-network) is not available from any neighbouring electrical sub-network (clause 8.8.3(aa)(2))
- The definitions of primary and secondary restart services were removed from the Standard and replaced by an "aggregate required reliability" for SRAS in each sub-network. (clause 8.8.3(aa)(3))
- The Standard can vary between sub-networks (clause 8.8.3(aa)(2))
- The Standard must specify that SRAS can only be acquired by AEMO for one electrical sub-network at any one time. (clause 8.8.3(aa)(5))
- AEMO must consult with the relevant NSP to identify and resolve issues in relation to the capability of any SRAS proposed to be provided in an electrical sub-network to meet the SRS (clause 3.11.7(b))

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# AEMO Advice

**Julian Eggleston**
Director, AEMC

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# AEMO advice

AEMO provided the following information to inform the review:

- A selection of generation and transmission restoration modeling results for a range of SRAS procurement scenarios
- The reliability of known SRAS sources (actual reliability of individual units confidential)
- Previous offers for known SRAS sources (actual offers not published to maintain confidentiality)

The review also built upon the following public AEMO information:

- Value of Customer Reliability Report – 2014
- Historical records of major power outages

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# Economic Assessment of SRAS

**Julian Eggleston**
Director, AEMC

# Deloitte Access Economics - Economic Assessment of SRAS

Deloitte Access Economics performed a cost benefit analysis of SRAS to inform the review, this assessment incorporates the following variables:

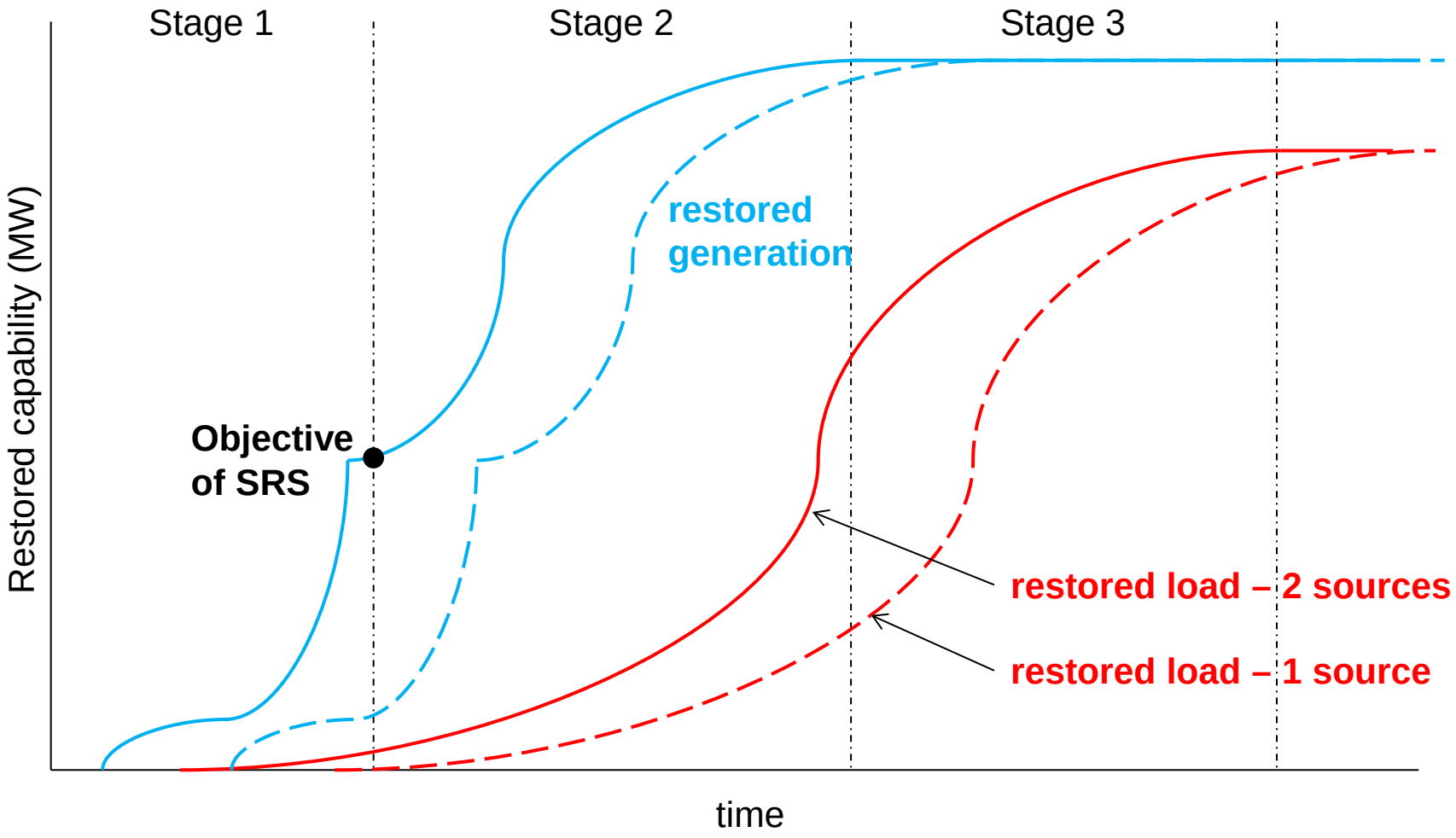
- Probability of an electrical sub-network wide black system event estimated from past interruptions
- Value of lost load based on AEMO's 2014 VCR (weighted for long interruptions and by sub-network)
- Reliability of known SRAS sources
- Cost of known SRAS sources (actual confidential offers to AEMO)

The assessment includes a sensitivity analysis of the results.

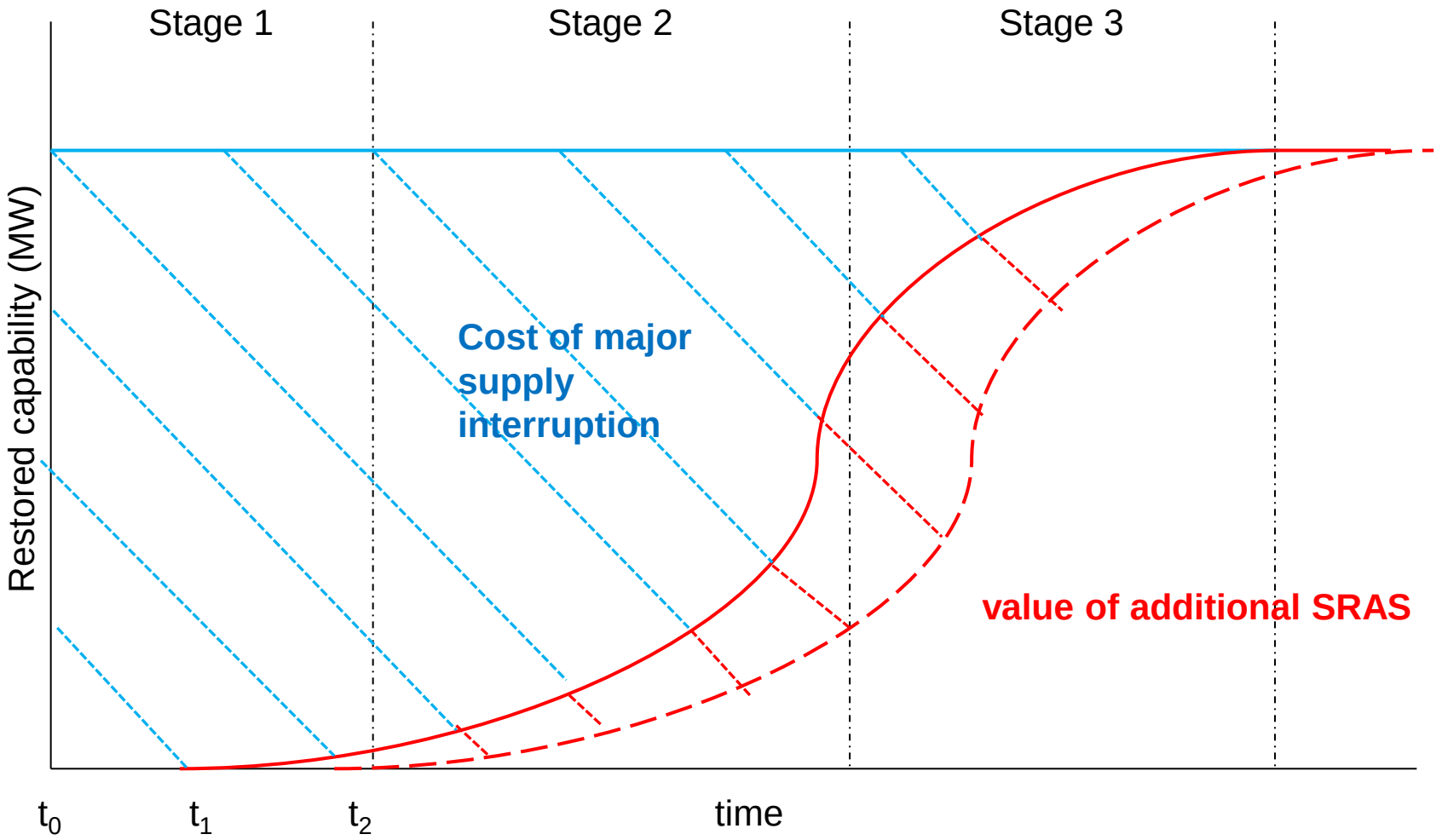
# Deloitte Access Economics - Economic Assessment of SRAS - Methodology

1. Establishing supply restoration pathways for each sub-network
2. Quantifying unserved energy associated with each restoration pathway and quantifying the associated cost (using VCR)
3. Weighting the cost of unserved energy by SRAS reliability
4. Calculating the annualised marginal benefit of each SRAS procurement scenarios, by weighting the cost with the probability of a system black event
5. Establishing the cost of procuring SRAS for each scenario
6. Determining the level of SRAS where the probability weighted net economic savings of an additional SRAS plant is positive
7. Quantifying uncertainty in these results with a sensitivity analysis.

# Stylised restoration process - delayed



# Value of additional SRAS



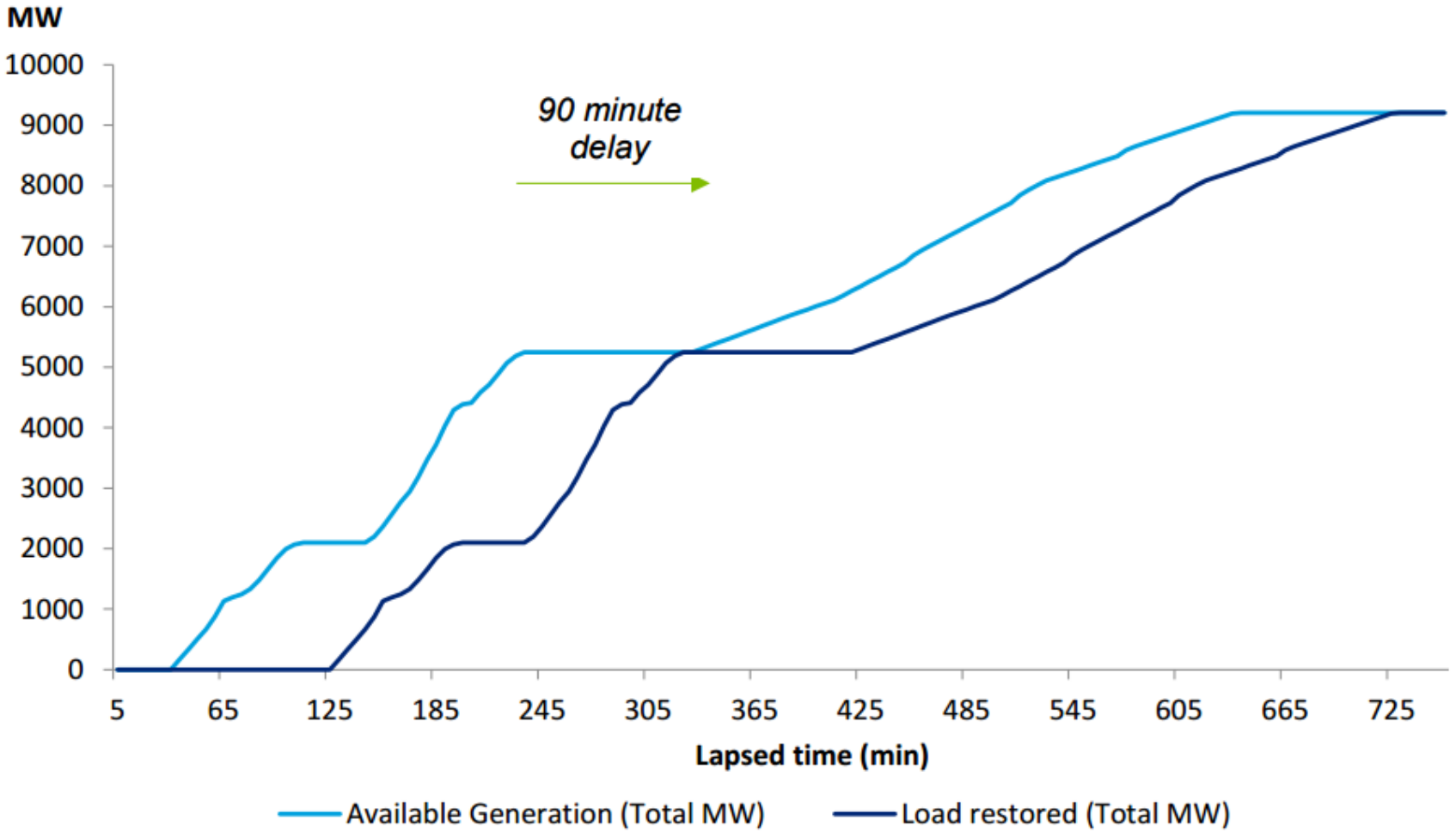
# Summary of key variables to the Economic Assessment

| Electrical sub-network | Probability of black system event (years) | | | Average VCR ($/kWh) |
|---|---|---|---|---|
| | Lower frequency Bound | Base Case | Upper frequency Bound | |
| **North Queensland** | 34 | 30 | 26 | 34.51 |
| **South Queensland** | 48 | 43 | 38 | 34.51 |
| **New South Wales** | 45 | 38 | 31 | 33.42 |
| **Victoria** | 38 | 34 | 29 | 32.75 |
| **South Australia** | 20 | 18 | 17 | 33.09 |
| **Tasmania** | 25 | 22 | 19 | 25.05 |

# Deloitte Access Economics - Economic Assessment of SRAS - Assumptions

- A major supply disruption is classed as a complete loss of generation within an electrical sub-network, where supply from neighboring sub-networks is not available.
- Supply restoration follows generation restoration with a time lag of 90 minutes.
- No network damage is assumed to have been incurred as a result of the black system event.
- The investigation covers the current six NEM sub-networks.
- SRAS plants availability is 95 percent as recommended by AEMO.
- Failure of generation post system re-start or network issues that may arise as a result of system re-start conditions are not captured in the economic assessment.

# Economic Assessment of SRAS
# Key Assumption – load restoration after 90 minutes

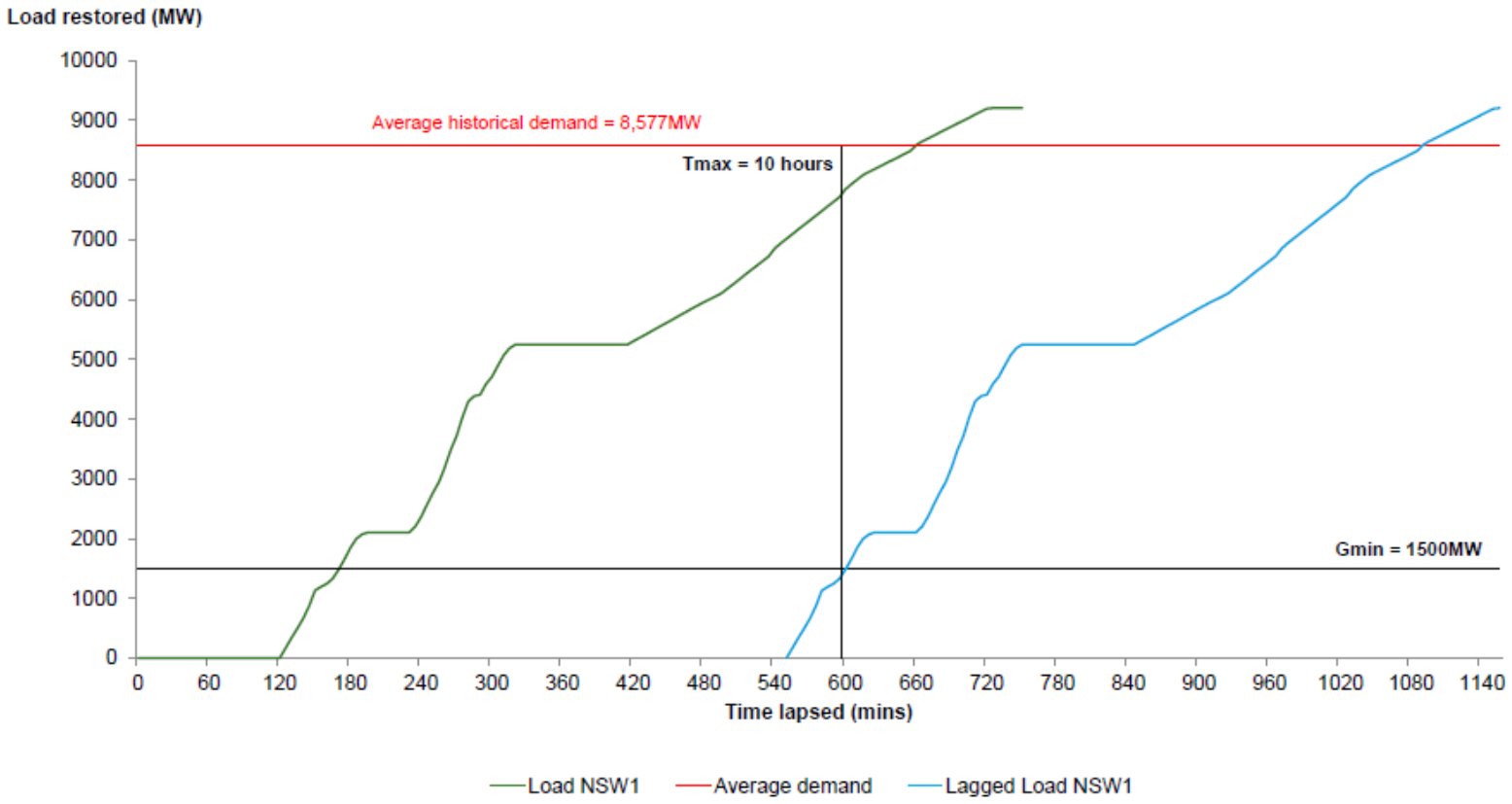


# Economic Assessment of SRAS
# Key Assumption – the "default blackout"

- The "default" blackout duration is defined as the time required to restore the system if all SRAS plants in a given scenario are unsuccessful in delivering the service (based on their inherent reliability).
- The "real" value for the time delay associated with this eventuality is uncertain. If all the SRAS sources initially fail to start the first time then one or more may start in a matter of minutes or much longer.
- To place a finite limit on this value we define the duration of the "default blackout" as equal to the time associated with the restoration curve of the slowest one SRAS plant case, delayed such that the minimum level of generation that provides acceptable stability in each sub-network ($G_{min}$) is reached before networks assets begin to experience secondary effects, such a substation batteries going flat, ($T_{max}$).

# Economic Assessment of SRAS
# Key Assumption – the "default blackout"

**Figure 2.1: Lagged system restoration – New South Wales**




Source: AEMO, Deloitte Access Economics Analysis

# Economic Assessment of SRAS
# Key Assumption – the "default blackout"

- The value of the default blackout impacts the marginal benefit of SRAS, proportional to the probability of all (n-n) contracted SRAS failing to operate.

| Electrical Sub-Network | Raw Default Blackout Value (billions) | SRAS failure probability (n-n) | | |
|---|---|---|---|---|
| | | 1 SRAS | 2 SRAS | 3 SRAS |
| **North Queensland** | $0.62 | 14.5% - 43.0 % | 1.4% | 0.6% |
| **South Queensland** | $1.00 | 9.8% | 2.8% | 0.4% |
| **New South Wales** | $2.63 | 14.5% | 2.8% | 0.5% - 0.7% |
| **Victoria** | $1.70 | 12.1% | 1.8% - 4.1% | 0.6% |
| **South Australia** | $0.48 | 14.5% | 3.1% | 0.5% - 1.2% |
| **Tasmania** | $0.26 | 9.8% - 28.8% | 1.0% | 0.2% |

# Summary Table – Estimated optimal level of SRAS

| Sub-network | Available sources | Current procured level | Central case | Optimal Range |
|---|---|---|---|---|
| **North Queensland** | 5 | 2 | 2 | 1 to 2 |
| **South Queensland** | 3 | 1 | 1 | 1 to 2 |
| **New South Wales** | 4 | 2 | 2 | 1 to 2 |
| **Victoria** | 4 | 2 | 2 | 1 to 2 |
| **South Australia** | 5 | 2 | 2 | 1 to 2 |
| **Tasmania** | 4 | 1 | 1 | 1 |

- This table presents the high level results of the economic assessment of SRAS undertaken by Deloitte Access Economics.
- Figures show the marginal benefit of SRAS for the scenarios assessed are included at the end of this presentation in the appendix.

# Questions and Comments?

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# The Draft System Restart Standard

## Time and Level Set-points by electrical sub-network

**Julian Eggleston**
Director, AEMC

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# The Draft Standard Set-points

- The Draft Standard defines a restoration set-point for each electrical sub-network in terms of:

  a) a level of generation and transmission capacity to be expected to be available at the end of stage 1 of the restoration process;

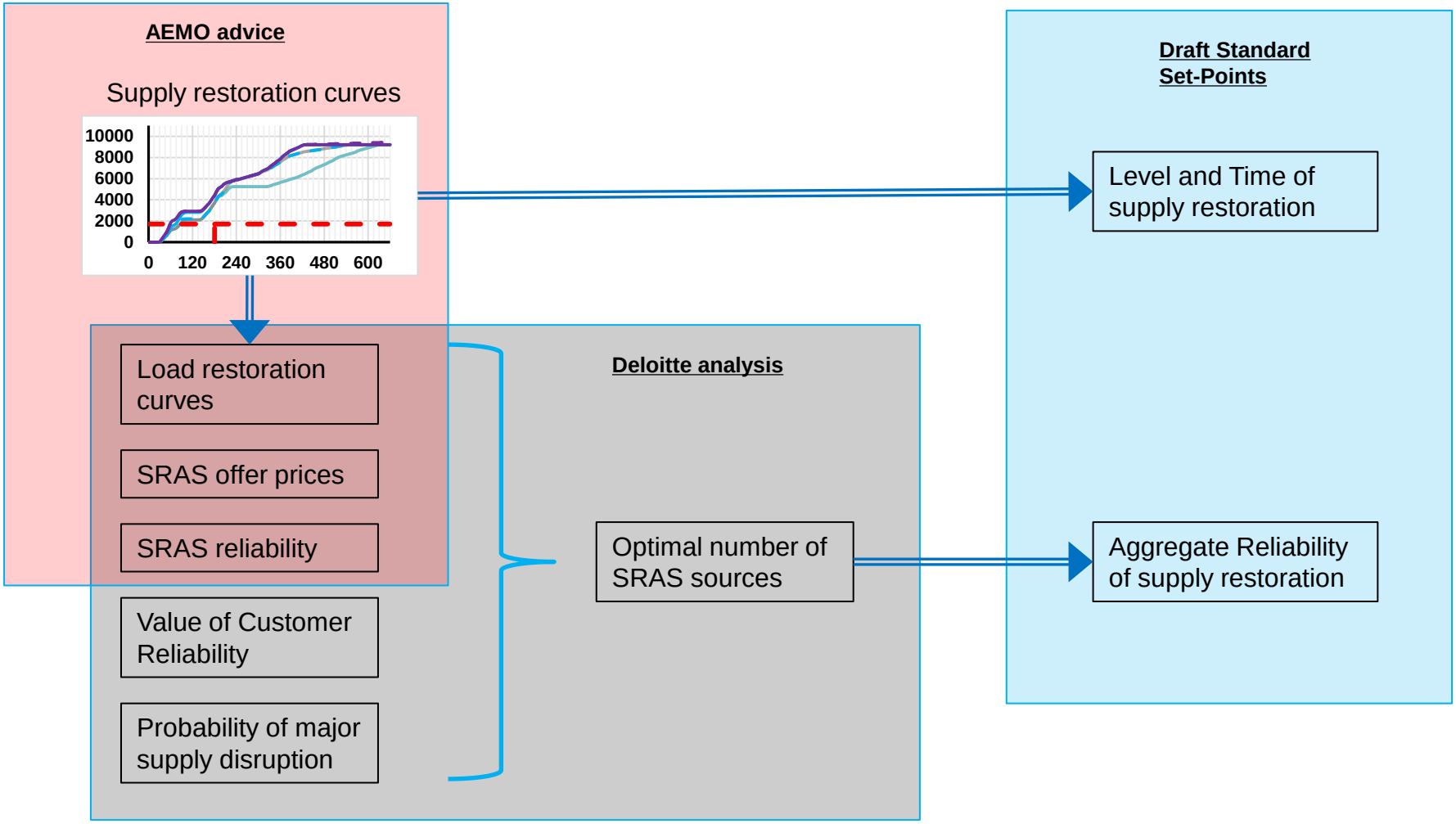
  b) a maximum time to achieve this level of generation and transmission capacity;

  c) an aggregate reliability, or probability, for achieving this level within the required maximum time.

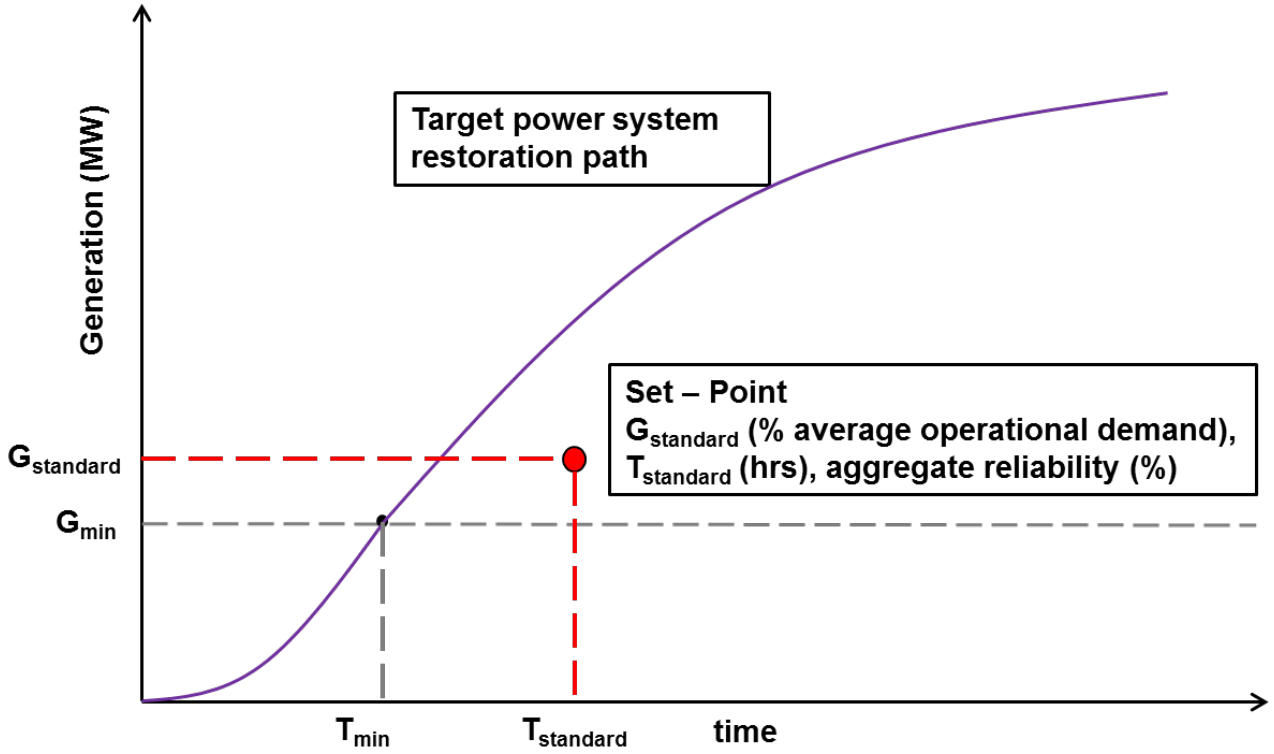
- Parts (a) & (b) are determined from the restoration modeling advice provided by AEMO for each electrical sub-network.

- Part (c) is determined from the economically optimal number of SRAS and the reliability of the individual SRAS sources.

# Determining the Draft Standard Set-Points



# Approach to setting the Time & Level




- The time and level set-points in the standard were set based on restoring sufficient supply to energise auxiliaries of all available generation ($G_{min}$) within a specified time.

# Draft Standard Set-Points

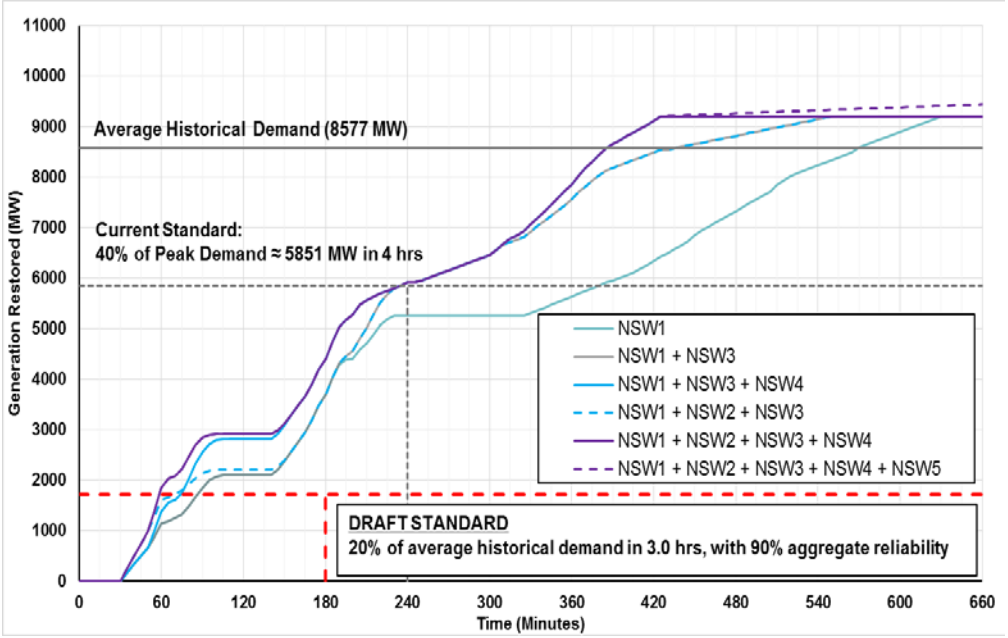
| Electrical Sub-Network | Level of Restoration (% of Average Operational Demand) | Restoration time (hrs) | Aggregate Reliability |
|---|---|---|---|
| **North Queensland** | 45% | 4.0 | 90% |
| **South Queensland** | 25% | 3.0 | 90% |
| **New South Wales** | 20% | 3.0 | 90% |
| **Victoria** | 20% | 3.0 | 90% |
| **South Australia** | 25% | 3.0 | 90% |
| **Tasmania** | 30% | 3.0 | 90% |

# Additional requirement for NSW

- The Draft Standard includes an additional requirement for AEMO to purchase SRAS in NSW sufficient to:

  "Re-supply and energise the auxiliaries of at least 500 MW of generation capacity north of Sydney within 1.5 hours of a major supply disruption with an aggregate reliability of at least 75%"

- This speeds up the expected restoration of Hunter Valley generation.
- An equivalent requirement for other electrical sub-networks adds little value.



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# The Draft System Restart Standard

## Aggregate Reliability and Diversity

**Ben Hiron**
Advisor, AEMC

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# Link between Aggregate Reliability and Diversity

- The Draft Standard defines aggregate reliability as:
  - "Aggregate reliability is the probability that the generation and transmission in a sub-network is expected to be restored to the specified level within the specified time."
  - "The reliability of any individual SRAS will incorporate the expected start-up performance and availability of that service."
- The Draft Standard also links the assessment of the aggregate reliability to the diversity between the individual SRAS sources:
  - "The aggregate reliability of the procured SRAS in each electrical sub-network shall be determined by AEMO, considering the combination of the individual reliabilities of the SRAS procured in that electrical sub-network, together with an assessment of the impact of the points of failure set out in the guidelines for diversity in section 8 of the standard."

# Aggregate Required Reliability

- The Draft Standard specifies the aggregate required reliability as 90% for all the electrical sub-networks in the NEM.

| Electrical Sub-Network | Best case expected aggregate reliability* | | | Estimated Minimum No. of SRAS* |
|---|---|---|---|---|
| | 1 SRAS | 2 SRAS | 3 SRAS | |
| **North Queensland** | 85.5% | 98.6% | 99.4% | 2 |
| **South Queensland** | 90.2% | 97.2% | 99.6% | 1 |
| **New South Wales** | 85.5% | 97.2% | 99.3% | 2 |
| **Victoria** | 87.9% | 98.2% | 99.4% | 2 |
| **South Australia** | 85.5% | 96.9% | 99.5% | 2 |
| **Tasmania** | 90.2% | 99.0% | 99.8% | 1 |

*(based on current available SRAS)

# Guidelines for the diversity of sources

- The Guidelines for the diversity of SRAS sources have been revised to include Electrical, Geographical and Energy Source factors.
- The factor relating to technological diversity has been removed as the new aggregate reliability requirement largely accounts for the risk of SRAS failure associated with technological characteristics.
- The intent is that AEMO would use the diversity guidelines as guide for identifying potential points of failure for each SRAS procurement option, then estimate the risk of those events and incorporate that assessment into the determination of aggregate reliability for each electrical sub-network.

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# The Draft System Restart Standard

## Guidelines for the determination of electrical sub-networks

**Ben Hiron**
Advisor, AEMC

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# Guidelines for the determination of electrical sub-networks

- The guidelines for the determination of electrical sub-networks includes the following factors:
  - the number and strength of transmission corridors connecting an area to the remainder of the power system;
  - the electrical distance (length of transmission lines) between generation centres; and
  - an electrical sub-network should be capable of being maintained in a satisfactory operating state to the extent practicable.
- The third factor replaces the current requirements for a minimum quantity of load and generation (1000MW) in a electrical sub-network.

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# Additional Recommendations

**Neville Henderson**
Chairman, Reliability Panel - Commissioner, AEMC

# Additional recommendations and comments

The Draft Determination discusses the following recommendations:

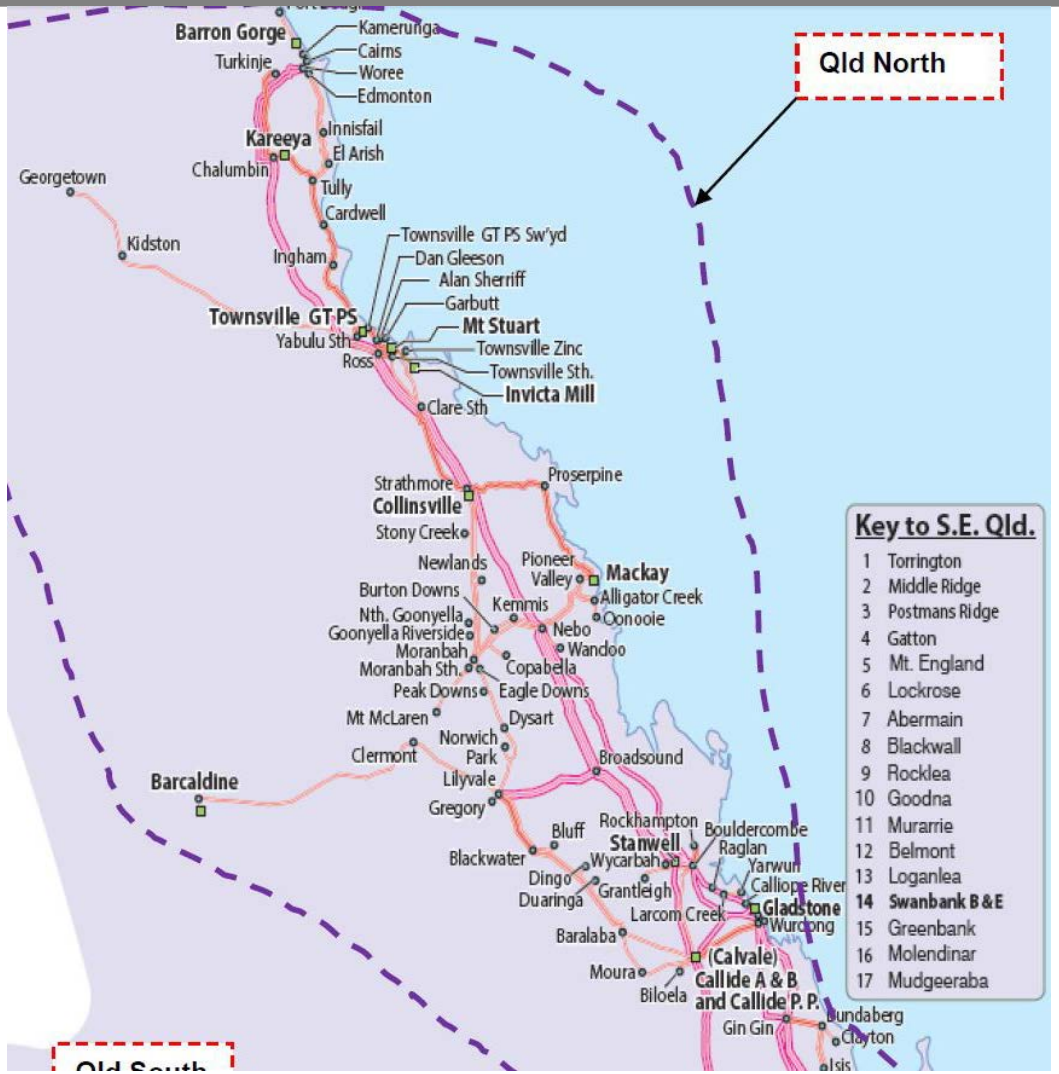
1. NSPs to review the standards for sub-station batteries
2. AEMO, NSPs and JSSCs to review their communications networks to ensure they are reliable
3. AEMO to consider ways to improve consultation with stakeholders, particularly TNSPs.
4. The Panel will monitor the impact of the growing penetration of renewable generation
5. Stakeholder with concerns with the implementation of the Standard should refer them to the AER
6. The Panel is consulting on the implication on the Standard of AEMO amending the electrical sub-network boundaries

# Questions and Comments?

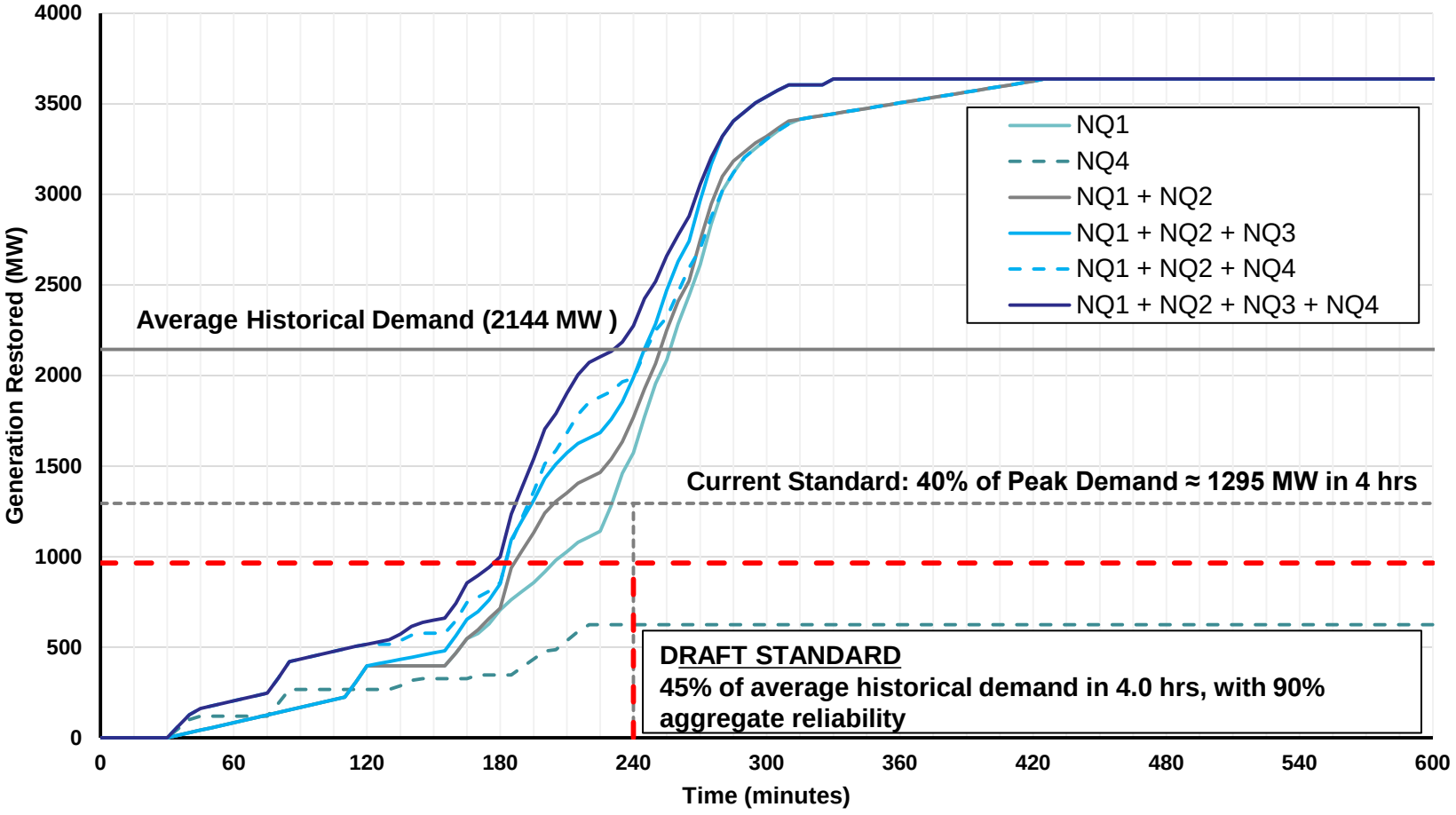
# Appendix

- Electrical sub-network restoration curves and the Draft Standard set-points
- Results of the Economic Assessment

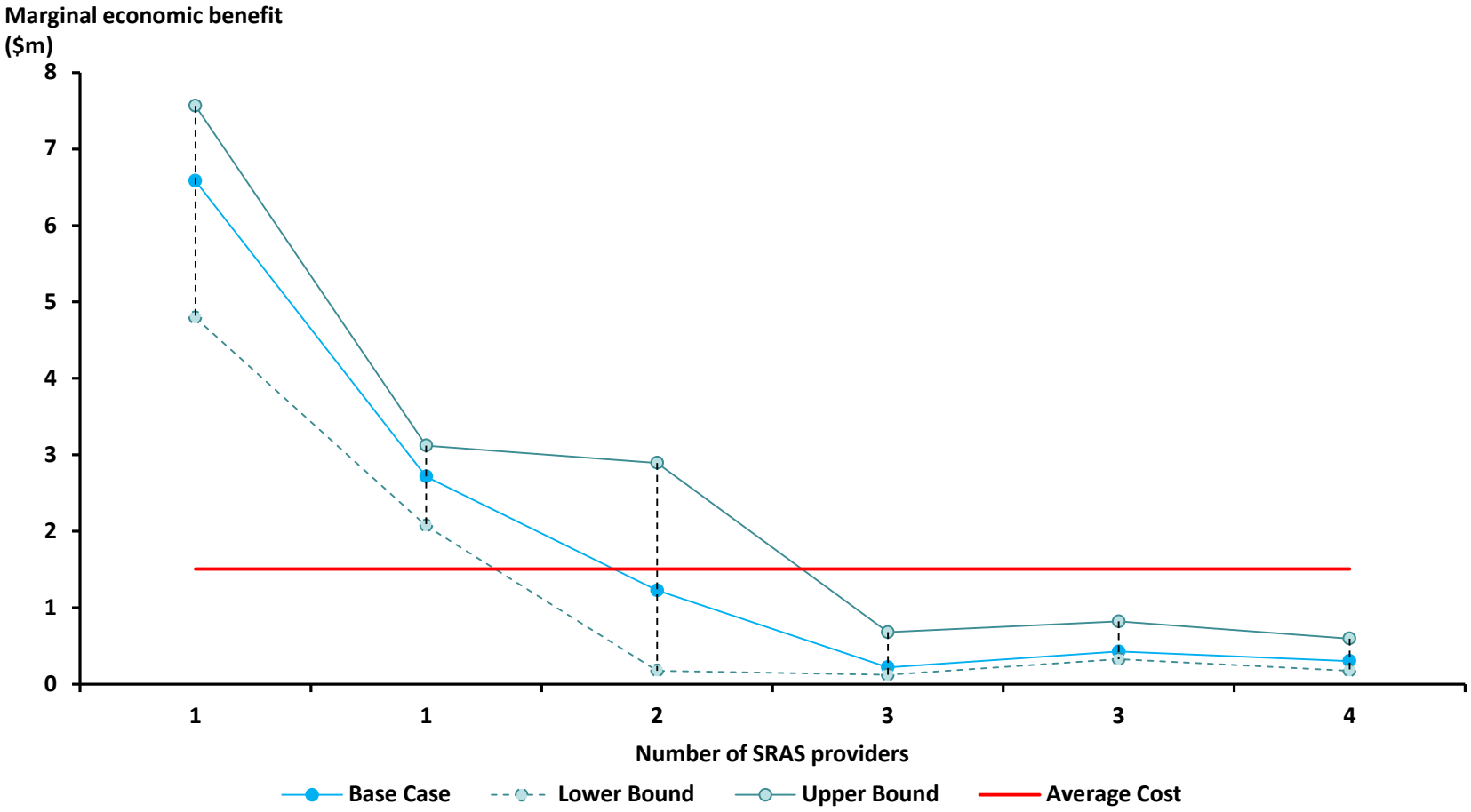
# North Queensland - Electrical Sub-Network



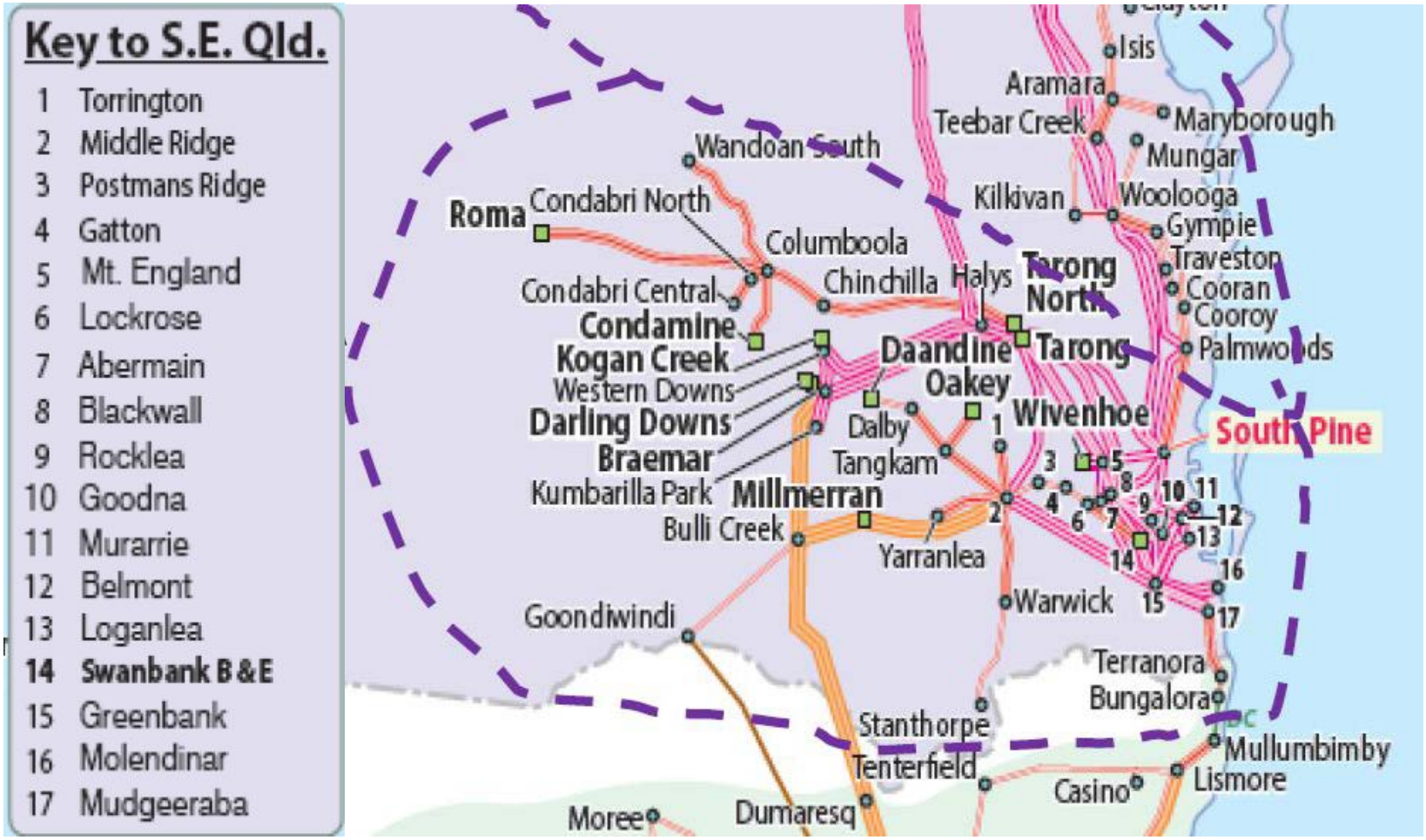
# North Queensland - Restoration Curves and Draft Standard



# North Queensland - Marginal Benefit of SRAS



# South Queensland - Electrical Sub-Network



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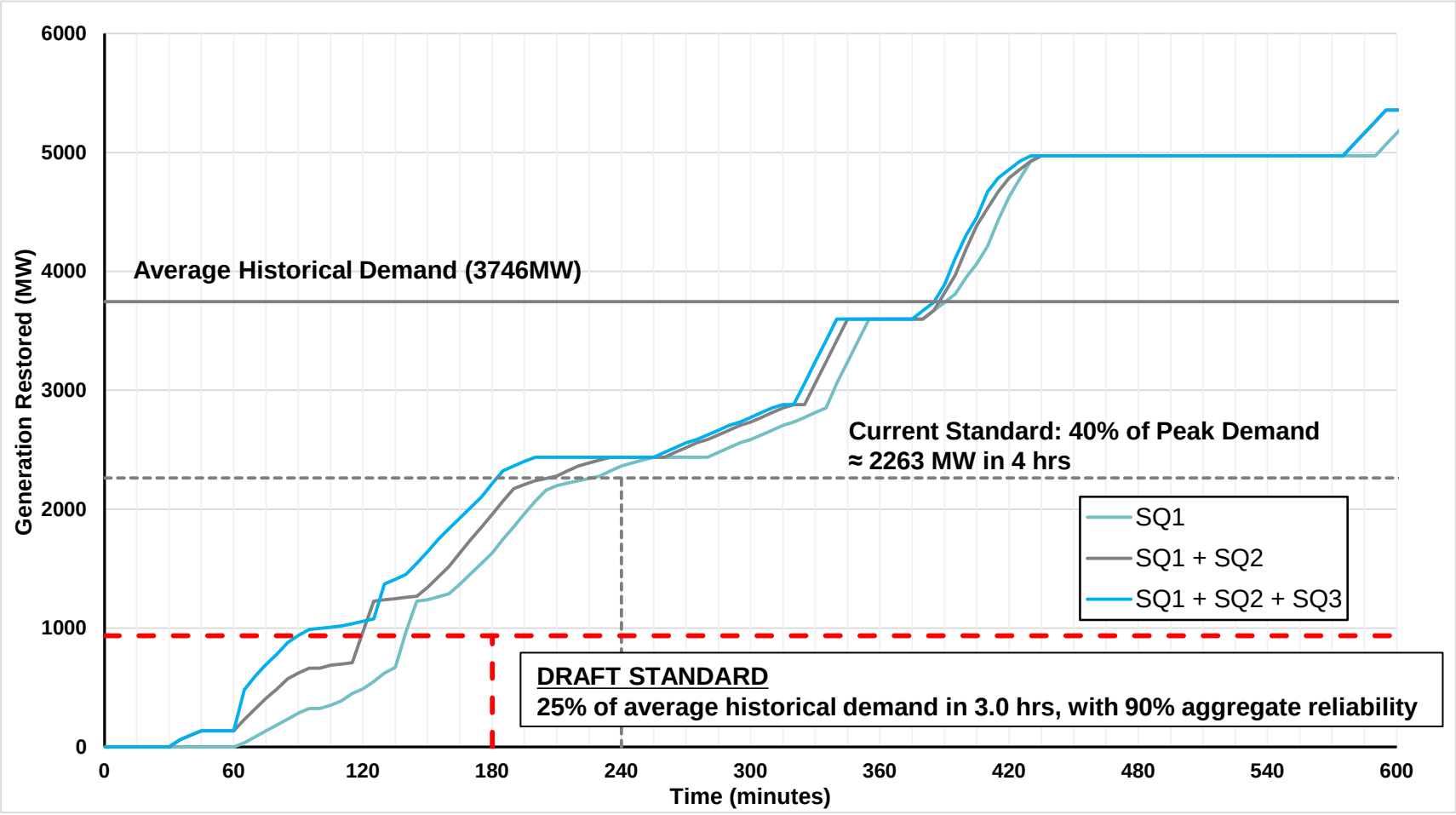

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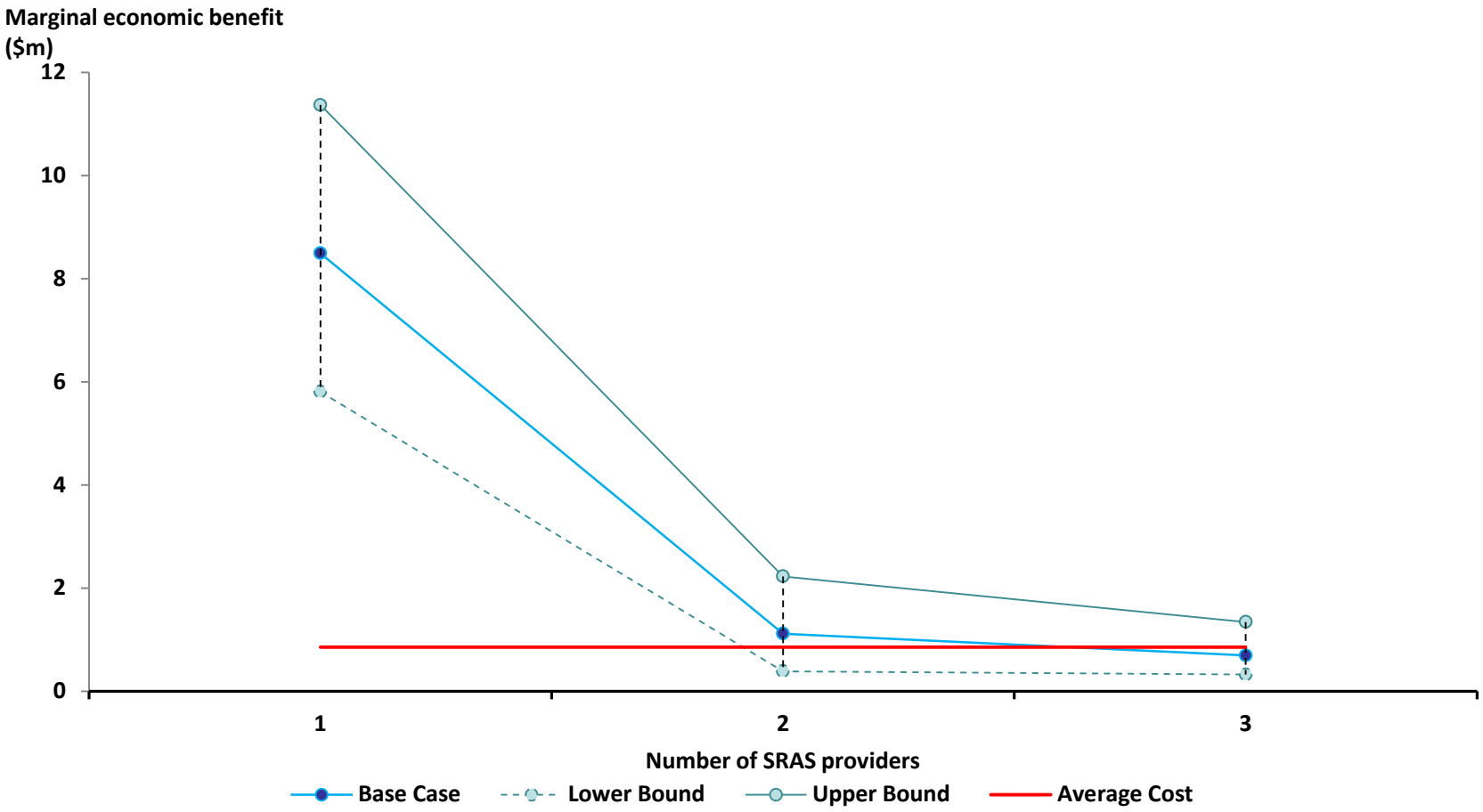
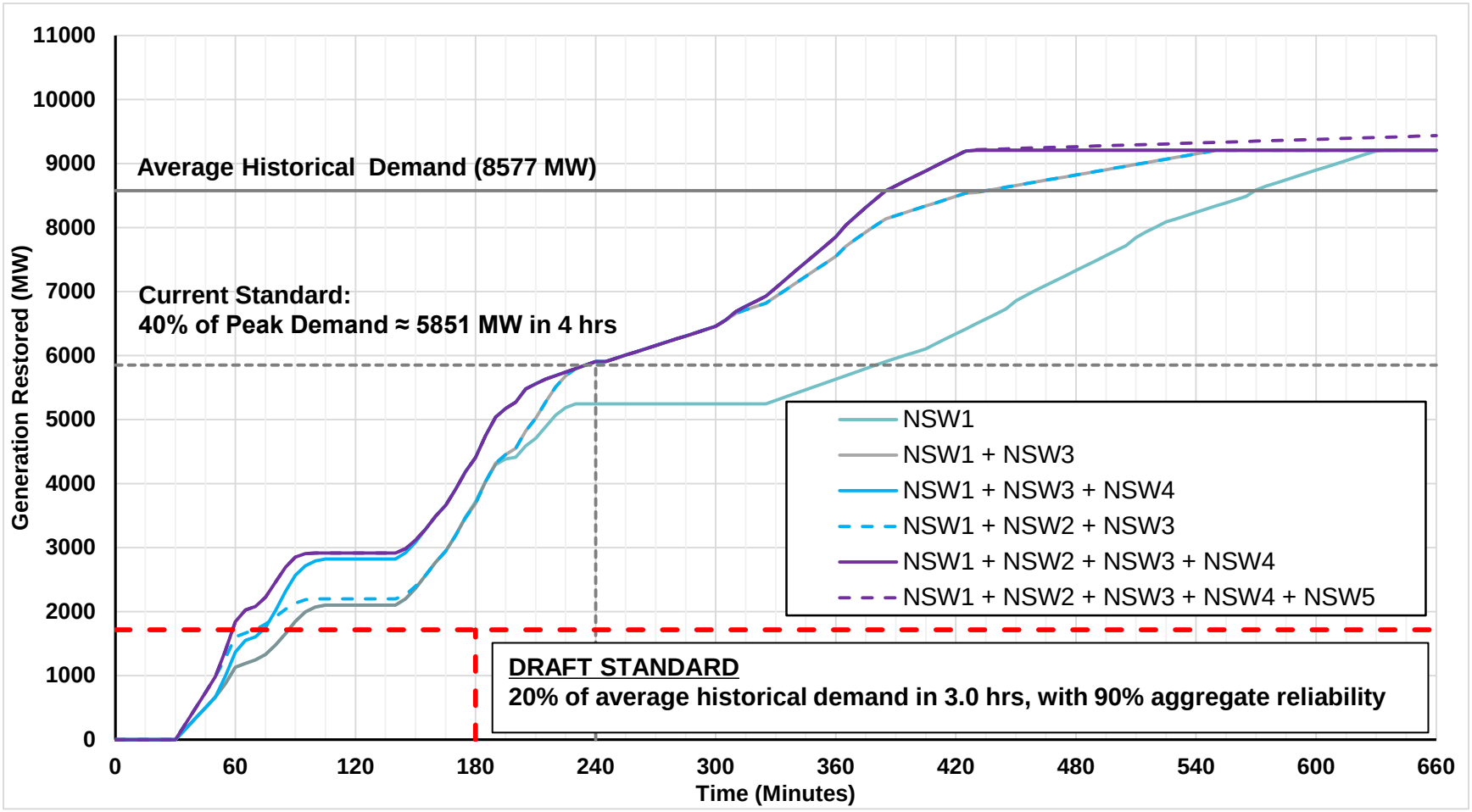


# New South Wales - Electrical Sub-Network

# New South Wales - Restoration Curves and Draft Standard



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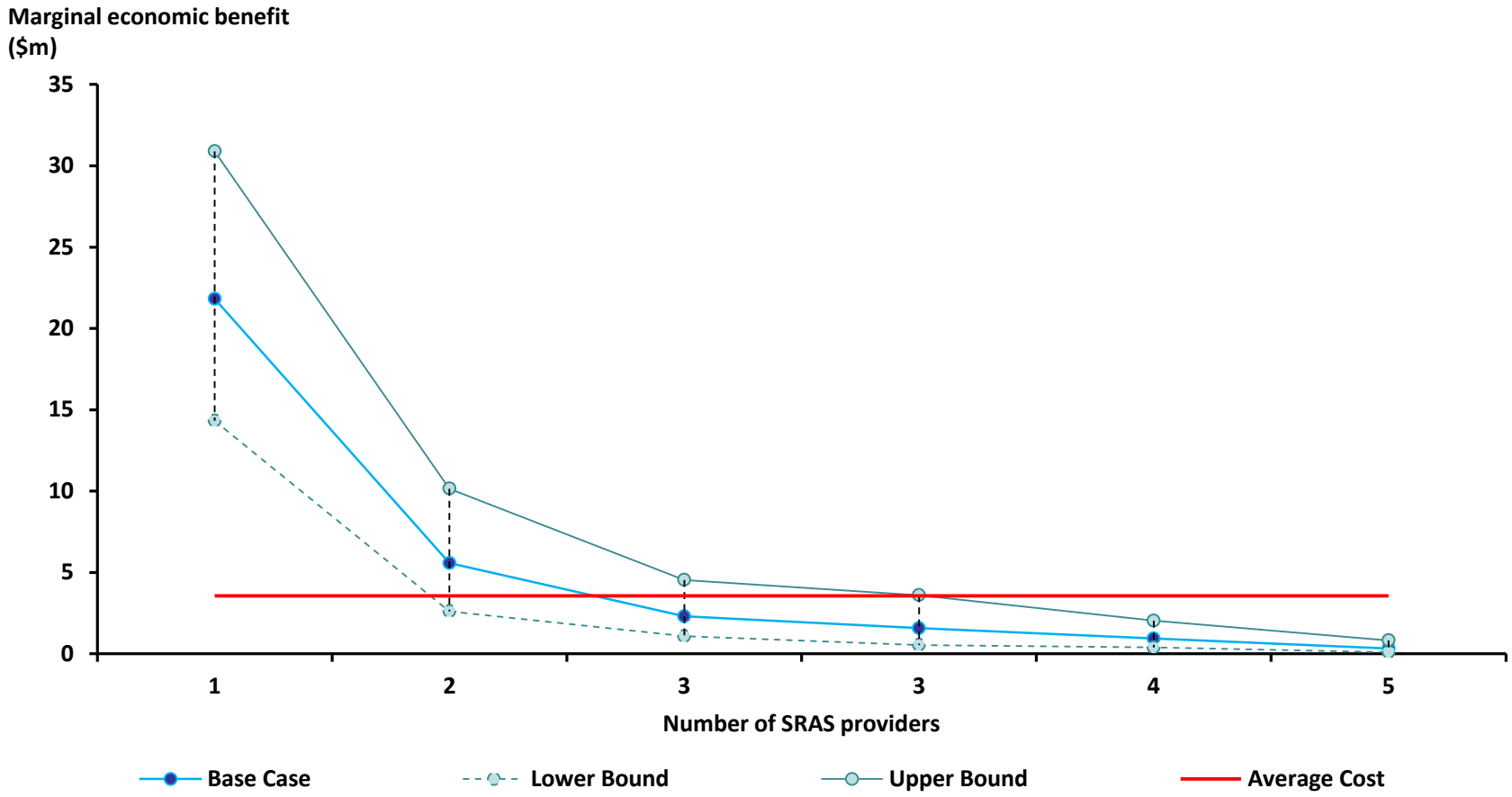
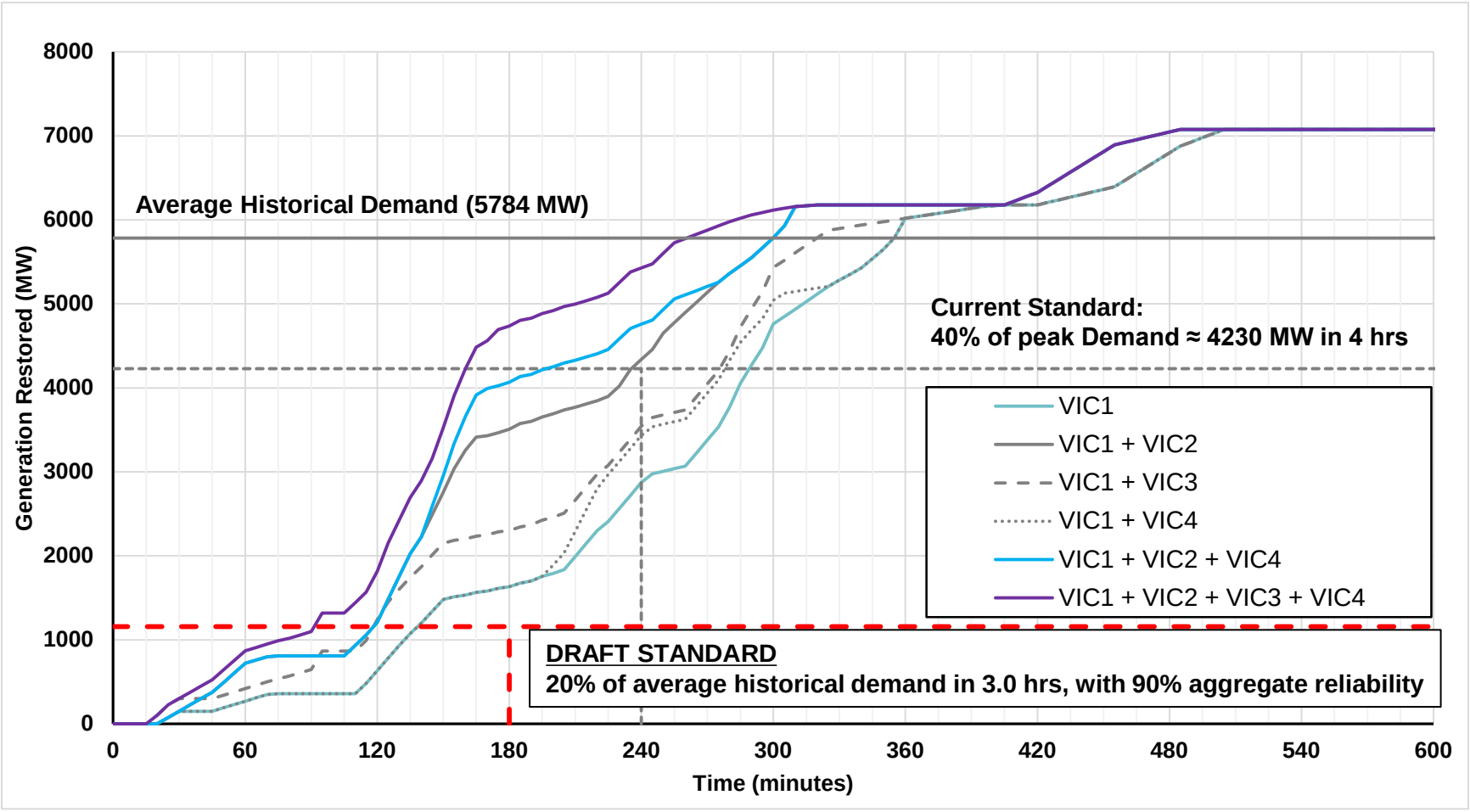
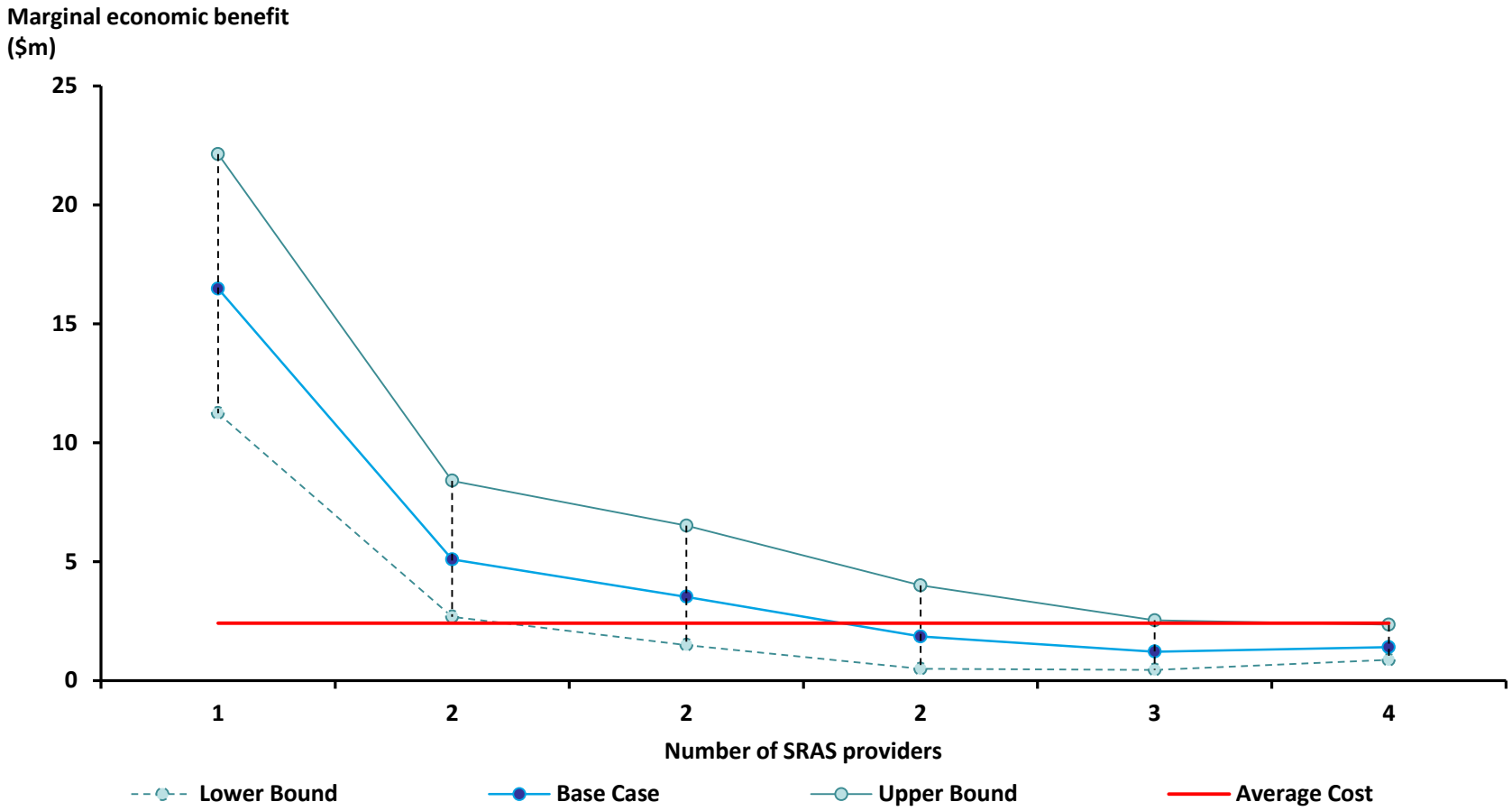


# Victoria - Electrical Sub-Network

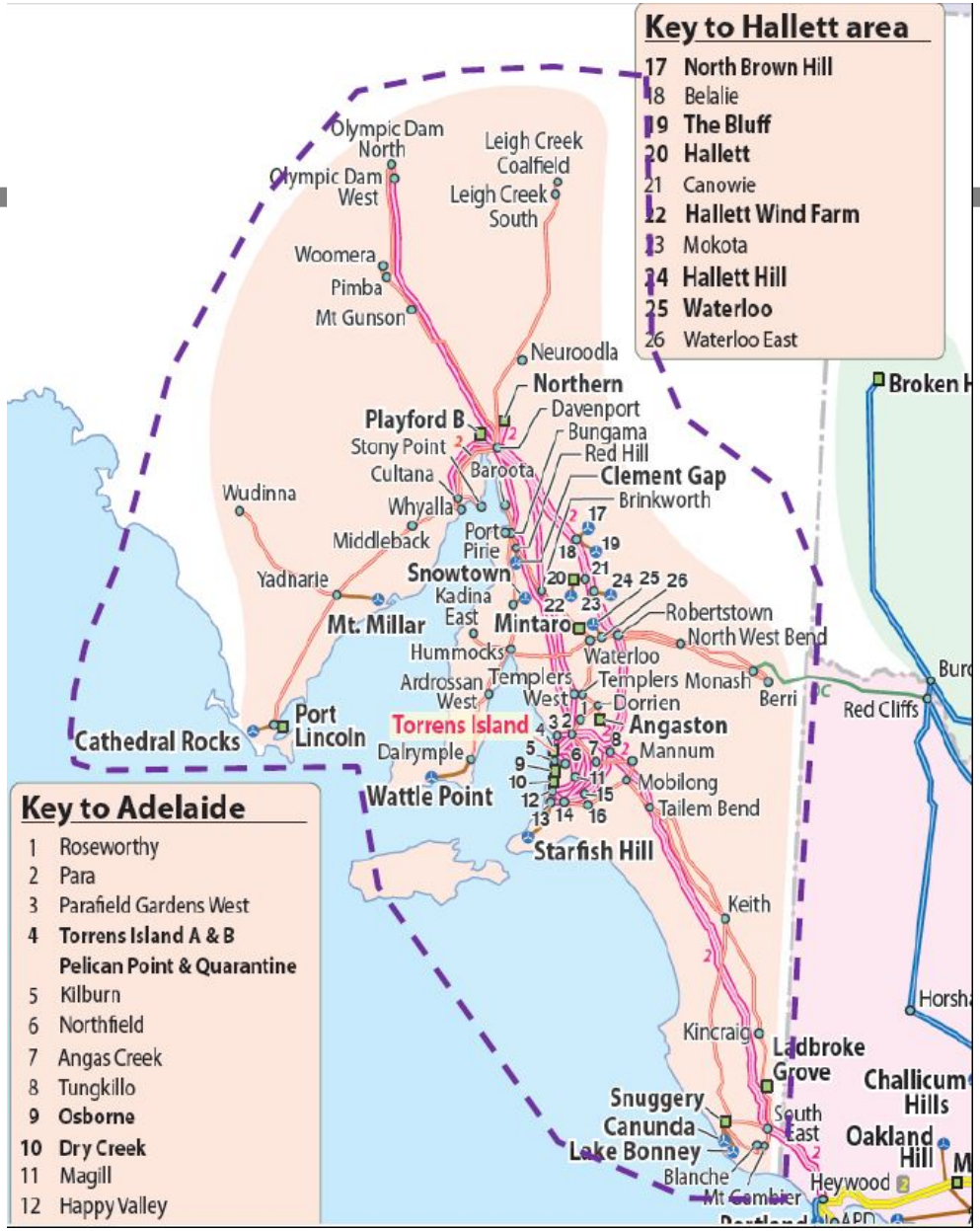
# Victoria - Restoration Curves and Draft Standard



# Victoria - Marginal Benefit of SRAS



# South Australia - Electrical Sub-Network



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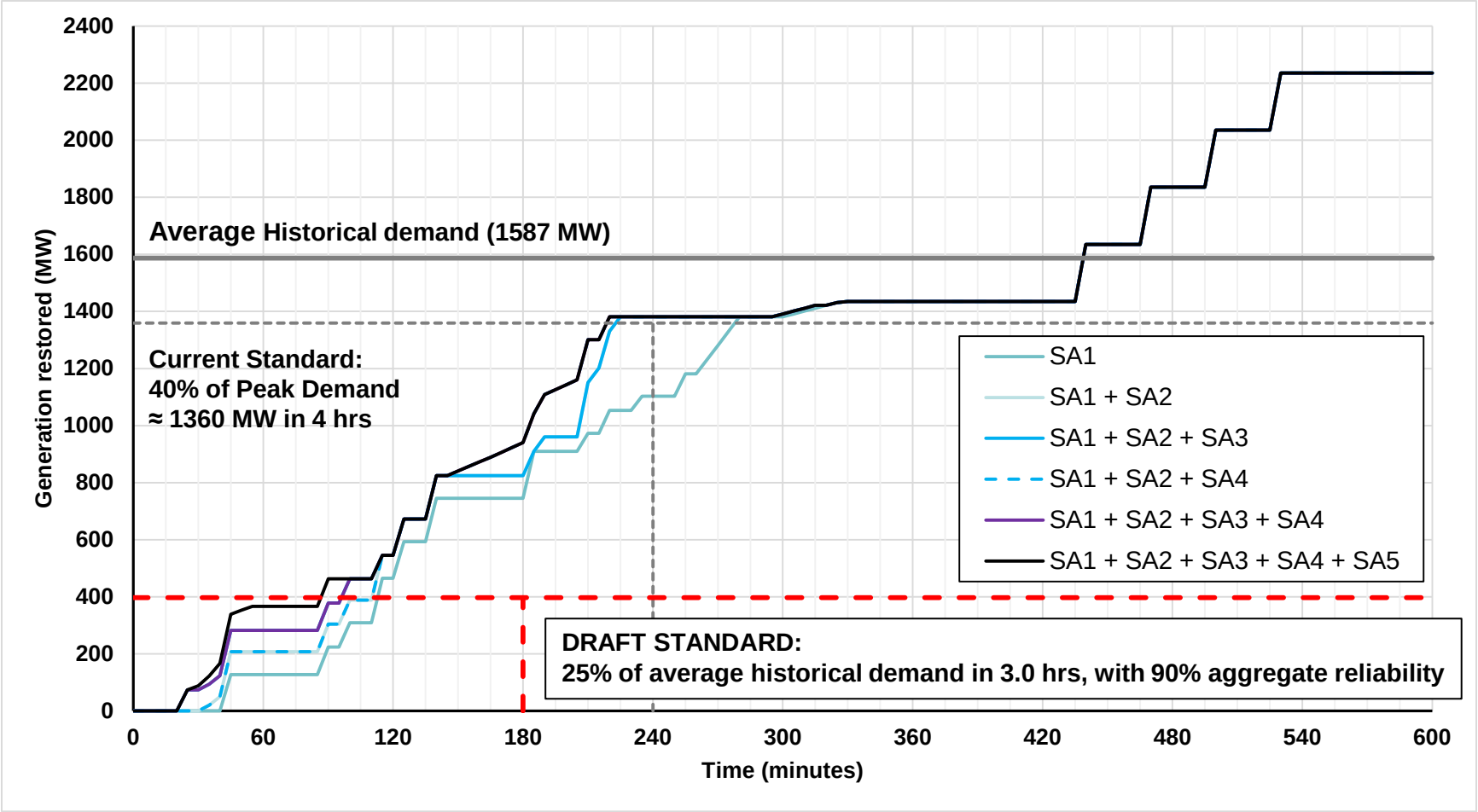

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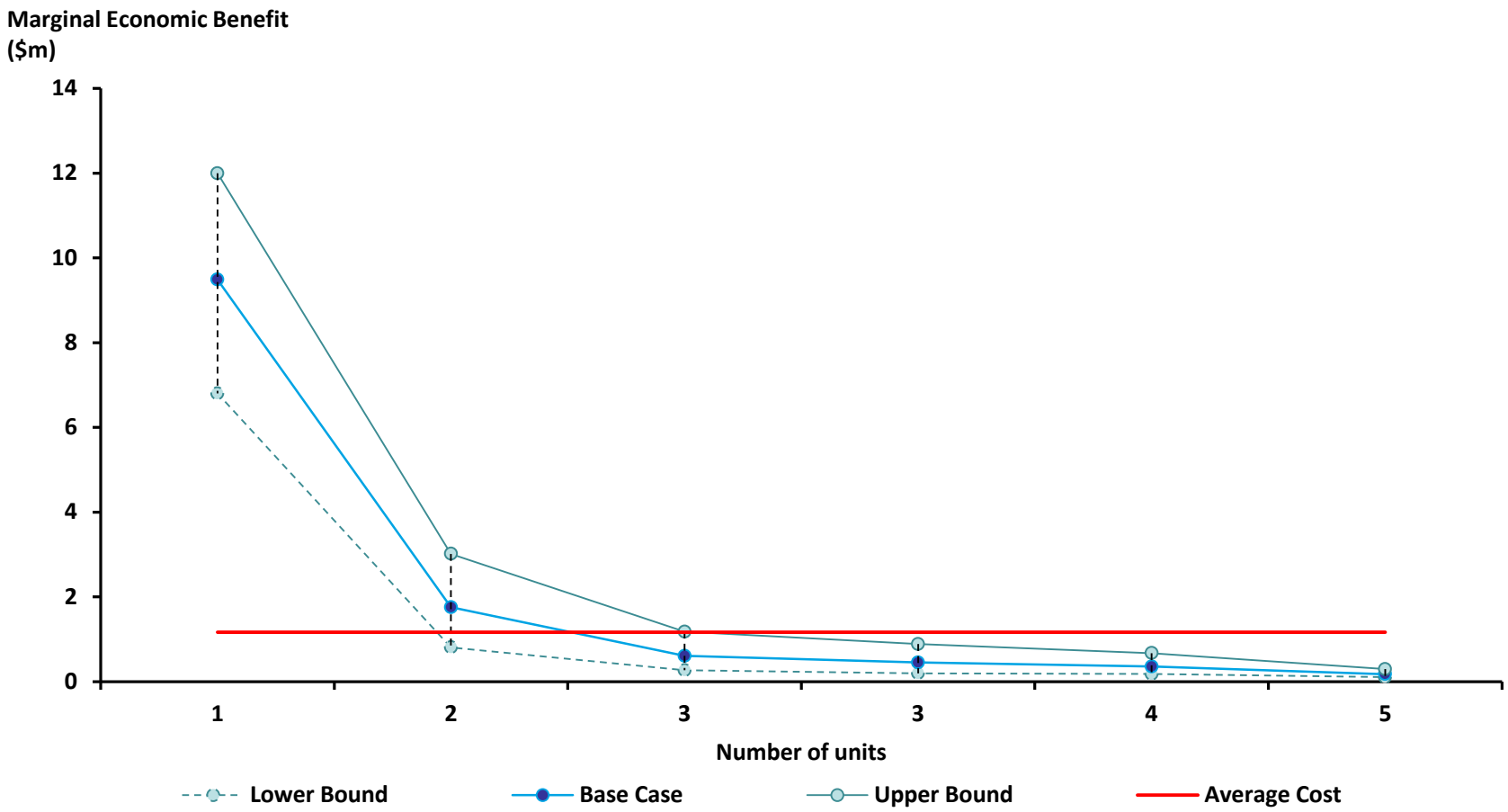
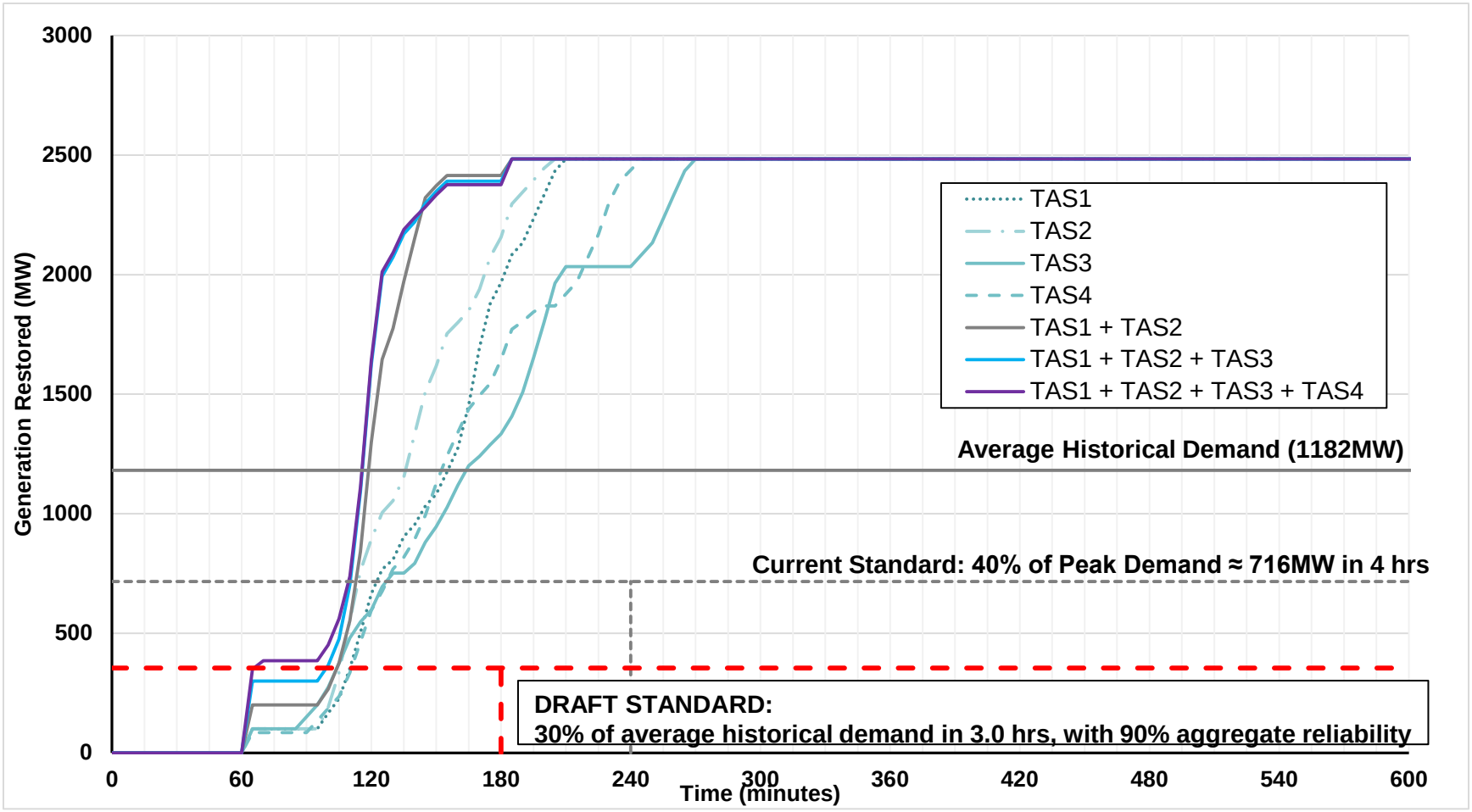


# Tasmanian Electrical Sub-Network

# Tasmania - Restoration Curves and Draft Standard



# Tasmania - Marginal Benefit of SRAS