Reliability Forecasting Methodology Workshop

Time	Agenda item	Discussion Lead
13:00	Welcome and introduction	Nicola Falcon
13:15	Demand forecasts	Magnus Hindsberger
13:45	Q&A session	Chair
14:15	Demand Side Participation	Magnus Hindsberger
14:30	Q&A session	Chair
14:50	Break	
15:00	Generation and transmission	Phil Travill
15:20	Q&A session	Chair
15:40	Calculation of reliability gap, reliability gap period and likely trading intervals	Nick Culpitt
16:00	Q&A session	Chair
16:45	Close	Nicola Falcon

Introduction

Nicola Falcon

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What’s not changing?

- The framework for producing the ESOO, and calculating USE to assess against the reliability standard remains unchanged.
- The **Reliability Standard Implementation Guidelines** continue to set out how AEMO implements the reliability standard, and the approach and assumptions AEMO uses in relation to:
  - Demand for electricity
  - Energy constraints
  - Treatment of extreme weather events
  - Reliability of generation
  - Intermittent generation
  - DSP and generation commitment
  - Network constraints

What's new?

- New **separate section** of the ESOO for the reliability forecast.
- New powers to source **additional information**.
  - Eg outage information and auxiliary supply information
- New oversight to improve **transparency** and **accuracy**
  - AER Best Practice Guidelines
  - Reliability Forecast Guidelines
  - Forecast Accuracy Report extended to include demand <u>and</u> supply, and key input drivers
  - Supplementary Materials (eg methodology reports, databases etc)
- New requirement to express the **reliability gap in MW**
  - only affects the POLR cost recovery mechanism.
- New requirement for a **one in two year demand forecast**.
- New metric of **actual demand** to determine trading intervals (TI's) subject to compliance
- New metric of **adjusted actual demand** for final compliance

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Demand forecasts

Magnus Hindsberger

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AEMO’s demand forecasts

- Forecasts of annual consumption and maximum demand by NEM region are critical inputs into AEMO’s reliability forecasts.
- The five-year reliability forecast only considers AEMO’s central scenario, but:
  - The ESOO ten year outlook will consider alternative scenarios
  - It should be noted that the differences between scenario outcomes are relatively small in the 1-5 year horizon

Maximum demand distributions

- Actual maximum and minimum demand outcomes for a particular summer or winter season vary significantly depending on:
  - Calendar effects (months, type of day, time of day)
  - Weather conditions (temperature, cloud cover, humidity, heat build-up)
  - Coincidence of consumption (the extent of how many are home at the same time, and what they do – affected amongst other things by TV programs)

- To reflect the uncertainty, AEMO forecasts maximum and minimum demand forecasts as distributions
  - 10%, 50%, and 90% probability of exceedance (POE) forecasts given for each region.

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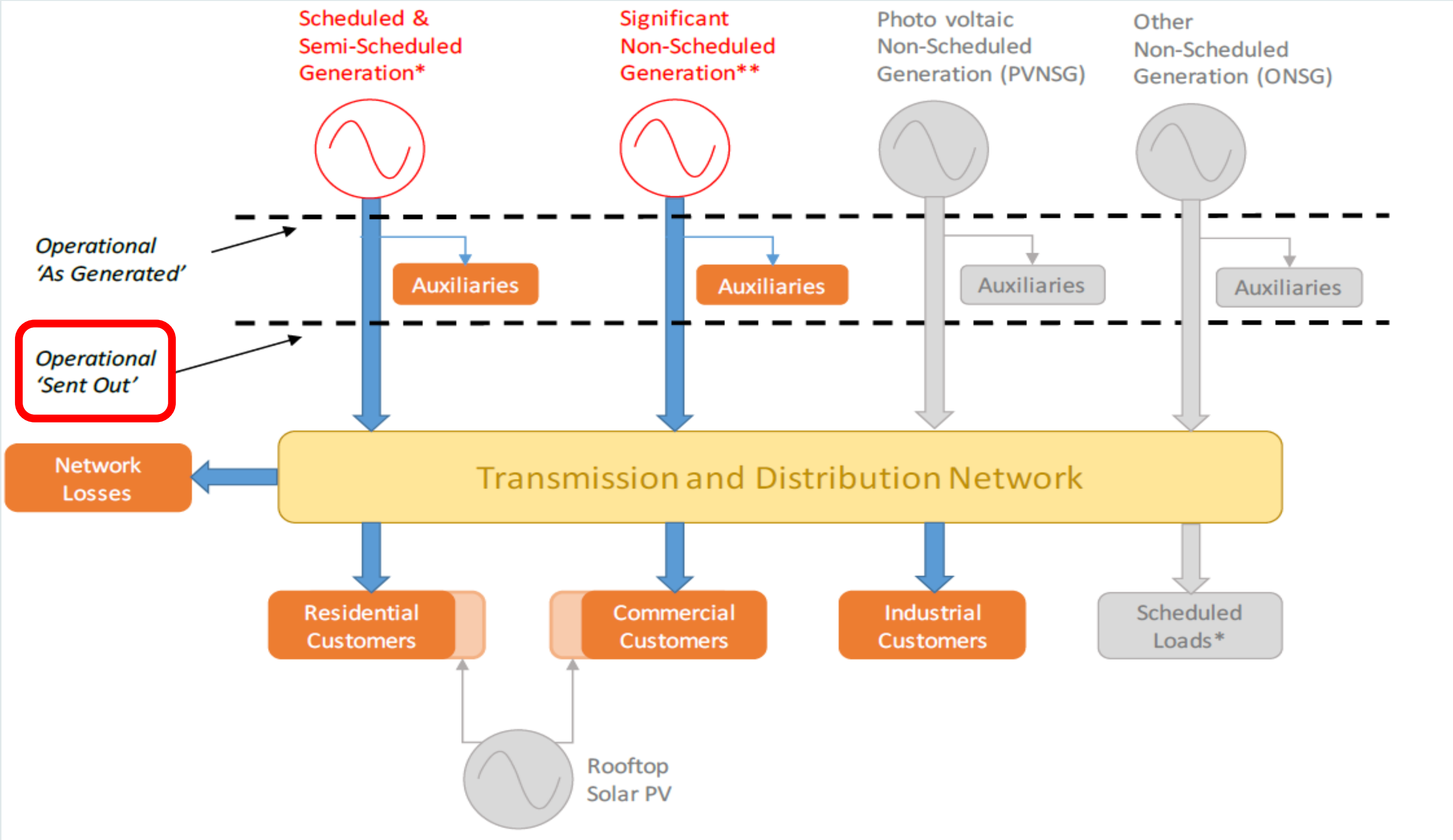
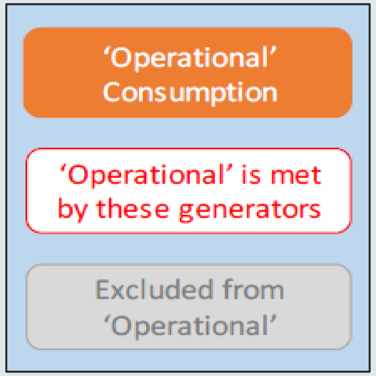
Demand forecast in reliability forecast

- As input into the reliability forecast, and eventual trigger for a reliability instrument request at T-3 and T-1 AEMO uses Operational – Sent out demand.





1-in-2 year peak demand

- AEMO must publish a 1-in-2 year peak demand forecast as part of the reliability forecast.
  - This represent the level of demand that is likely to be exceeded once in any two-year period.
  - This value is not used for the reliability forecast (as driver for a T-3 or T-1 reliability instrument request), but will function as a baseline for contracting requirements during reliability gap periods.
- AEMO will use 50% POE operational forecast, converted from 'sent out' to 'as generated' forecast auxiliary load, as the 1-in-2 year peak demand forecast.
- The use of 'as generated' will allow stakeholders to readily compare against demand in real time, because actual historical demand is reported ongoing by AEMO using this point of measurement.

Demand forecast improvements in 2019

- For the 2019 ESOO, AEMO is implementing a number of enhancements to its demand forecasts, in particular:
  - Improved business sector consumption forecast
  - Hybrid maximum/minimum demand forecasting methodology
  - Minor improvements to non-scheduled generation:
    - Forecast (and historical) generation of PV non-scheduled generation
    - Potential move of thermal peakers from ONSG forecast to DSP forecast
  - Potential update to energy efficiency at time of extreme temperatures

- This is in addition to refresh of all key input data, including connections, economic growth, PV uptake, energy efficiency, etc.

Large industrial loads

- Changes in large loads can have just as big impact as that of a major generator.
- For the reliability forecast, AEMO will only include new loads or the closure of existing this if there is a formal commitment by the owner.

Distributed Energy Resources

- In preparation for the 2019 demand forecasts, AEMO has got two consultancies to deliver:
  - Installed capacity projections for PV, ESS and EVs.
  - Half-hourly charging/discharging profiles of ESS
  - Half-hourly charging of EV
  - Share of ESS systems aggregated as VPP over time

- Draft forecasts have been presented to industry through AEMO's FRG.

- AEMO is in the process of reviewing final forecasts.

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Distributed Energy Resources: T-3 and T-1 reliability forecast

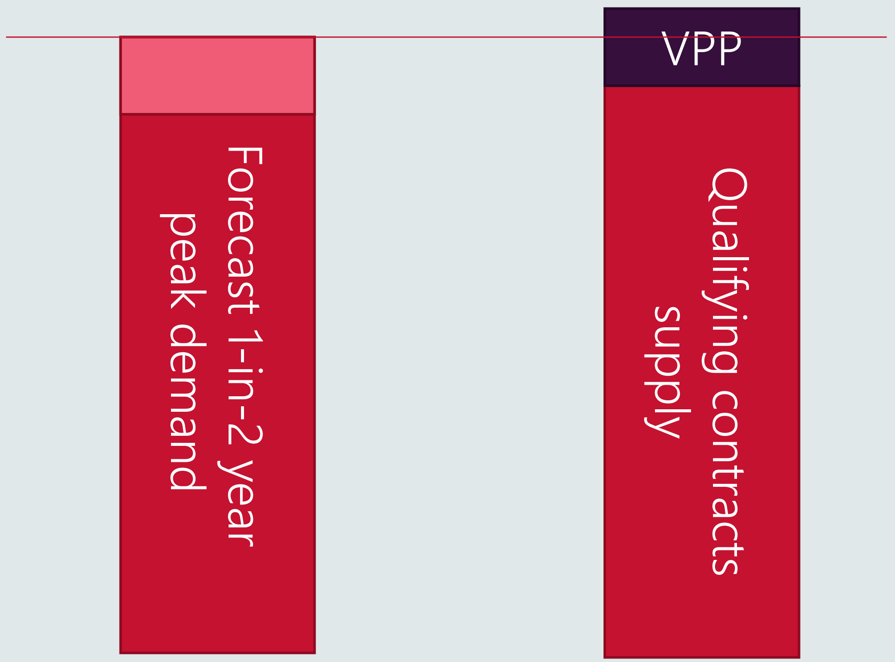
- For the reliability forecast potentially triggering T-1 and T-3 reliability instrument requests, AEMO will use its existing methodology, with the following updates to better represent DER:
  - Improved traces of PVNSG calculated by AEMO based on historical solar irradiation.
  - Traces* of ESS charging/discharging profiles provided by AEMO's consultants.
  - Traces* of EV charging profile provided by AEMO's consultants.

* Note that the ESS and EV traces will take local PV generation (if any) into account.

- VPP will be excluded from the traces, but instead modelled as a large-scale storage fully optimised to minimize USE.

Distributed Energy Resources: 1-in-2 year peak demand

- For the 1-in-2 year peak demand forecast, AEMO will exclude any ESS operated as VPP, as it is assumed there will be qualifying contracts that liable entities have with this resource to meet its share of peak demand.



Demand traces

- For the T-3 and T-1 assessments in the reliability forecast, expected unserved energy (USE) will be assessed based on the weighted outcomes of the market simulations using demand traces growth to 10% and 50% POE demands.
- Demand traces are created from different 8 historical reference years:
  - Grown so annual energy consumption matches forecast consumption.
  - The top demand days in Summer/Winter are scaled, so the peak day matches either 10% or 50% POE target for that region for that season.
  - Weekdays and public holidays shifted in future years to remain consistent with calendar.
- Traces are grown net of PV, ESS and EVs and effects of these are then added in the end.
- Supply traces are based on same years using consistent data for wind, solar and temperature.

Questions

- Are there further clarifications needed around the proposed demand definitions for use in the reliability forecasting process and the 1-in-2 year peak demand?
- Is AEMO's position on commitment criteria for new large loads (or closure of existing) understood?
- Has AEMO provided sufficient detail in how it will account for distributed energy resources in its modelling?
- Is there any need for clarifications around AEMO's demand traces used in the reliability forecasting process.

Demand side participation

Magnus Hindsberger

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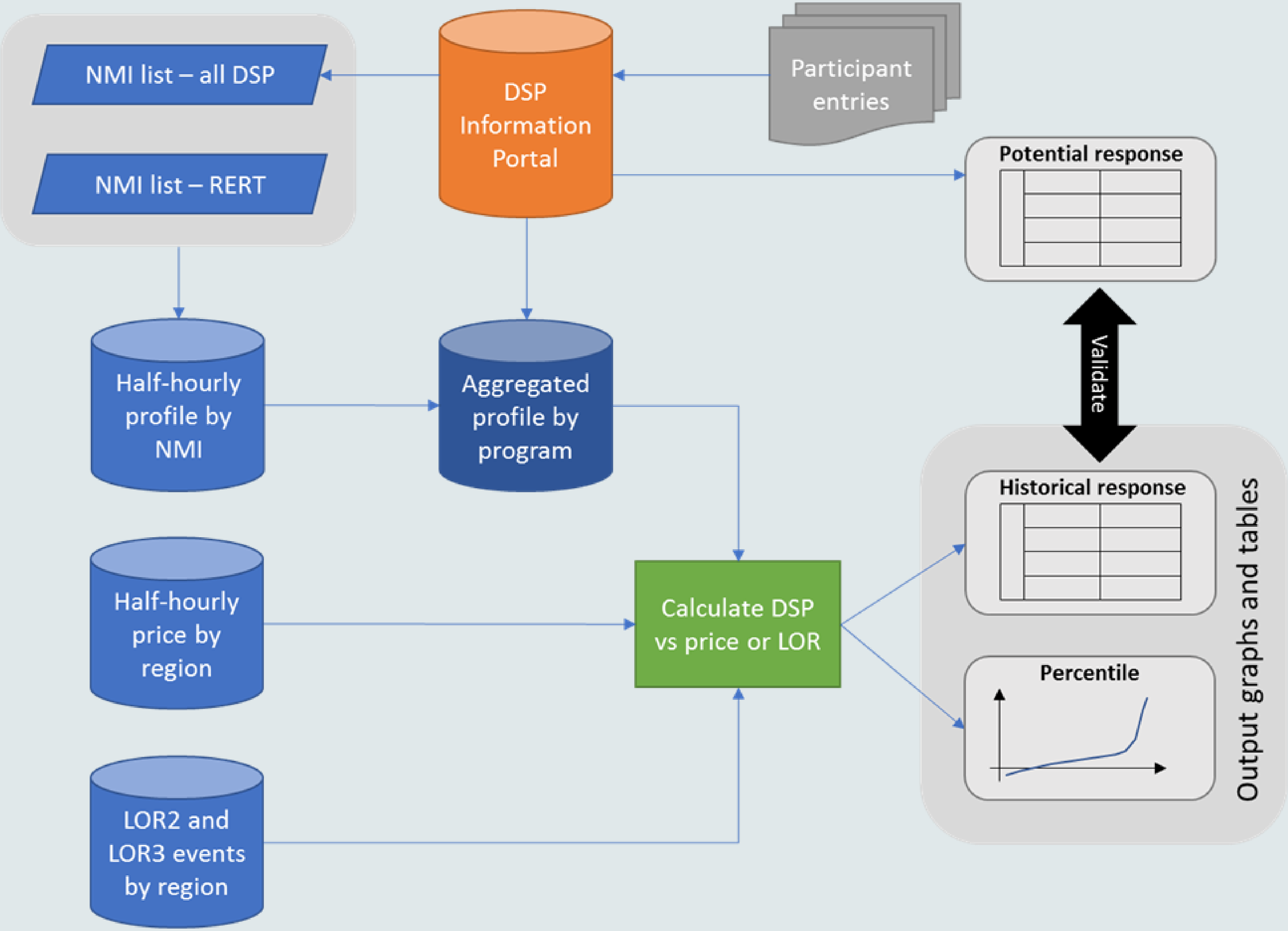
Demand Side Participation

- In forecasting context AEMO generally refers to demand side participation (DSP) when discussing the occasional (not daily/regular) response by consumers to price or reliability signals.
- AEMO’s maximum demand forecast represents demand in the absence of any DSP (or load shedding). Instead, DSP is represented as a resource to ensure supply can meet demand.

- AEMO therefore focusses on DSP from the occasional responses, though it is building up the analytical framework to study the use of daily DSP, such as hot water load control, time-of-use tariffs). This will allow AEMO to assess the current impact of such initiatives, whether capability is trending up or down, and potential impact of tariff changes.

AEMO's process for estimating existing levels of DSP in the market



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DSP triggers

AEMO estimates DSP responses for two different trigger types:

- Price triggers – the responses are estimated for when prices exceed different price levels. AEMO models the price triggers \$300/MWh, \$500/MWh, \$1,000/MWh, \$2,500/MWh, \$5,000/MWh, and \$7,500/MWh.

- Reliability triggers – the responses are estimated for periods with actual Lack of Reserve (LOR) 2 and LOR 3 events.

DSP response during trigger periods

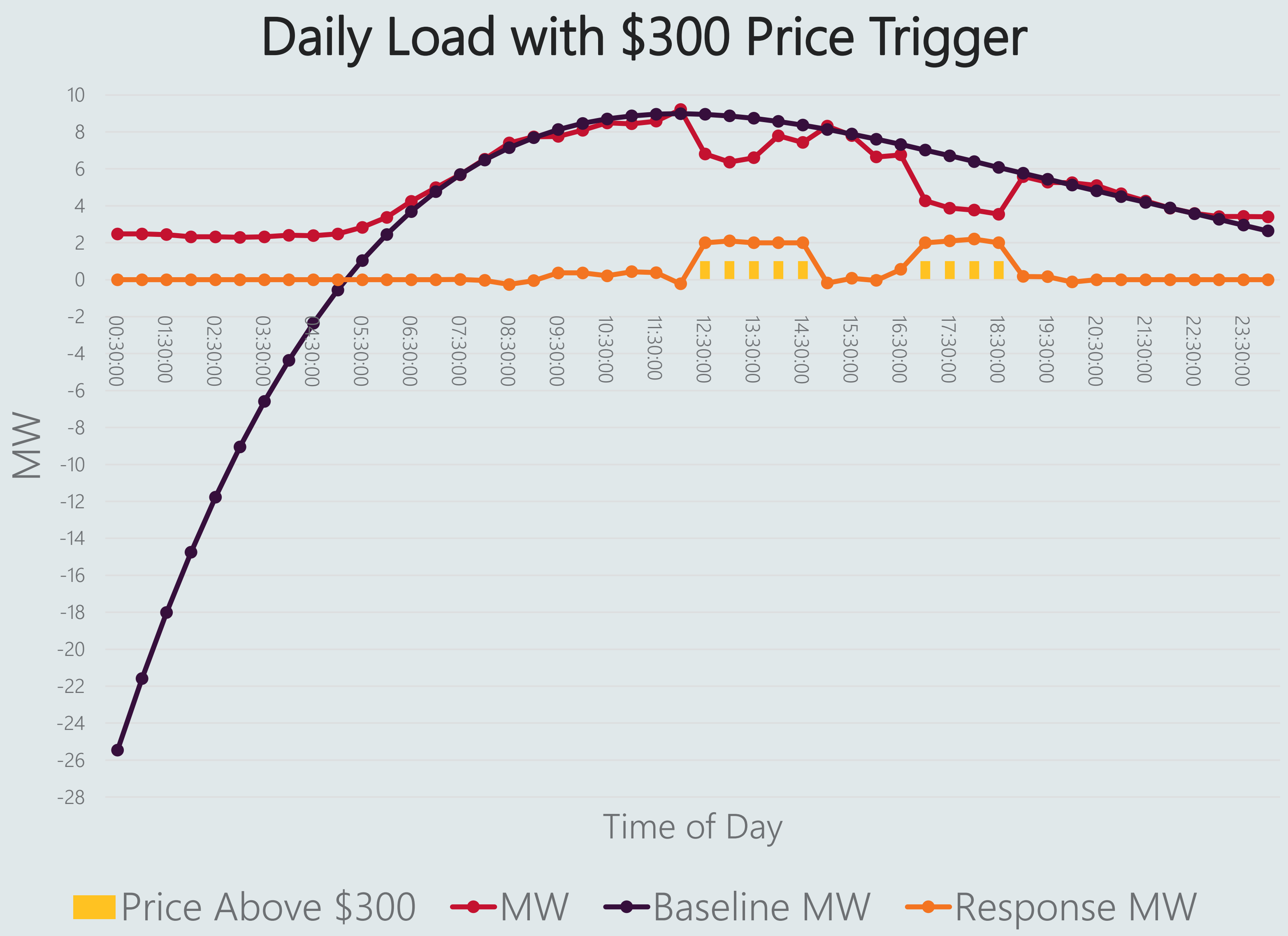
The response during the trigger period is found as:

$$DSP\ response = baseline\ energy - actual\ energy$$

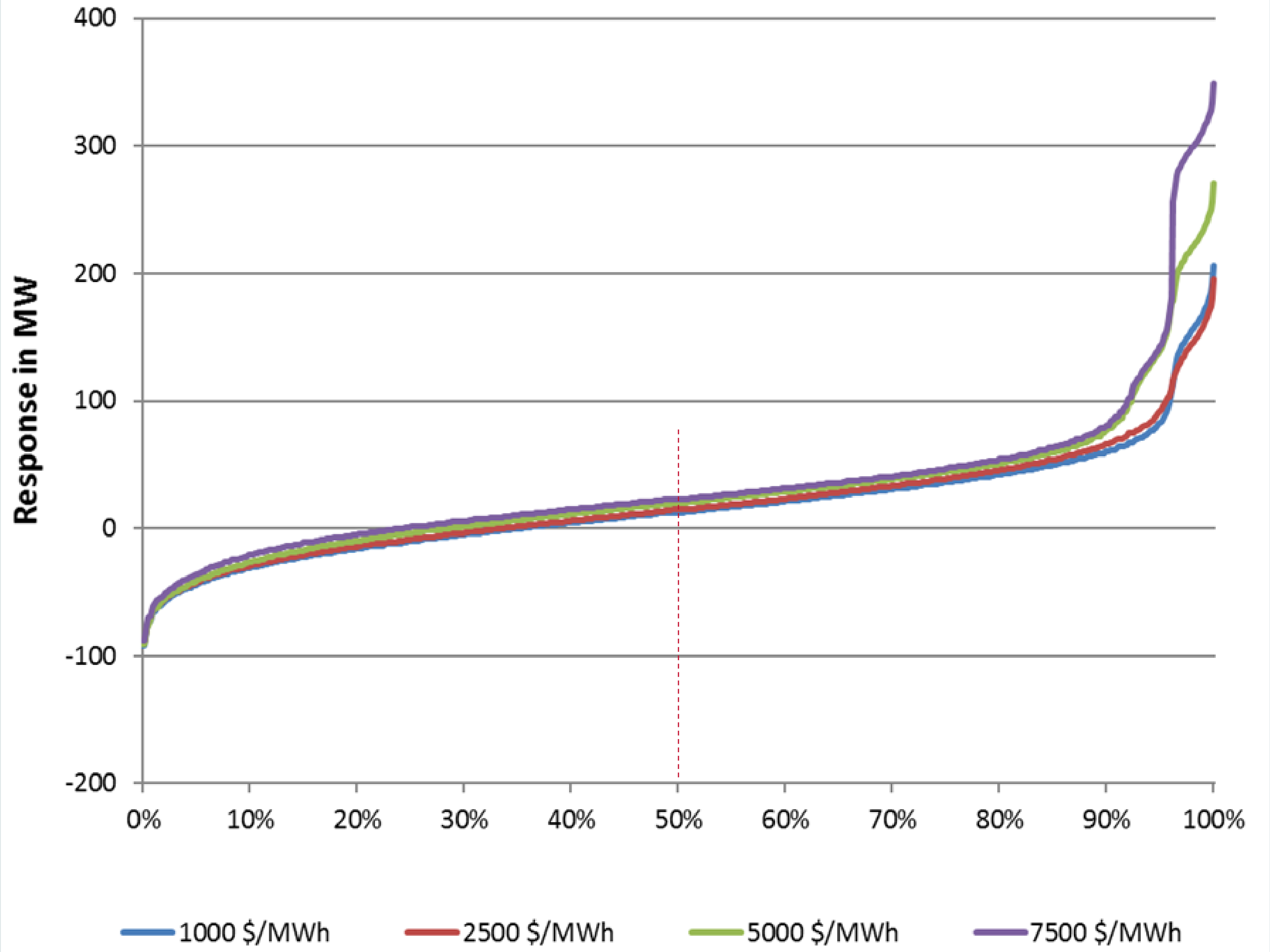
where a positive number reflects DSP lower consumption from the grid.

Example of DSP response calculation

Daily load with price above $300 trigger.



Example of DSP response to different price levels (percentiles of observed response)



AEMO uses the 50th percentile outcomes in its estimate of the current level of DSP responses for the different price bands.

From observed DSP to forecast DSP

- Forecast DSP is mainly derived from observed historical response, for example:

	NSW	QLD	SA	TAS	VIC
$300/MWh	77.7	32.5	1.2	5.6	28.4
$500/MWh	78.0	32.8	2.1	18.8	31.4
$1000/MWh	78.0	33.9	2.1	19.3	33.0
$2500/MWh	91.5	40.3	2.1	21.5	33.0
$5000/MWh	97.2	40.3	5.4	21.5	33.0
$7500/MWh	105.0	40.3	6.4	21.5	33.7
Reliability	105.0	66.4	6.4	23.2	77.2

50th percentile response for each price level used as forecast

Adds additional response from network reliability programs where available

Latest DSP (summer) forecast from March 2018 :

- AEMO use forecast "Reliability DSP" in its reliability forecast for T-3 and T-1.
- Participants can count qualifying contracts with DSP when comparing against their share of 1-in-2 year peak demand.

Questions

- Are there any questions for clarification on the definition of DSP?
- Is it clear how AEMO proposes to use DSP in the reliability forecast?

Generation and Transmission inputs

Phil Travill

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RRO Principles

- **Improved data for better accuracy:**

  Forecasts should be as accurate as possible, based on comprehensive information and prepared in an unbiased manner.

- **Conservatism in the long-term:**

  If overly optimistic at T-3, there is no opportunity for recourse.
  If more cautious (i.e. only include inputs with greatest certainty), by T-1 AEMO will have more accurate data which will be used to determine whether a T-1 reliability instrument will be issued

Generator Inputs

New entrants, auxiliaries and forced outages.

Key generator inputs

- **New generator entry:**

  In the 2019 ESOO, AEMO will not include generators that are Com*

  - i.e. projects that have commenced construction but do not meet all of AEMO's commitment criteria.

- **Generator Auxiliaries:**

  AEMO models generator capacity on an as-generated basis and takes into account auxiliary load in meeting sent-out demand. AEMO will include the proposed auxiliary rate in a letter to each generator and provide the ability for generators to propose different auxiliary rates.

Forced Outage Rates – data collection

- Market participants are required to submit 'Forced Outage' data to AEMO annually for each generator unit.
- AEMO use this historical data to calculate 'Forced outage rates', 'Partial outage rates', 'Partial deratings' and 'mean times to repair' to input into our model.
- AEMO requested outage information in April and are currently processing this data.

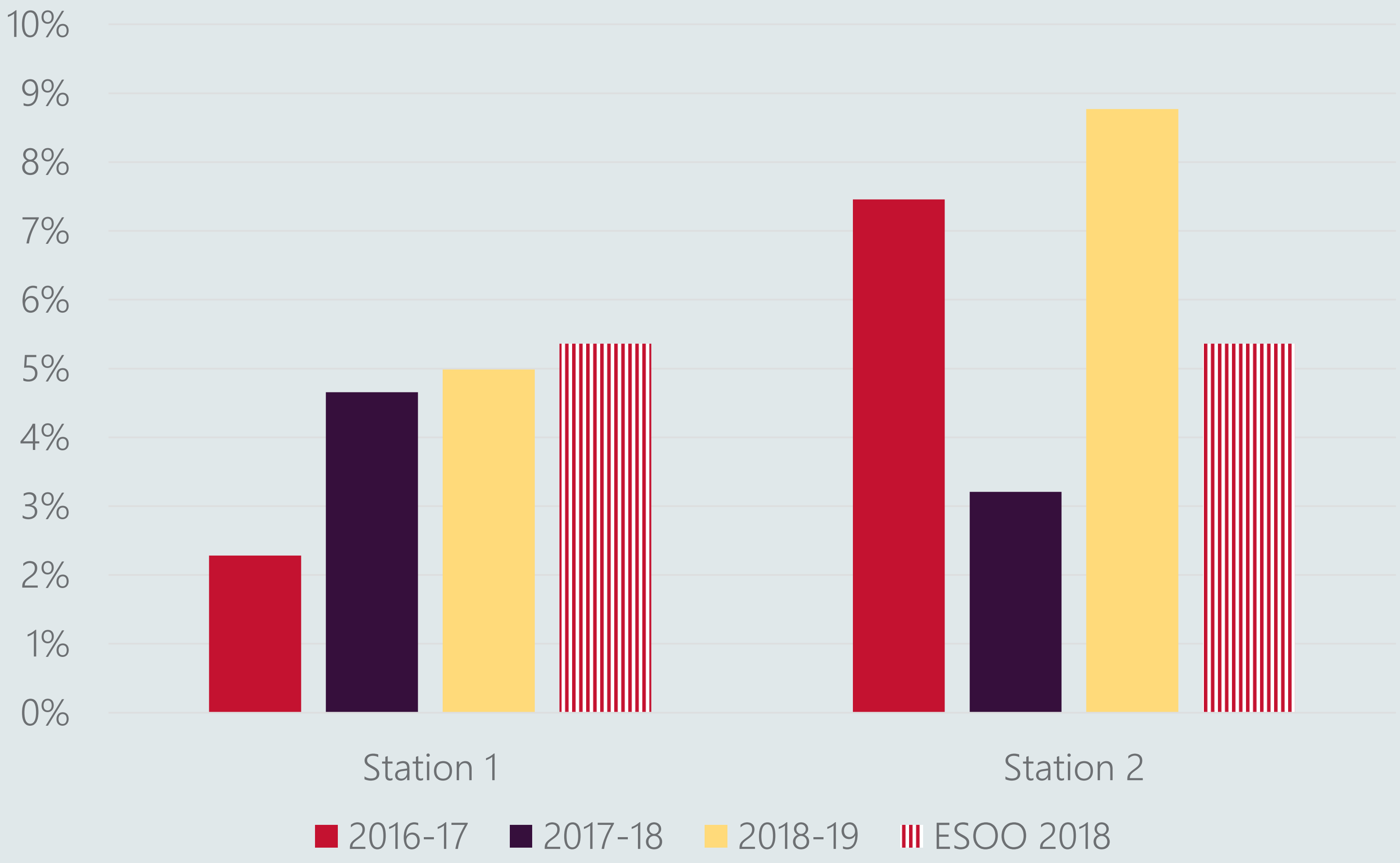
Forced Outage Rates – outline of new approach

- Previously AEMO has used FOR data calculations based on aggregations by fuel types and averaged across multiple years of data.
- In the 2019 ESOO AEMO will be using FOR data based on 3 separate years and having large thermal generators use their station level rates.
- This will allow modelling to capture a broader range of outcomes observed historically.
- To protect the confidentiality of this data, AEMO will only publish calculated outage parameters on a technology aggregation level

Example FOR calculations

- Shows Full Forced outage for 2 stations of same fuel type using old and new method
- The rate used for each simulation will be consistent across all generators
- Same calculation methodology is applied to partial and mean time to repair values
- Each rate will have even weighting across the simulations

Sample FOR using ESOO 2019 methodology compared to ESOO 2018



Forced Outage Rates – revising calculated rates

- The participants will be provided the opportunity for the estimated outage rates to be revised for any future year of the outlook period
- If an alternative outage parameter is accepted, AEMO will use this instead
- For example, if a station had historical outage rates over the past three years of 3%, 5%, and 7%, but a new average outage rate of 3% is accepted by the AER, the outage rates applied in the model would be 1.8%, 3%, and 4.2% respectively
- If instead the proposal that is accepted is to replace the 3rd year with a 4% outage rate, outage rates of 3%, 5% and 4% will be applied.

Transmission Network

Interconnectors and network constraints

Modelling the transmission network

- The reliability forecast will include all existing interconnectors and committed transmission augmentations and lines that have successfully passed the Regulatory Investment Test for Transmission (RIT-T).
- AEMO applies network constraint equations to model thermal and stability constraints. These constraint equations factor in the impact and timing of any inter-connector and intra-regional transmission augmentations.
- Interconnector loss functions will be applied based on the inter-regional loss factor calculation published in AEMO’s latest Regions List and Marginal Loss Factors report.

Network outages

- In addition to modelling system normal transmission constraints, AEMO include the impact of a number of key unplanned transmission line outages or deratings which affect inter-regional transfer capability.
- Outage rates are based on historical analysis. The 2018 ESOO applied outages rates to the following key flow-paths:
  - Dederang to South Morang
  - Heywood to South East
  - Basslink
- The rates used in the 2018 ESOO were relatively low and had minimal impact on expected USE.

Questions

- Is the approach whereby only projects that meet AEMO's commitment criteria will be included in the Reliability Forecast clear?
- Is the approach for modelling variable forced outage parameters explained in sufficient detail?
- Is the ability for generators to provide alternative parameters well understood?
- Does any additional detail need to be provided in understanding AEMO's approach to modelling the transmission network?

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Data and Information:

MLF and IC loss information:
https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Loss-factor-and-regional-boundaries

Generator Information Page: New Entrants and generator capacity ratings
https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/Generation-information

RRO Issues Paper:
https://www.aemo.com.au/Stakeholder-Consultation/Consultations/Reliability-Forecasting-Methodology-Issues-Paper

2018 ESOO:
https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Planning-and-forecasting/NEM-Electricity-Statement-of-Opportunities

Reliability gap calculations

Nick Culpitt

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USE forecast

- Core input to the reliability gap calculation is the expected USE for each region on a financial year basis.
- Reliability gap calculations will be based on the Neutral/Central scenario only.
- USE is calculated as an expectation by weighting on:

  - Peak demand probability of exceedance (POE)
    - Weightings of 30.4% and 39.2% for 10% POE and 50% POE respectively (remainder is assumed to be 0 as a substitute for modelling 90% POE demands).
  - Reference year
    - Demand/wind/solar based on historical weather patterns over the past 8-9 years.
    - All equally weighted

What is included in the reliability forecast?

- AEMO's forecast of unserved energy (USE) for the reliability forecast gap period:
  - The forecast reliability gap period (start and end date)
  - The likely time of occurrence of the shortfall, specified as trading intervals

    eg: The trading intervals between 13:05 – 22:00 (ending) each weekday during the forecast reliability gap period
  - The size of the gap, expressed in MW

Reliability gap period and trading intervals

Proposed method for determining the start and end date of the Reliability gap period, and relevant trading intervals:

- For T – 3 instrument request:
  - Start date and End date: Months with LOLP > 5% (including any single month where LOLP is < 5%)
  - Likely trading intervals:
    - For each month, include weekends if LOLP in that month > 2%
    - Time-of-day: between the first and last trading interval times where LOLP exceeds 2%

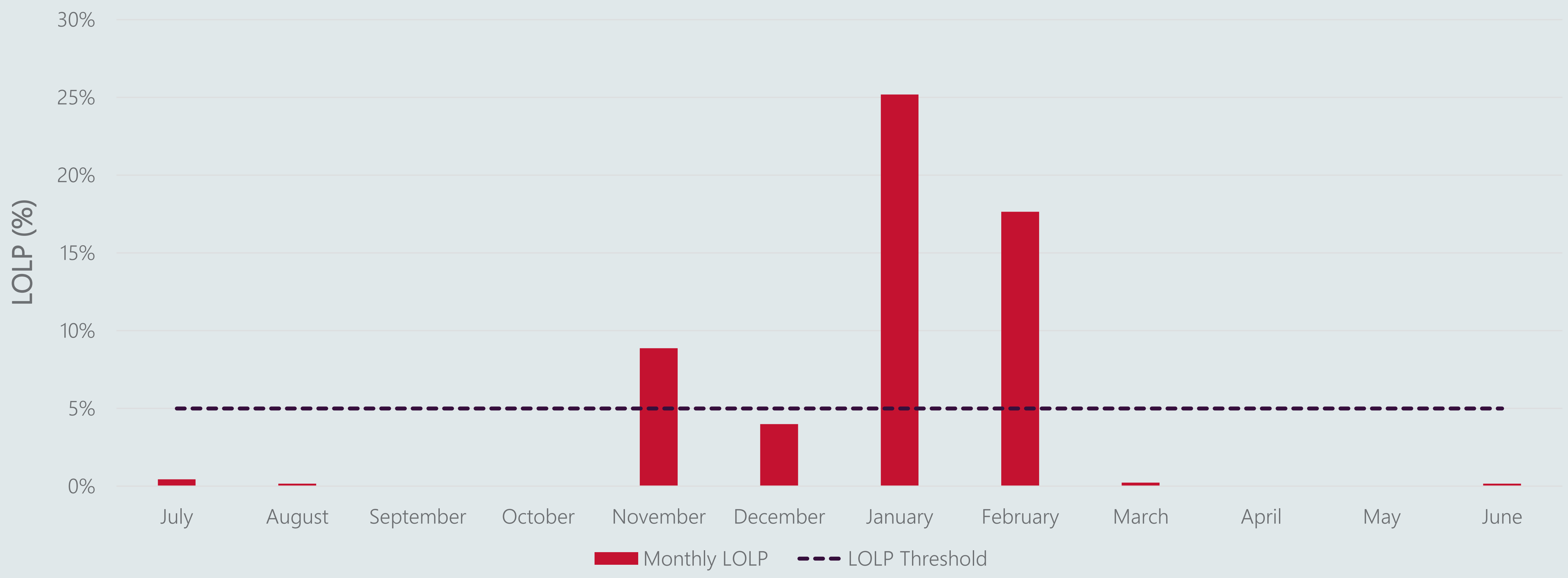
- For T – 1 instrument request:
  - Start date and End date: Months with LOLP > 5% (including any single month where LOLP is < 5%)
  - Likely trading intervals:
    - For each month, include weekends if LOLP in that month > 5%
    - Time-of-day: between the first and last trading interval times where LOLP exceeds 5%

Meaning of LOLP

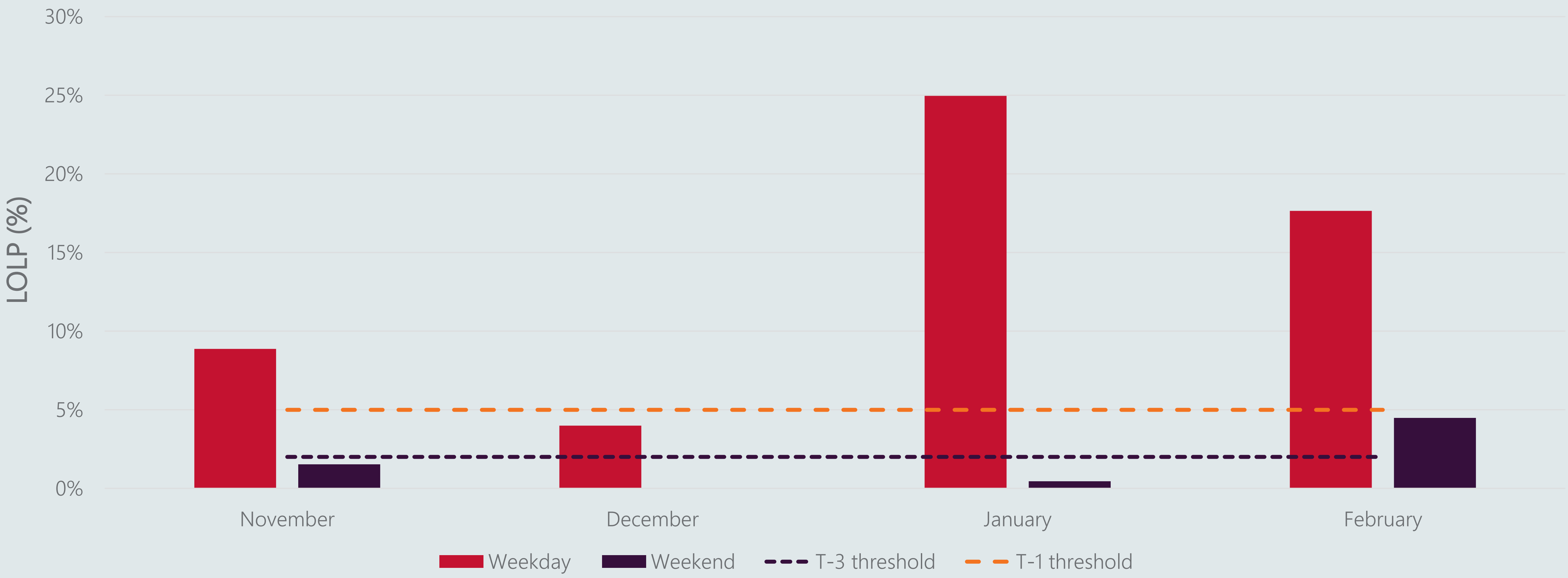
- The LOLP referred to in this methodology is a measure of the likelihood of any USE occurring in a given month, time-of-day period or weekend.
- For example, the LOLP for January is calculated as:
  - For each POE and reference year, calculate the number of samples which had any USE in January and divide this by the number of samples.
  - Weight POEs and reference years using the approach described for USE.

The LOLP is therefore a measure of likelihood, and does not consider the severity of any load shedding that occurs within the specified period. LOLP has been found to be more stable to minor changes in supply/demand than other measures such as USE percentage.

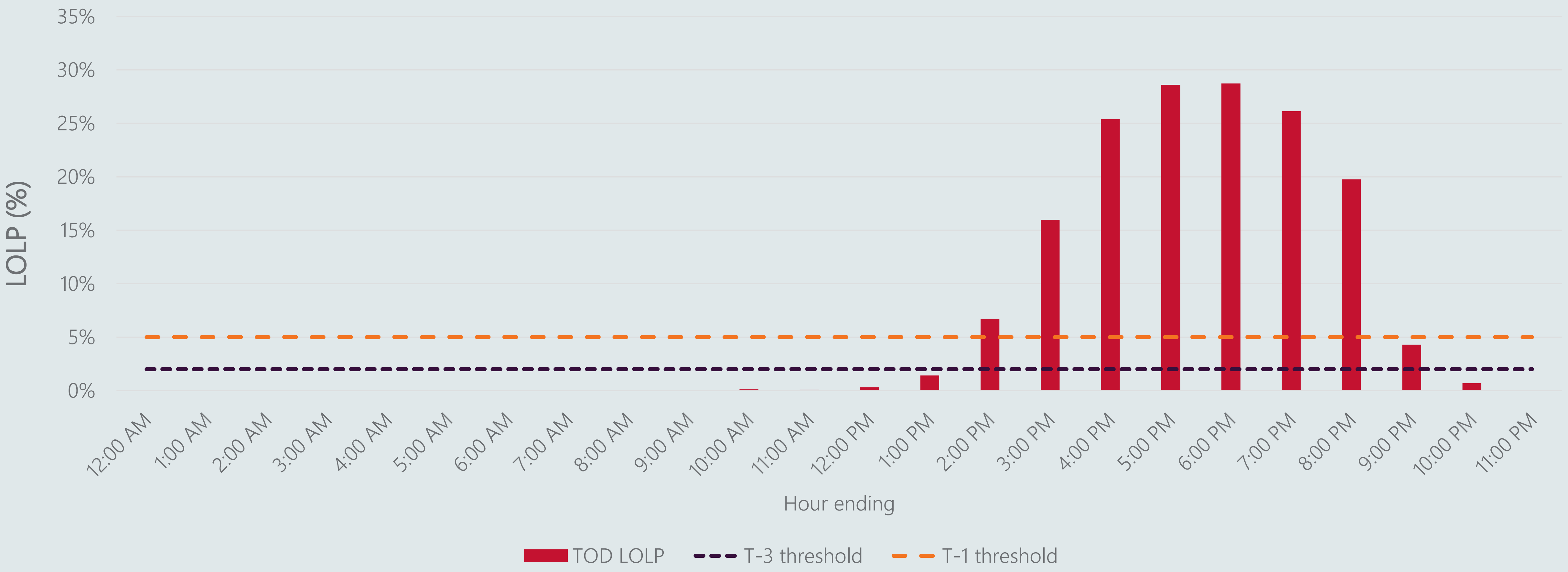
Example – start/end date



Example – start/end date



Example – trading intervals



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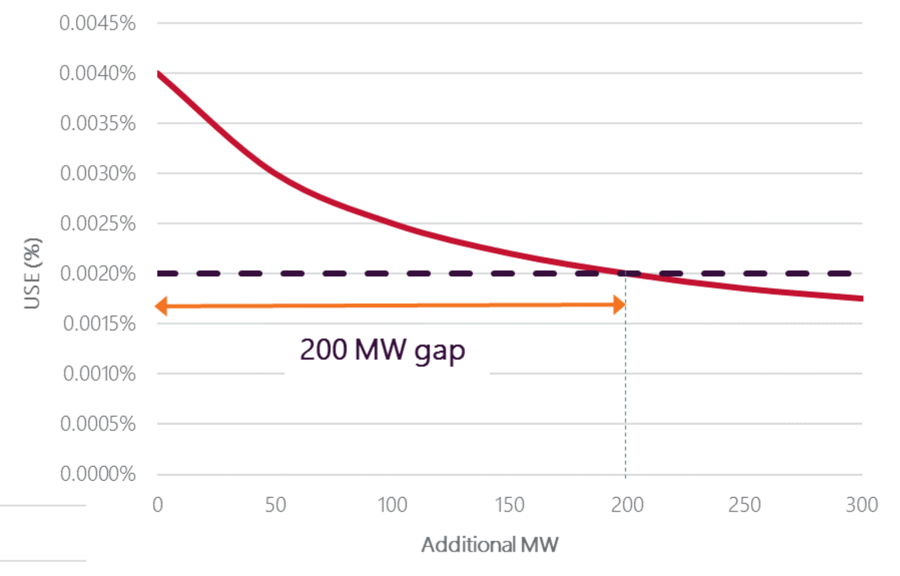
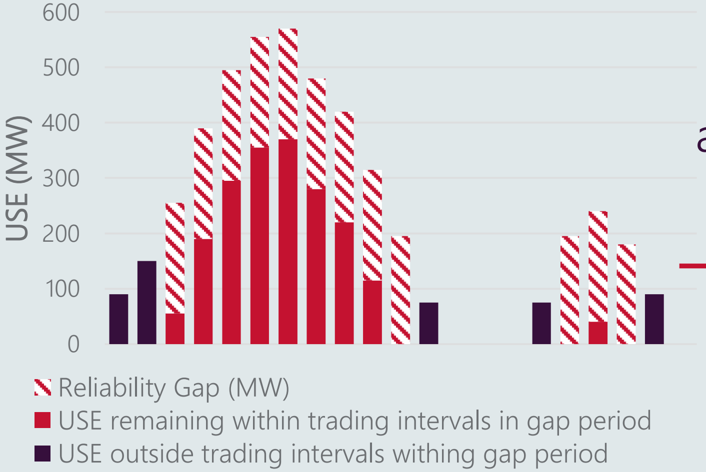
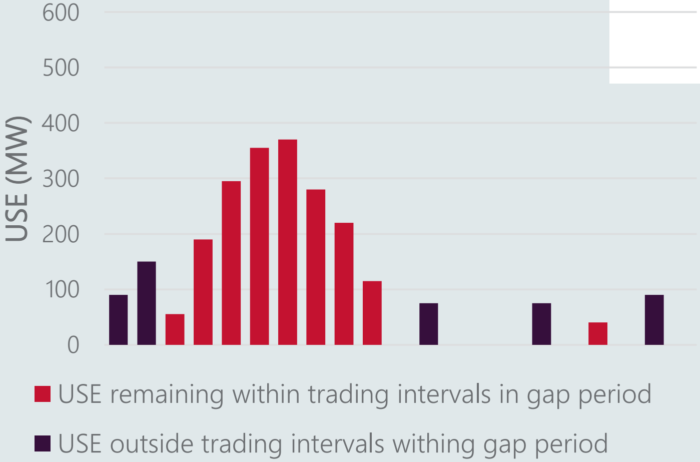
Calculating the size of the gap (in MW)

- Based on additional firm capacity required to reduce USE to the level of the reliability standard..
- Will be determined for each region separately, based on effect of additional capacity in reliability gap period on USE in each interval in each Monte Carlo iteration:





Effect of additional MW



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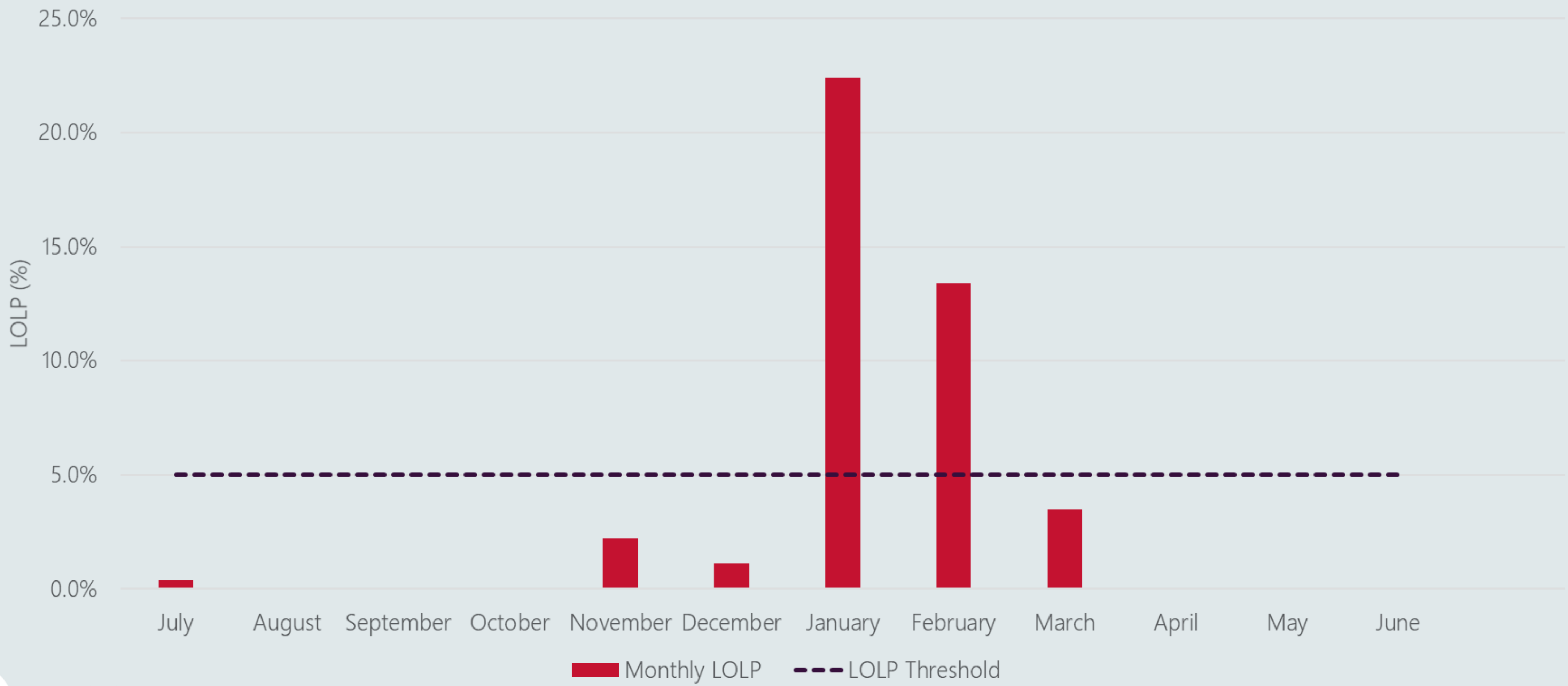
Victoria 2018-19



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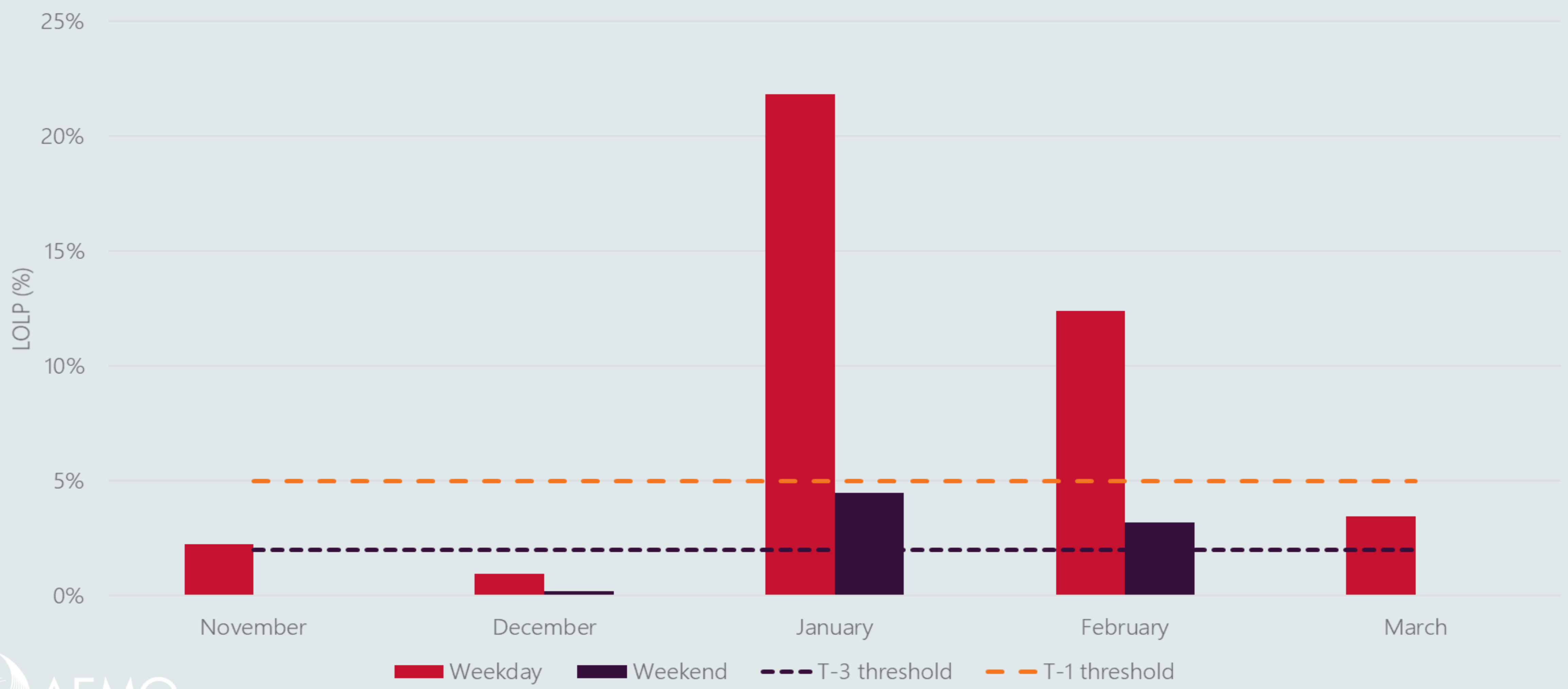
Victoria 2018-19



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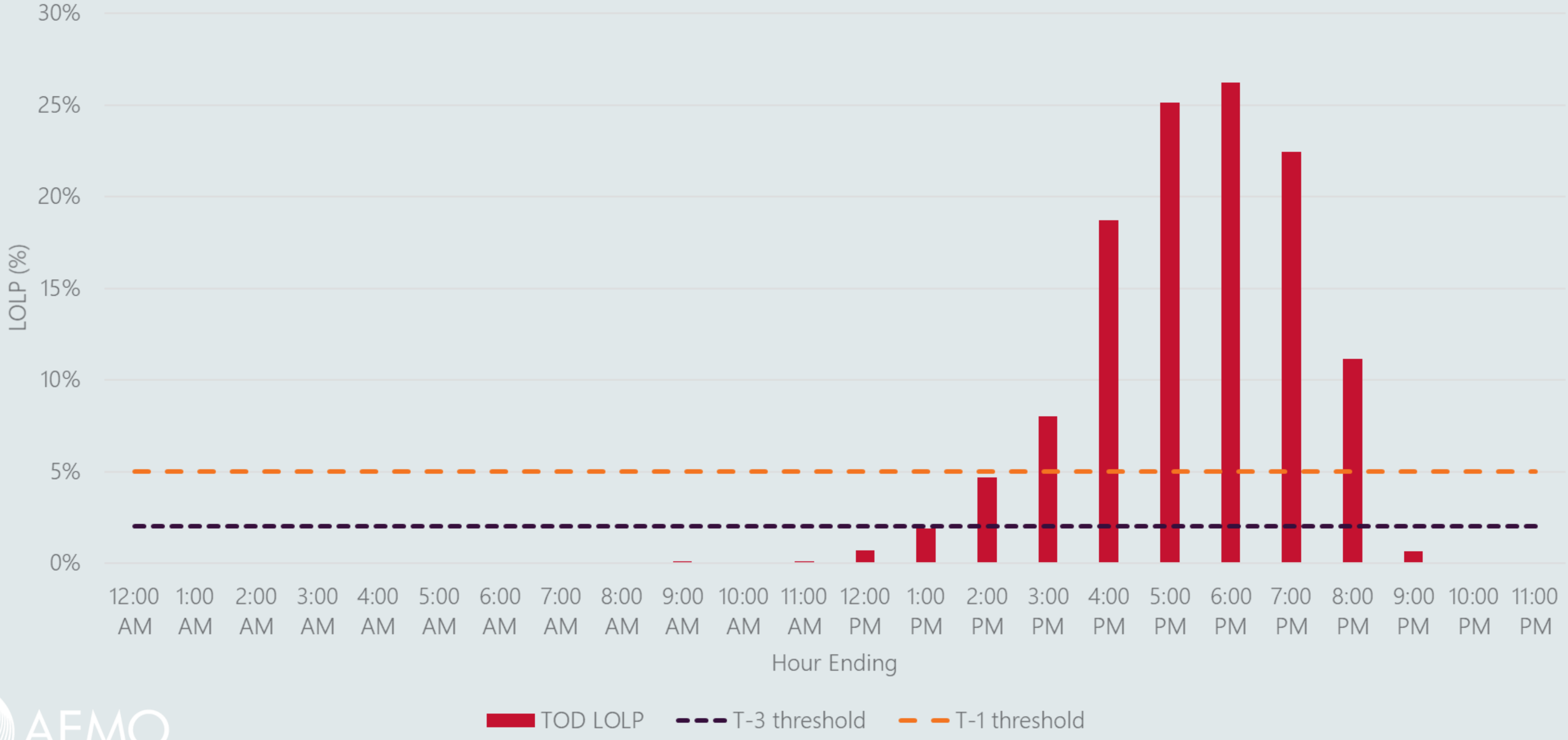
Victoria 2018-19



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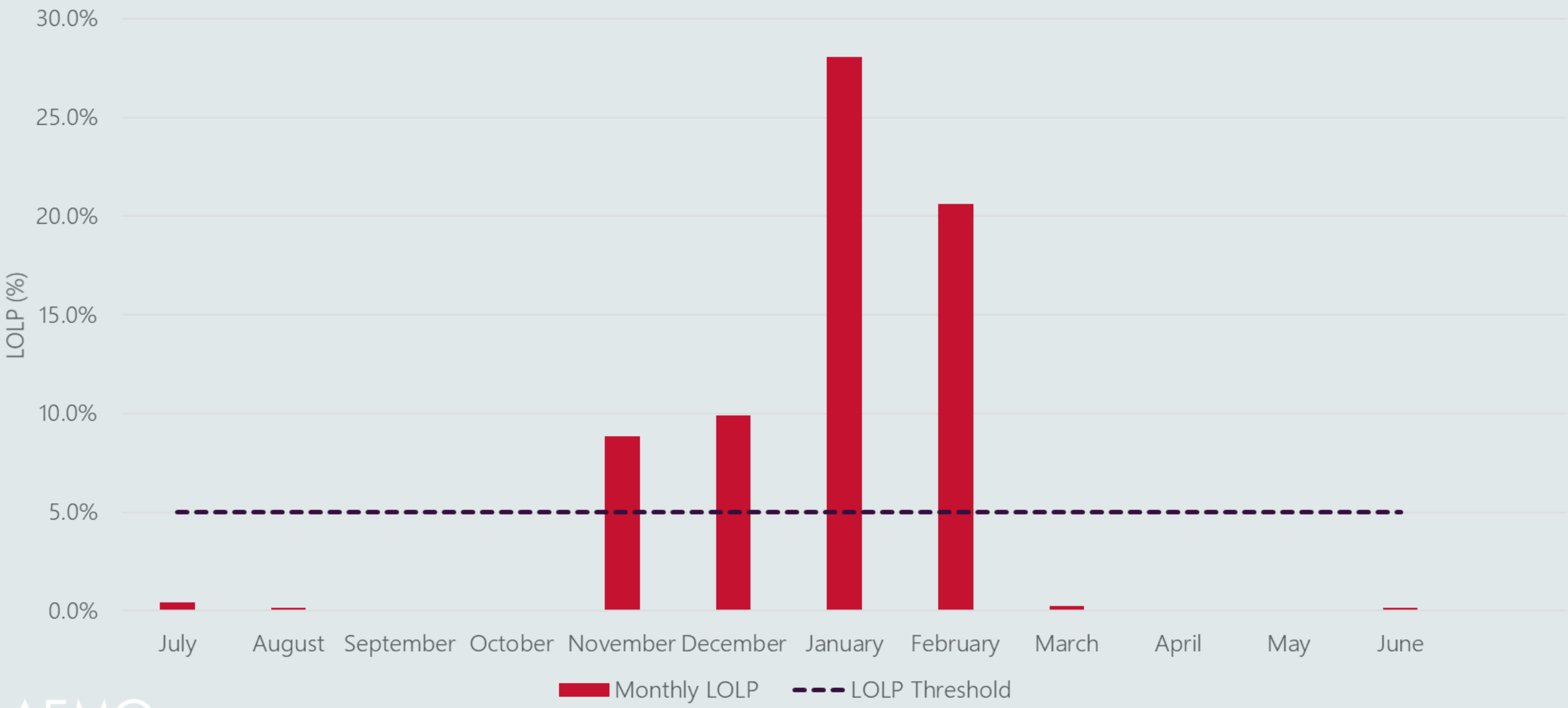
NSW 2023-24



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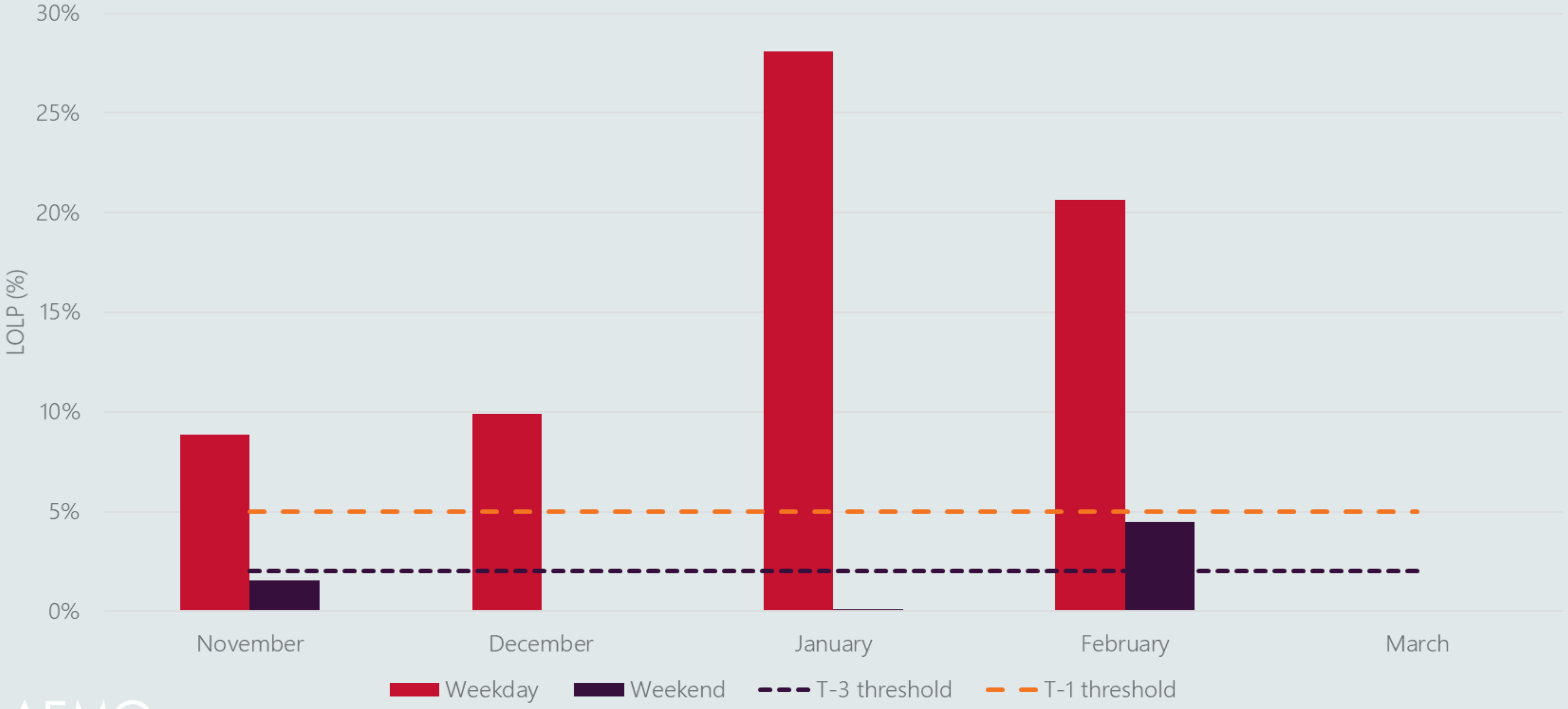
NSW 2023-24



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LOLP (%)
November
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T-3 threshold
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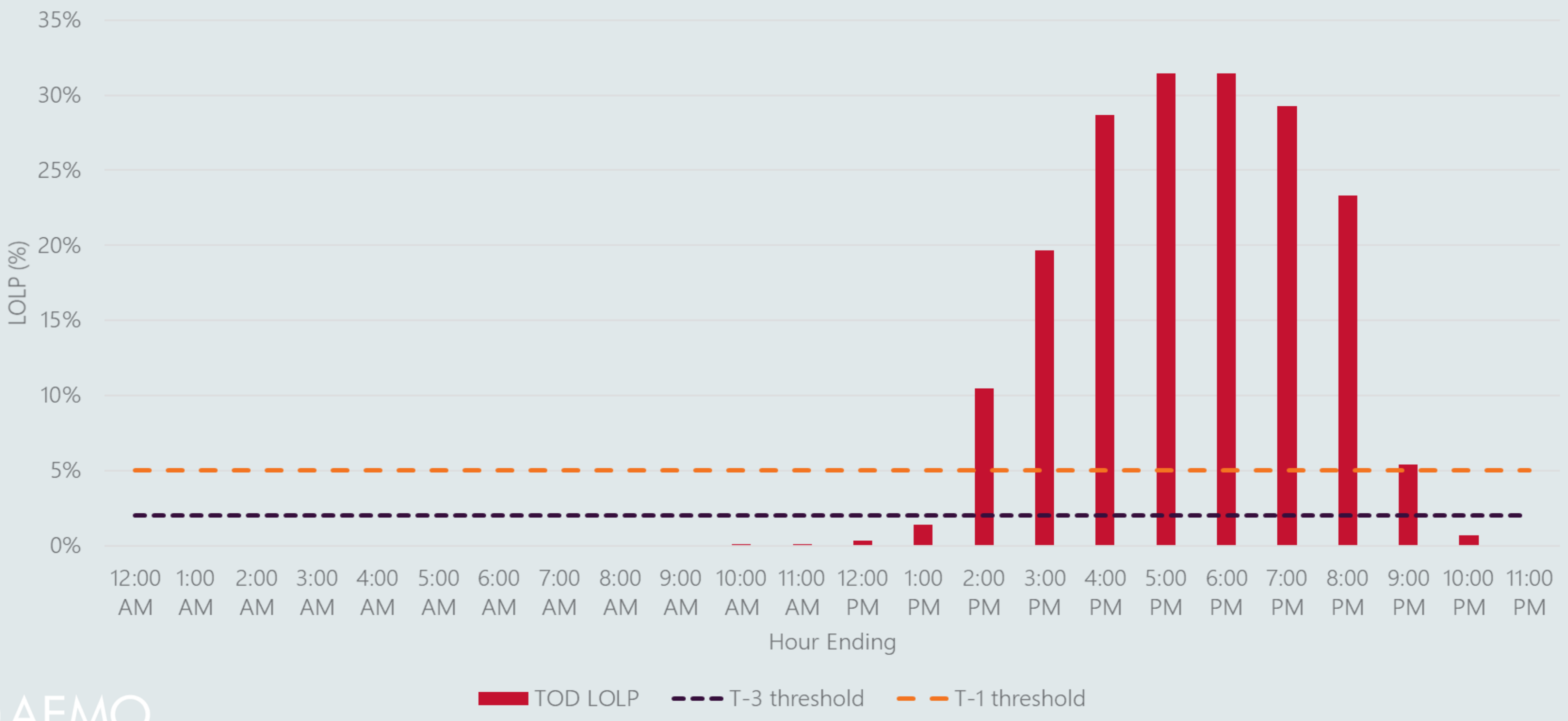
NSW 2023-24



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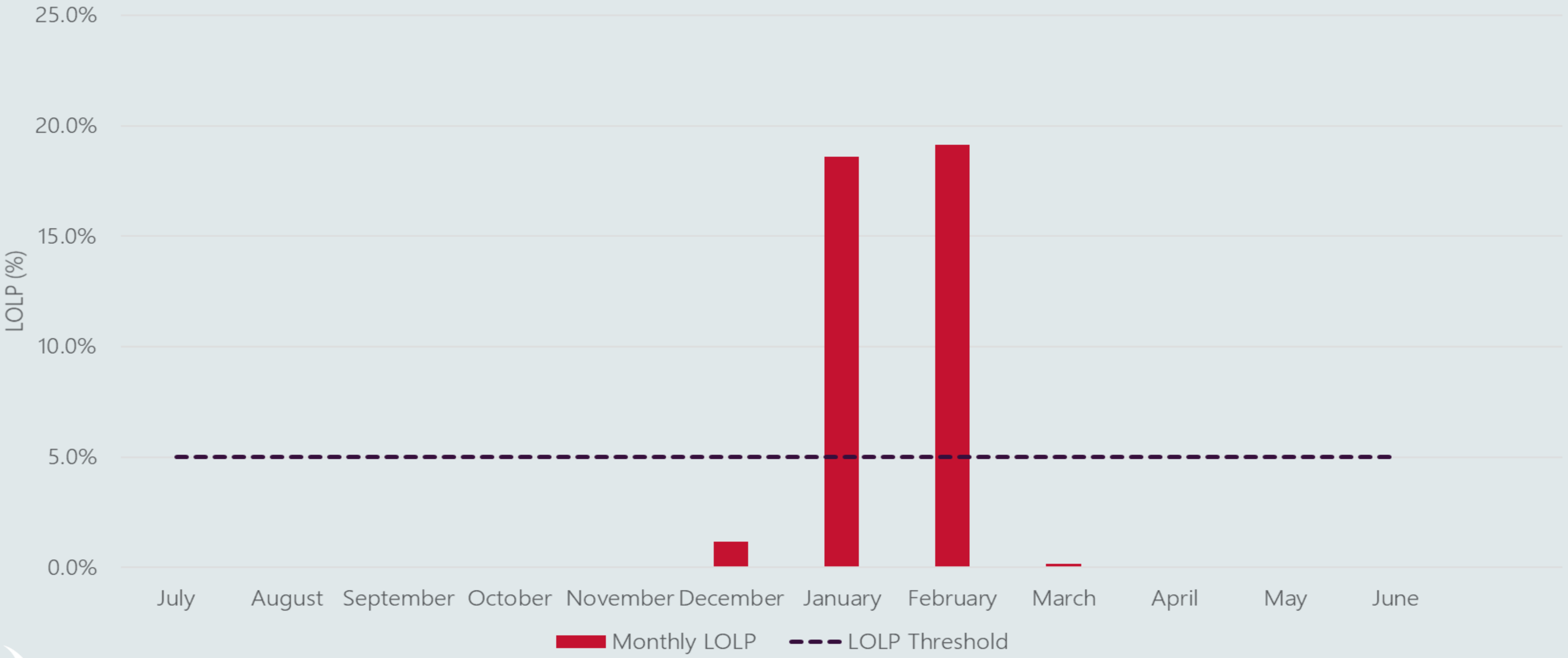
SA 2024-25



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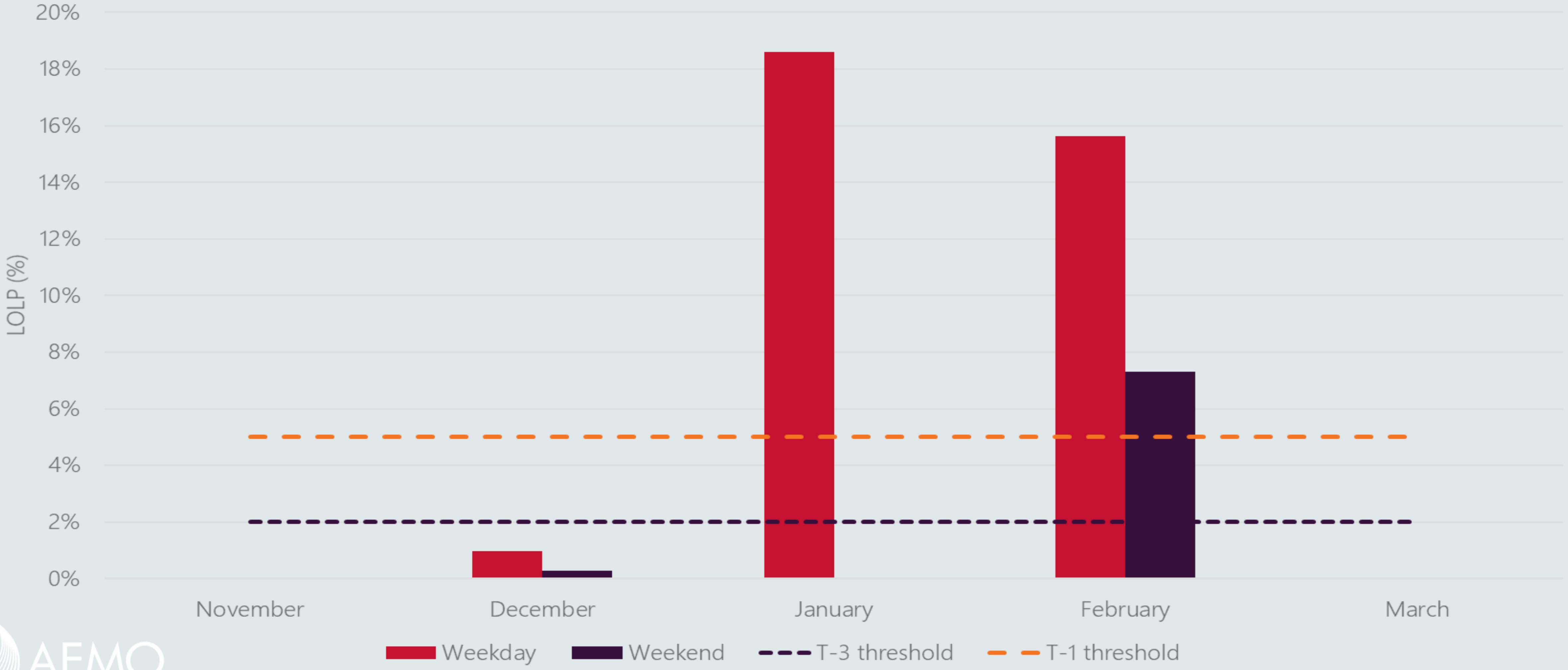
SA 2024-25



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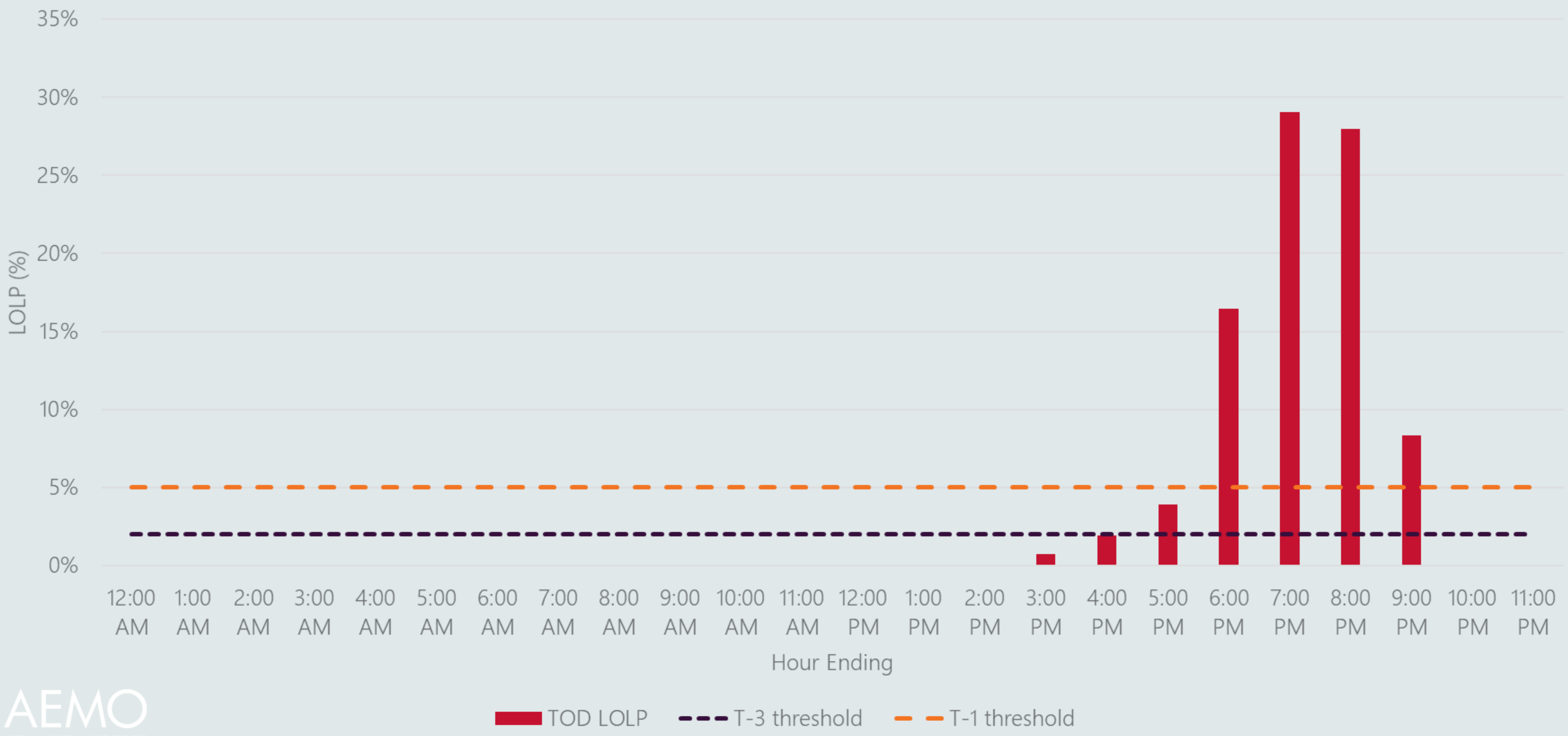
T-1 threshold

SA 2024-25



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T-3 threshold
T-1 threshold

Instrument request

Instrument request

- In addition to the above, AEMO will publish a number of accompanying visualisations to assist participants in understanding the timing of any reliability shortfalls.
  - What would be useful in addition to figures shown above and visualisations generally provided in and ESOO?

- AEMO will also submit the sensitivity of the USE estimates to additional capacity in the form of a table showing the impact of addition MW on USE when applied during the reliability gap periods and likely trading intervals.

Questions

- Has sufficient detail been provided on what information will be included in a reliability instrument request?
- Is the level of detail provided on AEMO's reasons for proposing the LOLP threshold approach to determining the reliability gap period sufficient for stakeholders to provide a submission?
- Do the examples provided effectively communicate how the reliability gap period and likely trading intervals are determined?
- Is it understood that AEMO is seeking to understand what else could be provided in an instrument request to better inform stakeholders?

Next steps

Timeline for consultation:

Deliverable	Indicative date
Issues Paper published	Wednesday 17 April 2019
Industry workshop	Thursday 9 May 2019
Submissions due on Issues Paper	Wednesday 22 May 2019
Consultation response published	Wednesday 19 June 2019