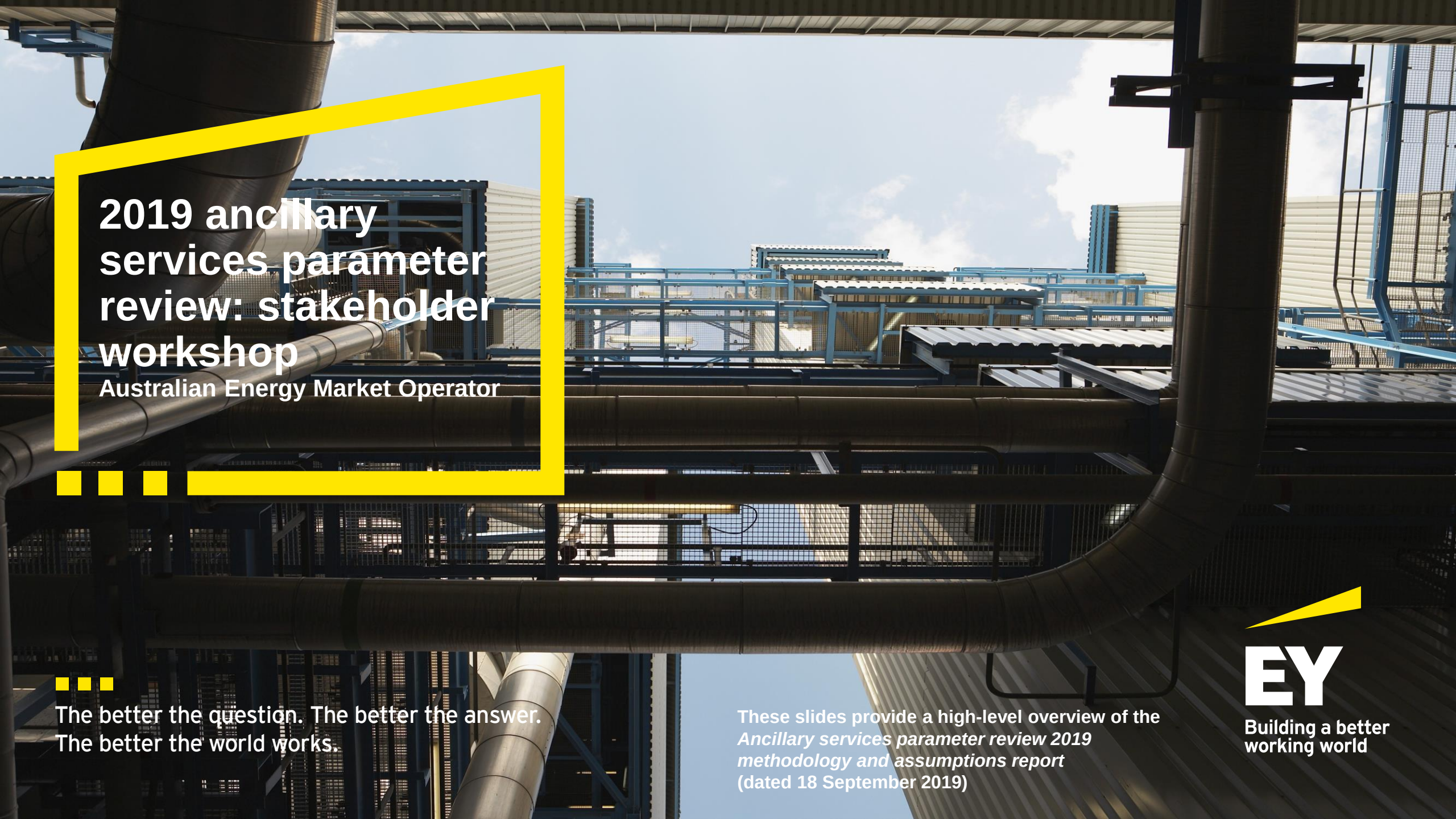

2019 ancillary services parameter review: stakeholder workshop

Australian Energy Market Operator

The better the question. The better the answer.
The better the world works.

These slides provide a high-level overview of the *Ancillary services parameter review 2019 methodology and assumptions report* (dated 18 September 2019)

Building a better working world

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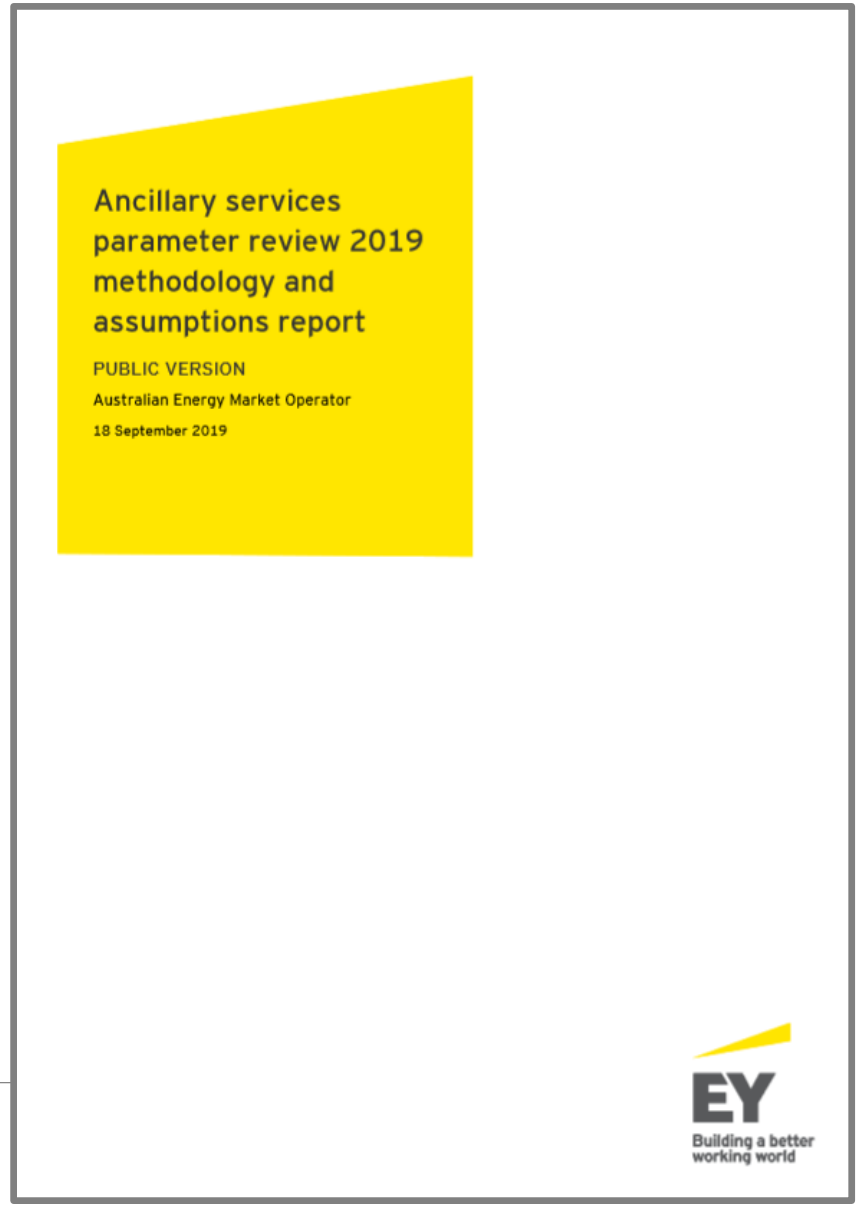
2019 ancillary services (AS) parameter review

- **EY's report published by AEMO:***
  - Detailed methodology and assumptions
- **Structure of the report**
  1. Introduction
  2. Frequency AS in the SWIS
  3. Identified market and modelling developments
  4. Modelling of the WEM
  5. Backcasting
  6. SRAS and LRR modelling methodology steps
  7. Sensitivity analysis of modelling results
  8. Appendices (A to F)



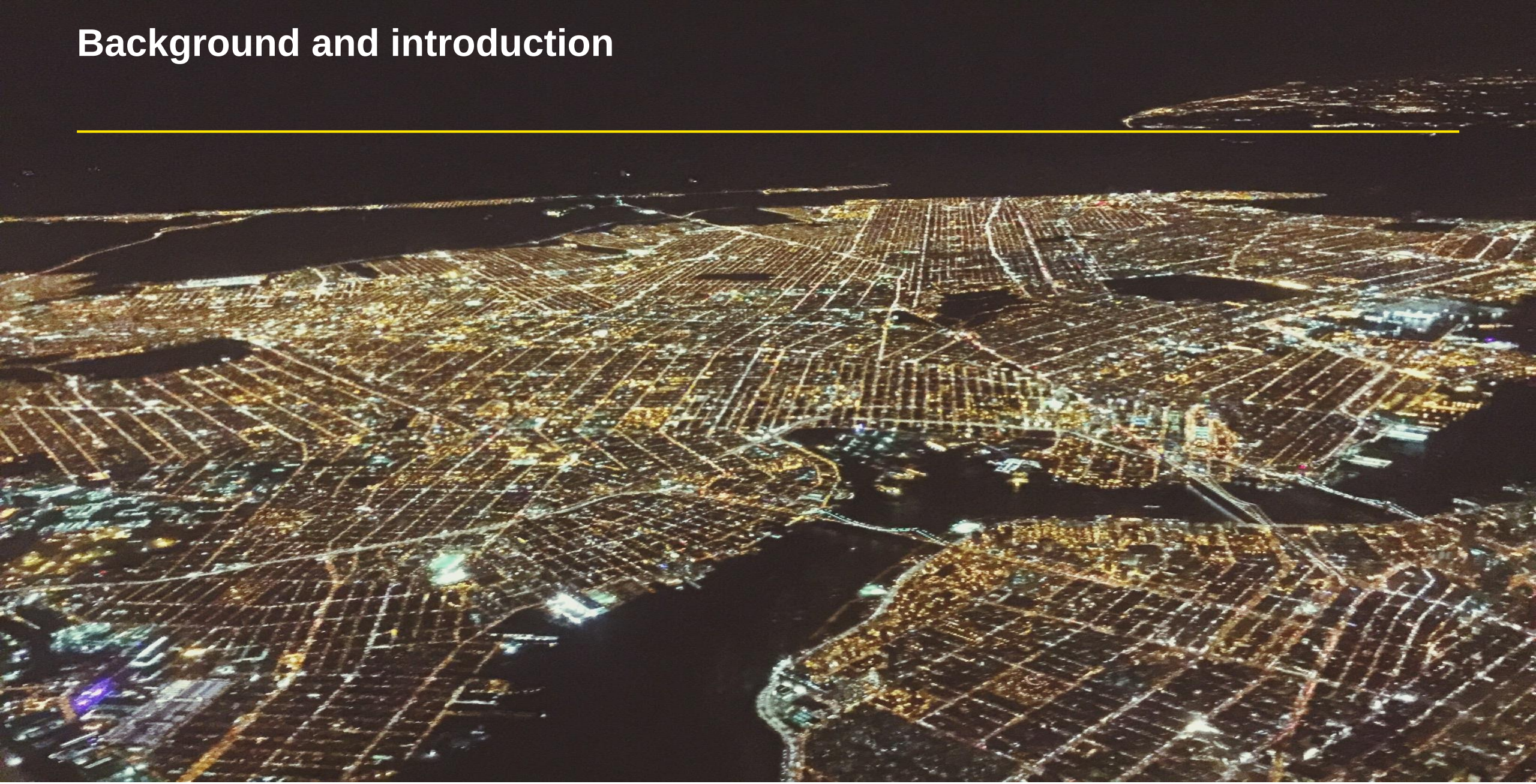
*** Available here:** https://aemo.com.au/-/media/Files/Electricity/WEM/Security_and_Reliability/Ancillary-Services/2019/2019-Draft-Methodology-and-Assumptions-Report.pdf

Workshop agenda and key dates

- **Background and introduction**
- **Market and modelling developments**
- **EY market model, backcasting and sensitivity analysis**
- **SRAS and LRR modelling methodology steps**
- **Questions?**

- **24 September 2019:** stakeholder workshop
- **2 October 2019:** closure of consultation period
- **30 November 2019:** deadline for submission of proposed AS parameters

Background and introduction



Project background

EY is engaged by AEMO to provide electricity market modelling services to assist in calculating ancillary services parameters

WEM Rules

AEMO required to:

- **Determine**
- **Procure**
- **Schedule**
- **Dispatch**

generation services to meet the AS requirements.

AEMO

Spinning reserve service (SRAS)

Load rejection reserve service (LRR)

Margin values (peak / off-peak)

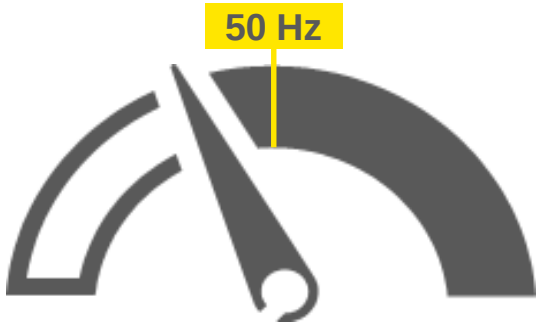
SRAS capacity values (peak / off-peak)

'L' parameter of Cost_LR* (2020-21 only)

EY to estimate these parameters for 2020-21 financial year

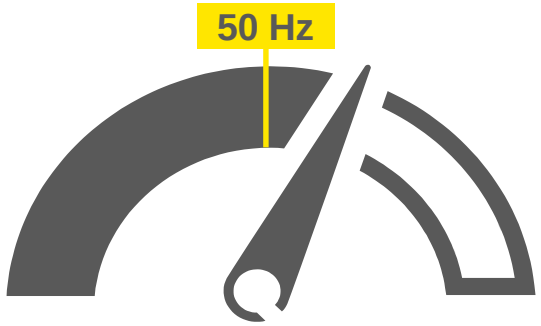
*** The 'R' parameter of Cost_LR is outside of scope for EY modelling**

Project background: SRAS and LRR



SRAS

- Prevent under-frequency excursions below 48.75 Hz
- Capacity held in reserve which can respond rapidly to a sudden decrease in system supply*



LRR

- Prevent over-frequency excursions above 51 Hz
- Capacity held in reserve capable of responding rapidly to a sudden decrease in system load**

May be provided by:

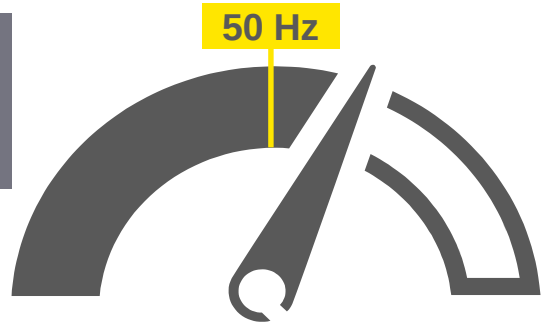
- Non-Synergy providers (under contract)
- Synergy (default provider)

*** Clause 3.9.3 of WEM Rules**
**** Clause 3.9.7 of WEM Rules**

Project background:
SRAS and LRR remuneration

No centralised market exchange for provision of SRAS or LRR

As a default SRAS / LRR provider, Synergy is remunerated through an administered mechanism*



SRAS remuneration for Synergy

Opportunity and direct costs of SRAS provision

'Availability payment' for Synergy is determined on the basis of:

- The margin values (MV) approved by ERA
- The balancing price
- The modelled SRAS requirement assumed in forming the MV

LRR remuneration for Synergy

Direct costs of LRR provision

Determined on the basis of:

- The 'L' component of Cost_LR approved by ERA

*** Clause 3.13.3A, 3.13.3B and 3.13.3C of the WEM Rules**

Synergy's SRAS/LRR costs and payments

Synergy's SRAS costs (availability cost) =

- Loss of balancing market operating margins (opportunity cost)
- Costs associated with any operating inefficiencies
- Direct out of merit operating losses

Synergy's LRR costs =

- Direct out of merit operating losses
- Direct cost of delivering the service

Synergy's SRAS payment = **Margin value*** × **Balancing price** × **Synergy's administered SRAS quantity for settlement****

Synergy's administered SRAS quantity for settlement** = **SR_Capacity parameter*** − **LFAS Up** − **Non-Synergy SRAS providers (contracted individually)**

AS parameters to be determined:

- **SR_Capacity parameter***
- **Margin value***
- **'L' parameter of Cost_LR**

Detailed explanation in the course of this workshop

*** Margin values and SR capacity parameters are modelled for peak and off-peak periods.**
Peak (off-peak) trading interval: 8:00 AM to 10:00 PM (10:00 PM to 8:00 AM)
**** In accordance with clause 9.9.2(f) of the WEM Rules**

Identified market and modelling developments

Identified market and modelling developments

- Single largest supply-side contingency
- LFAS market developments
- ‘Full runway’ method for SRAS cost allocation
- Calculation of LRR requirement
- Modelling ready reserve
- Modelling Generator Interim Access (GIA) network constraints

Single largest supply-side contingency

- 390 MW of intermittent generators connected in 2020
- Loss of single transmission line (up to 730 MW generation can be lost)

While rule changes are being considered, due to lack of certainty around outcome, AEMO regards this methodology as appropriate

Proposed modelling approach:

- SRAS requirement: 70% of the largest supply-side contingency (incl. transmission line contingency)
- If SRAS requirement not met, a shortfall will be reported

LFAS market developments: Sculpted LFAS requirement

- Daytime variability of PV
- 2019-20: varied LFAS requirement proposed by AEMO / accepted by ERA
- 2020-21: LFAS requirement yet to be defined

AEMO assumption driven by:

- Expected increase in PV
- Expected connections of other new non-scheduled generators

Proposed modelling approach:

- 116 MW from 5:30 AM to 7:30 PM
- 70 MW from 7:30 PM to 5:30 AM

LFAS market developments: Exclusion from SRAS

- AEMO clarified reasons for excluding some LFAS capacity from available SRAS
- LFAS units unable to meet all SRAS technical requirements not counted towards SRAS
  - E.g. 6 seconds response

Currently, the only facilities certified for both LFAS and SRAS are balancing portfolio facilities

Proposed modelling approach:

- Only facilities certified for both LFAS and SRAS will be counted towards available SRAS

LFAS market developments: Non-Synergy LFAS

- Assumed LFAS merit orders for time of day periods (from AEMO)
- Confidential assumptions from new LFAS market participants

Proposed modelling approach:

- Offer behaviours of LFAS providers and assumed portfolio merit order
- Monte Carlo outage simulations passed through all modelling steps

‘Full runway’ method for SRAS cost allocation

- ‘Full runway’ effective from 1 September 2019
- Expected changes to offer behaviours

Proposed modelling approach:

- Use ‘full runway’ formula
- Allocate past modelled SRAS cost to past modelled generation output levels
- Conduct regression analysis
- Modify generators’ offer curves

Calculation of LRR requirement

- Dynamic LRR requirement trialled by AEMO
- AEMO expects to procure sufficient LRR through committing facilities before the trading interval to ensure the LRR requirement can be met in real time

Proposed modelling approach:

- Model LRR requirement based on AEMO's procurement timeframe and formula

AEMO's formula accounts for:

- Boddington Gold Mine and the Eastern Goldfields
- SWIS total system load
- Aggregate output from selected wind farms (assumed to be zero at procurement timeframe)

Modelling ready reserve

- Not modelled in the past
- Expected to improve accuracy of simulated dispatch outcomes

Currently, ready reserve is provided by:

- Synergy units only (exclusively gas-fired facilities)
- Keeping specific units off-line to meet the standard

Proposed modelling approach:

- Model AEMO's operational practice, ensuring specific Synergy units are:
  - Kept in reserve
  - Not available for provision of SRAS or LRR

Modelling Generator Interim Access (GIA) network constraints

- Past modelling: no GIA-connected facilities
- Present: two GIA facilities
- FY 2020-21: three more expected

AEMO considered three options:

- Implement constraint equations
- Apply reduced capacity factors
- Assume unconstrained connection

AEMO's understanding:

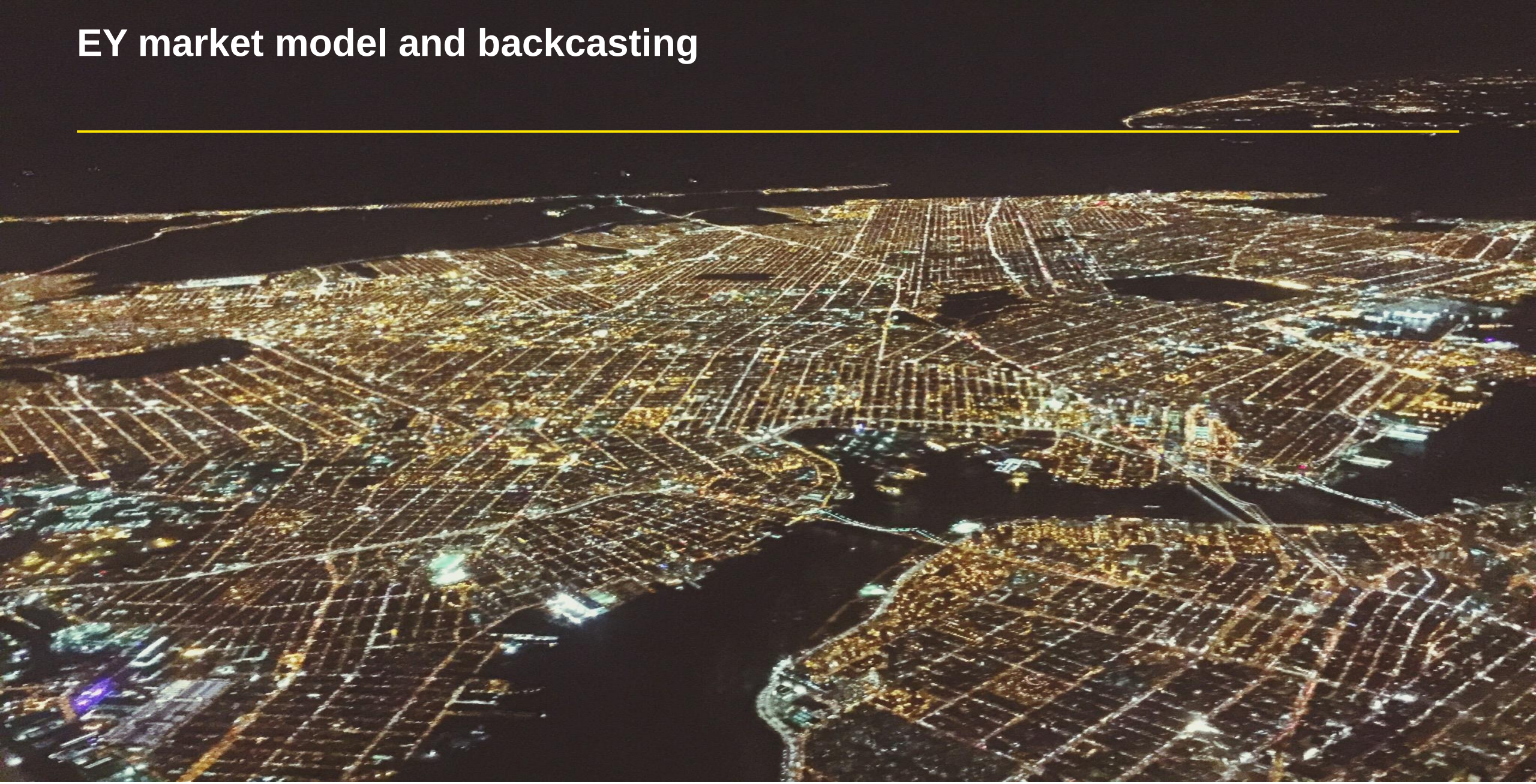
- GIA constraint equations not yet developed
- Implementing GIA pre-dispatch constraint equations not feasible

Proposed modelling approach:*

- Reduced capacity factors (if data available)
- No constraints to new GIA generators (if no data)

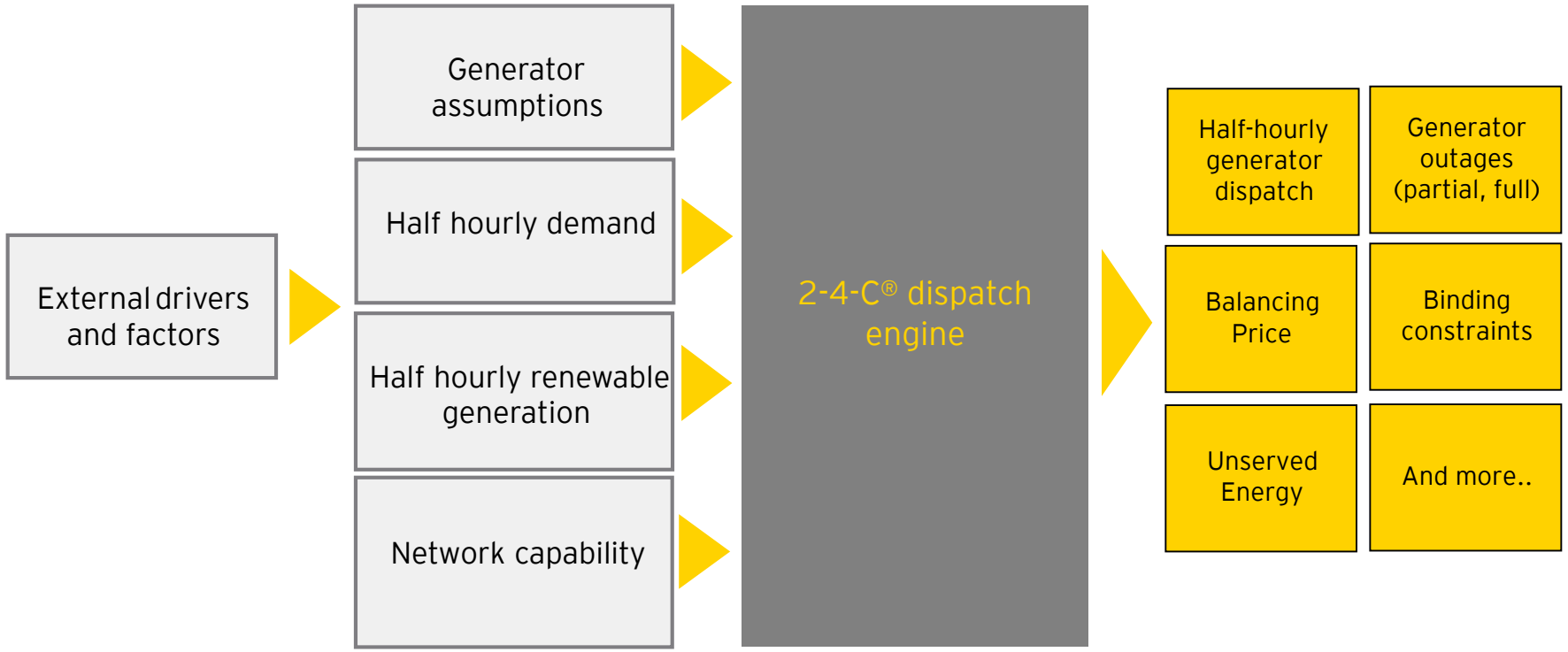
*** To be reviewed for future AS reviews**

EY market model and backcasting



EY's dispatch model (2-4-C®) for the Wholesale Electricity Market

▶ EY's in-house market dispatch modelling software (2-4-C®)



- ▶ 2-4-C® developed to include LFAS modelling
- ▶ Inputs and assumptions agreed with AEMO to reflect planning and operational practices

Backcasting

Purpose:

- Mathematical and logical integrity of 2-4-C®
- Validate input assumptions
- Reconcile modelled results with observed practice
- Understand model's limitations
- Tune model and inputs to reproduce historical price and dispatch outcomes

2018 lesson learnt:

- Better to backcast after collection of facility assumptions data
- False sense of precision (over-tuning)

Further considerations for 2019

- Rule changes
- Market reforms
- Other market developments

Sensitivity analysis of modelling results

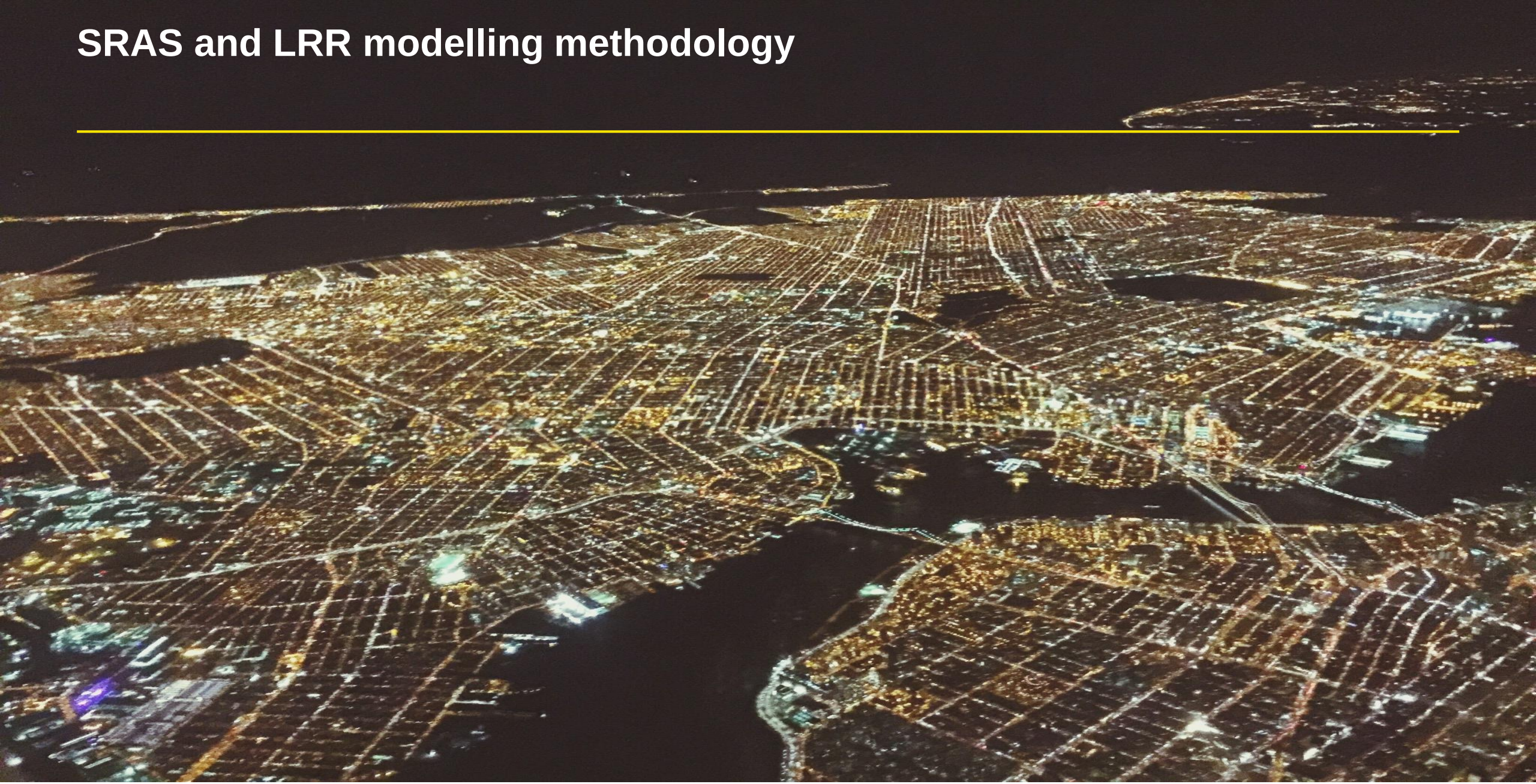
Sensitivity analysis of modelling results

Base case modelled results compared against sensitivity cases

- Investigate impacts of varied assumptions on modelling outputs
- Determine inputs with greatest influence on outputs
- Determine outputs most sensitive to varied inputs

Assumptions to be varied from base case in consultation with AEMO

SRAS and LRR modelling methodology



SRAS and LRR modelling methodology

1. Modelling of generation outages and the least-cost mix of LFAS providers
2. Preliminary dispatch model run
3. Calculation of the dynamic SRAS requirement and the LRR requirement
4. Non-linear constrained optimisation (minimisation) of SRAS and LRR costs
5. Balancing price modelling
6. Forecast of the total opportunity cost of SRAS and out-of-merit LRR provision
7. Calculation of Synergy's SRAS and LRR availability cost
8. Calculation of SR_Capacity_Peak and SR_Capacity_Off-Peak parameters
9. Calculation of Margin_Peak and Margin_Off-Peak parameters
10. Calculation of LRR response costs

This will include:

- The opportunity costs of providing SRAS
- The direct cost of out-of-merit provision of SRAS and LRR

subject to the SRAS and LRR requirement being met.

Calculation of SR_Capacity_Peak and SR_Capacity_Off-Peak

SR_Capacity parameter derived from:

- **Modelled SRAS requirement**
- **LFAS not certified for SRAS**

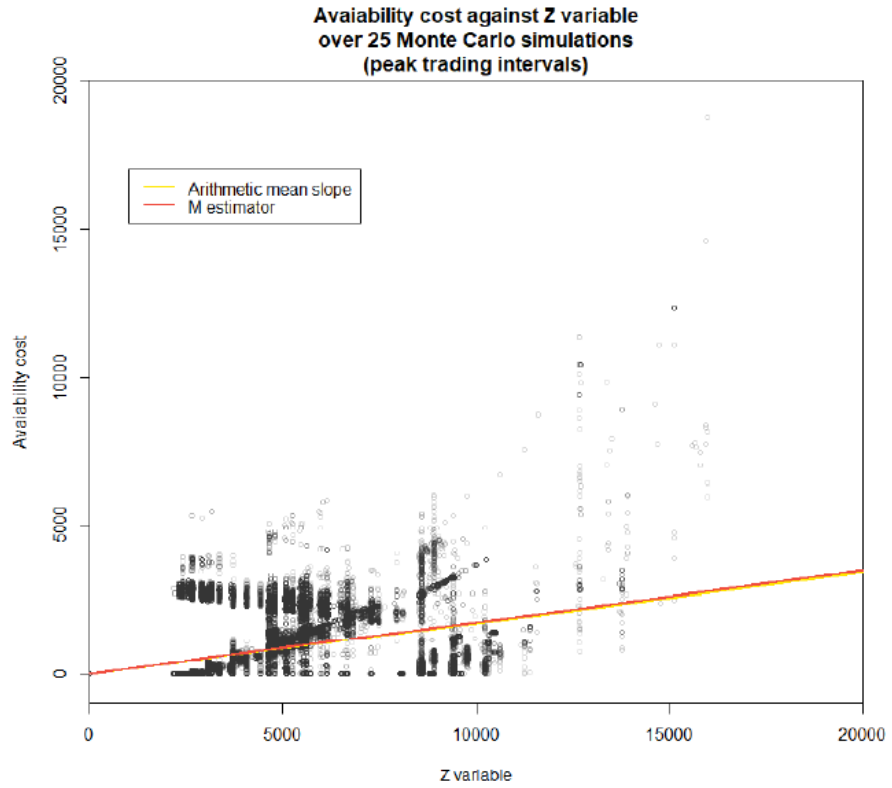
For market settlement, expressed as two fixed values:

- **Average across peak trading intervals**
- **Average across off-peak trading intervals**

Calculation of Margin_Peak and Margin_Off-Peak: robust linear regression

- Outputs of steps 1 to 8 used as variables for linear regression
- Regression model solution will provide Margin_Peak / Margin_Off-Peak parameters

Indicative regression results from 2018 modelling presented below



Structural changes from 2018 modelling

Integrate SRAS and LRR modelling algorithms

Minimise:

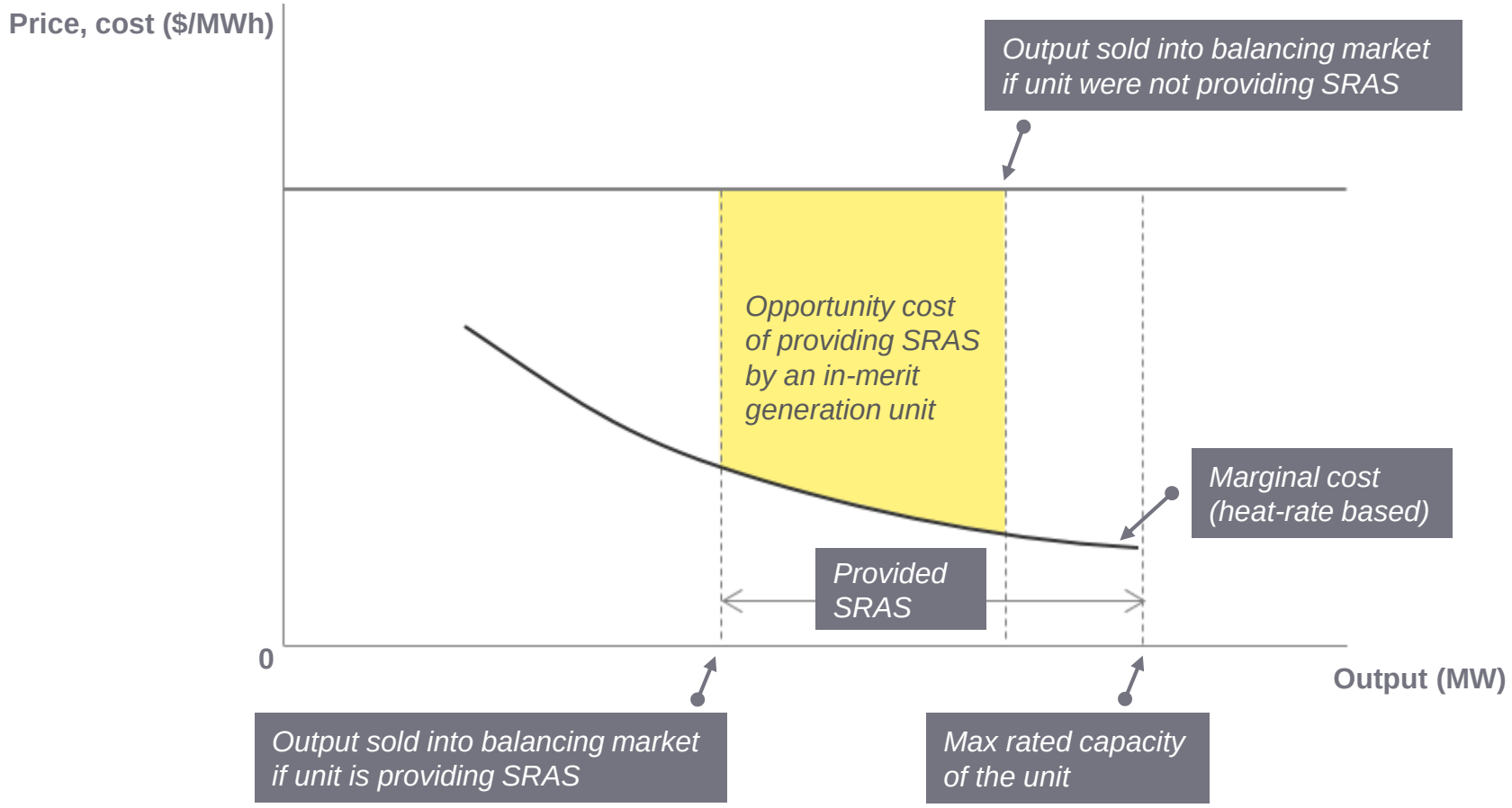
- **Costs**

Subject to:

- **SRAS and LRR requirement**
- **Other constraints**

Cost concept: in merit units

Opportunity cost of providing SRAS by an in-merit generation unit



Cost concept: out of merit units

Opportunity cost of dispatching SRAS and LRR out of merit

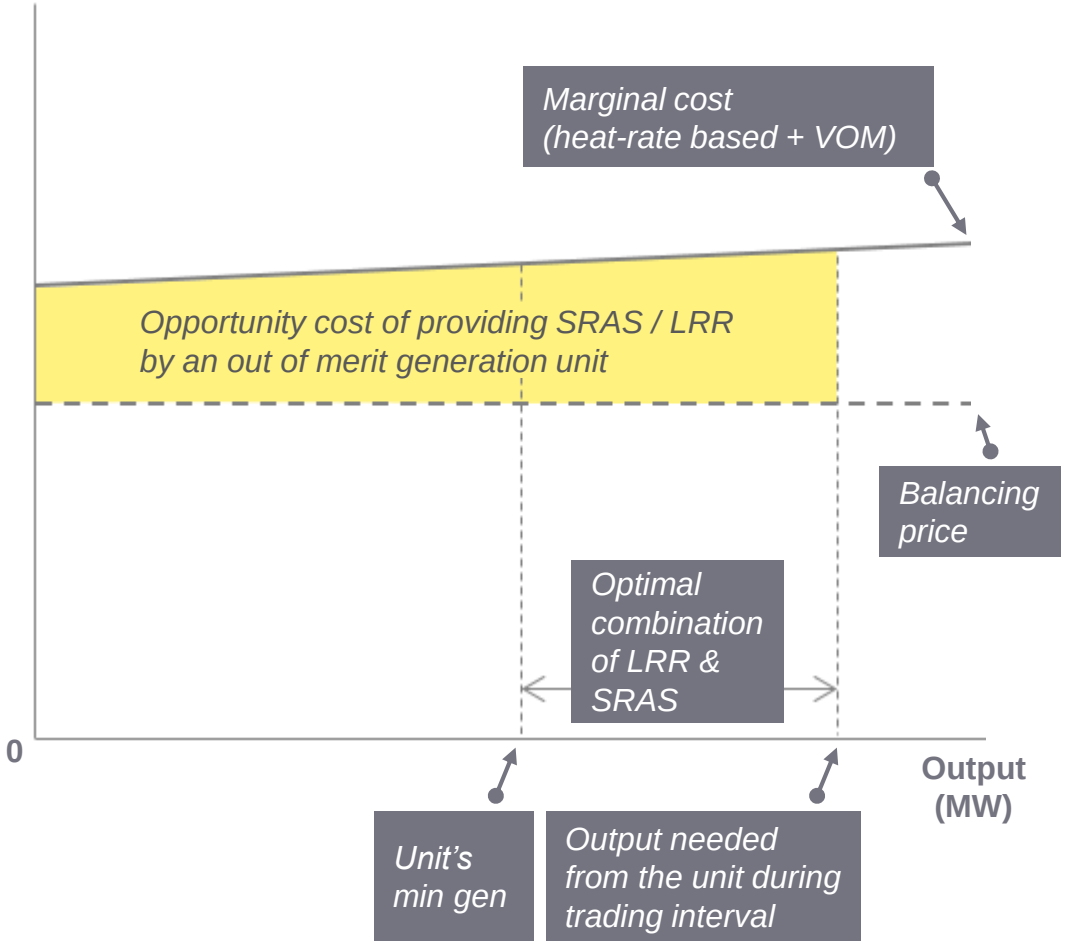


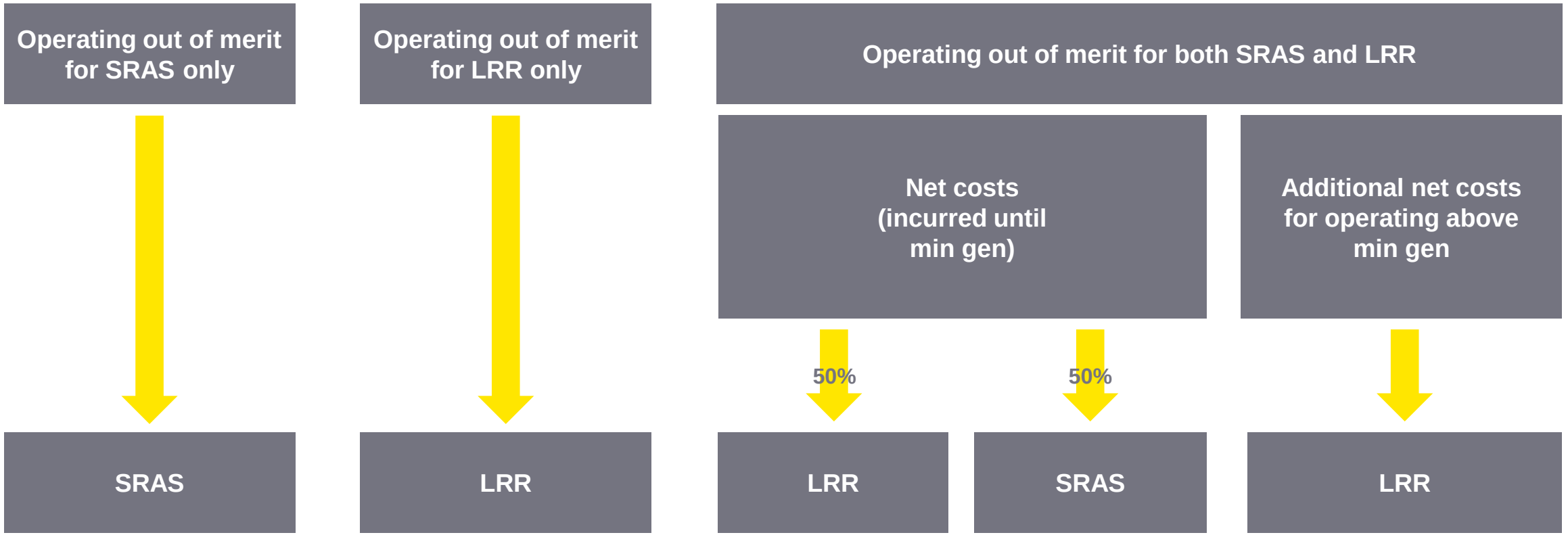
Illustration for an out of merit unit providing LRR.

It would not be optimal for an out of merit unit only needed for SRAS to operate above min gen.

*** Variable operations and maintenance costs**

Allocation of out of merit costs

Out of merit SRAS / LRR provision cost proposed allocation rule




Thank you!
Questions?

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