Government of **Western Australia**
Energy Policy WA

Reserve Capacity Mechanism Review Working Group

Meeting 2022_02_17

17 February 2022

Working together for a **brighter** energy future.

Meeting protocols

- Please place your microphone on mute, unless you are asking a question or making a comment
- Please keep questions relevant to the agenda item being discussed
- If there is not a break in discussion and you would like to say something, you can 'raise your hand' by typing 'question' or 'comment' in the meeting chat
- Questions and comments can also be emailed to energymarkets@energy.wa.gov.au after the meeting
- The meeting will be recorded and minutes will be taken (actions and recommendations only)
- Please state your name and organisation when you ask a question
- If you are having connection/bandwidth issues, you may want to disable the incoming and/or outgoing video

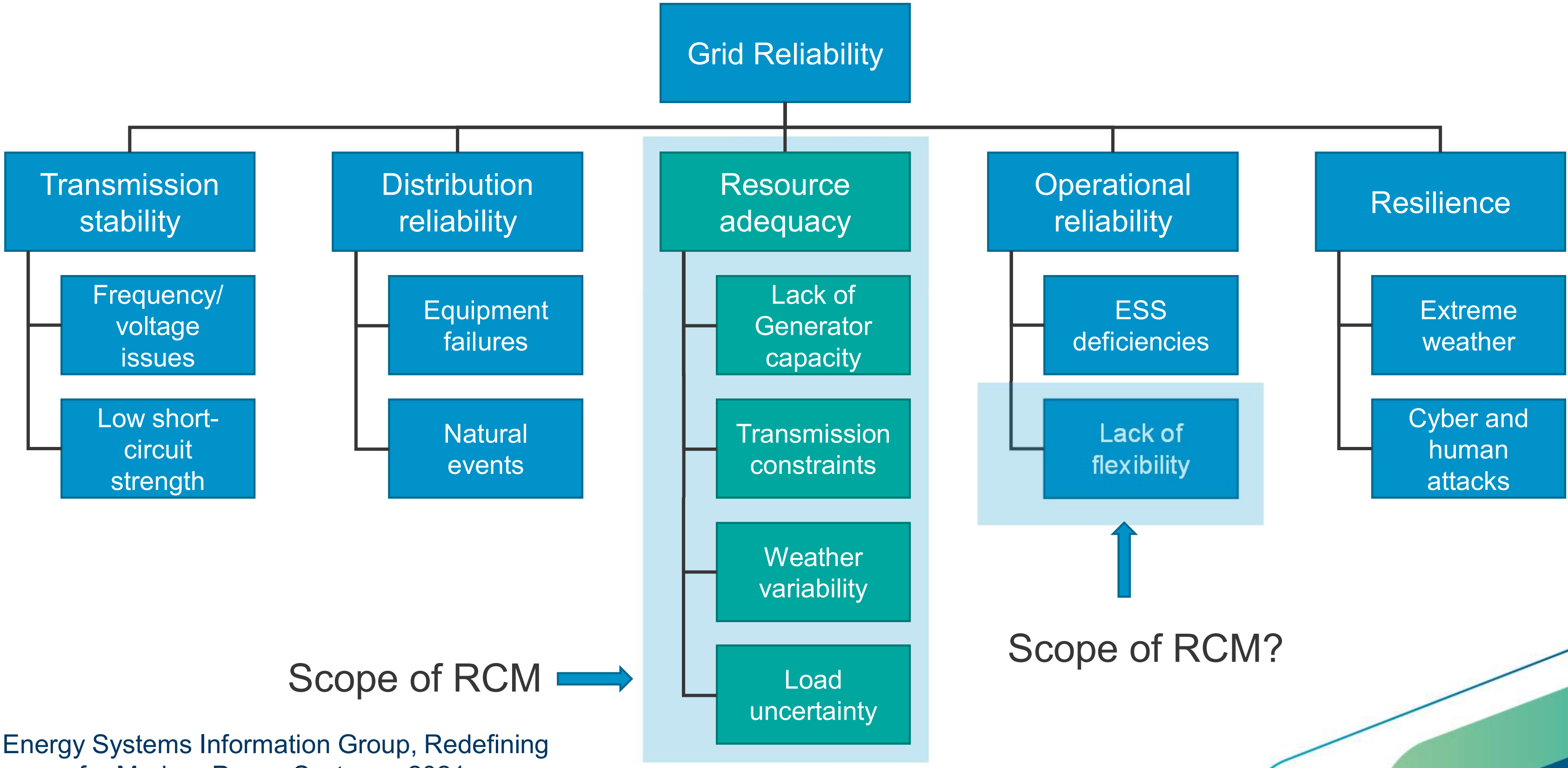
Agenda

Item	Item	Responsibility	Type	Duration
1	Welcome and Agenda	Chair	Noting	5 min
2	Meeting Apologies/Attendance	Chair	Noting	2 min
3	Minutes of RCMRWG meeting 2022_01_20	Chair	Decision	3 min
4	Reliability, resource adequacy and the RCM	RBP	Discussion	5 min
5	Modelling methodology	RBP	Discussion	30 min
6	Modelling assumptions (incl scenarios)	RBP	Discussion	20 min
7	Modelling tools	RBP	Discussion	15 min
8	Next Steps	Chair	Discussion	5 min
9	General Business	Chair	Discussion	5 min

Next meeting: To be determined

4. Reliability, resource adequacy and the RCM

The elements of grid reliability



Adapted from Energy Systems Information Group, Redefining Resource Adequacy for Modern Power Systems, 2021

5. Modelling Methodology

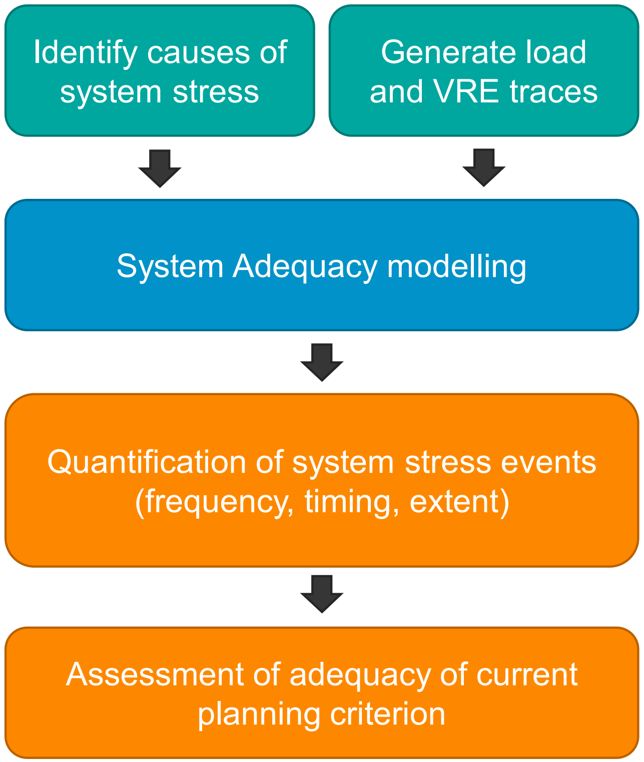
RCM Review Modelling – Introduction

Modelling is associated with the following RCM review tasks:

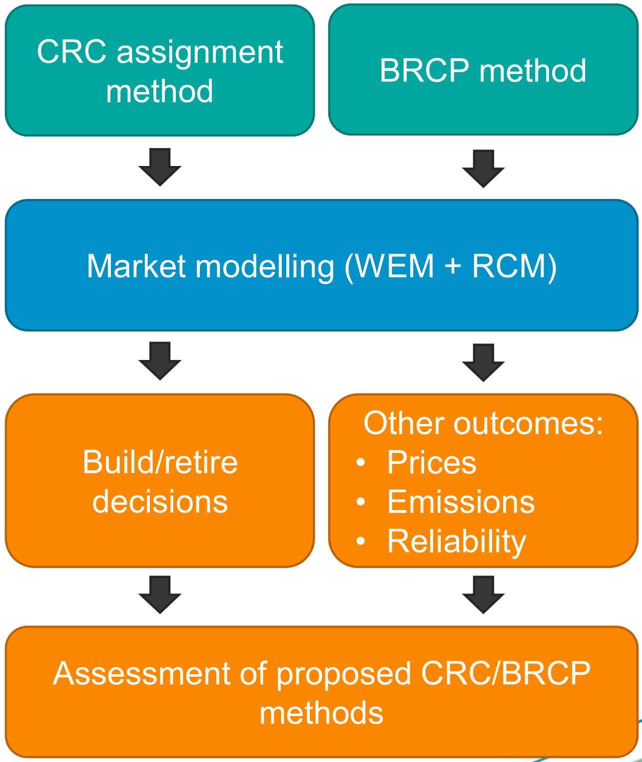
- System stress and required capacity services:
  - Identify causes of system stress – current and future
  - Quantify how the current generation mix (and other capacity sources) accommodate the identified types of system stress under credible demand scenarios (current, 2030 and 2050) and identify any deficiencies
- Assess whether the current Planning Criterion is adequate for meeting the capacity requirements of the SWIS and,3 if not, develop a planning criterion that will meet them
- Testing the developed approaches for assigning the CRC and setting the BRCP

Two Distinct Modes of Modelling

1. System Stress modelling and Planning Criterion assessment:

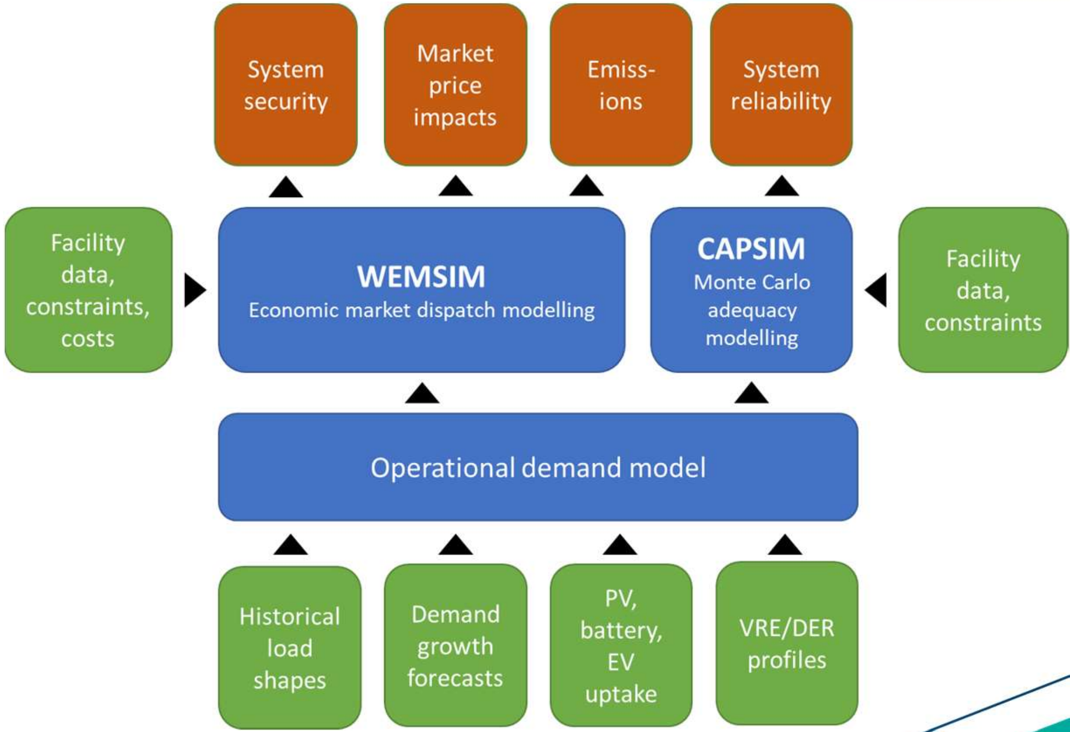


2. CRC/BRCP method assessment:



Modelling Suite

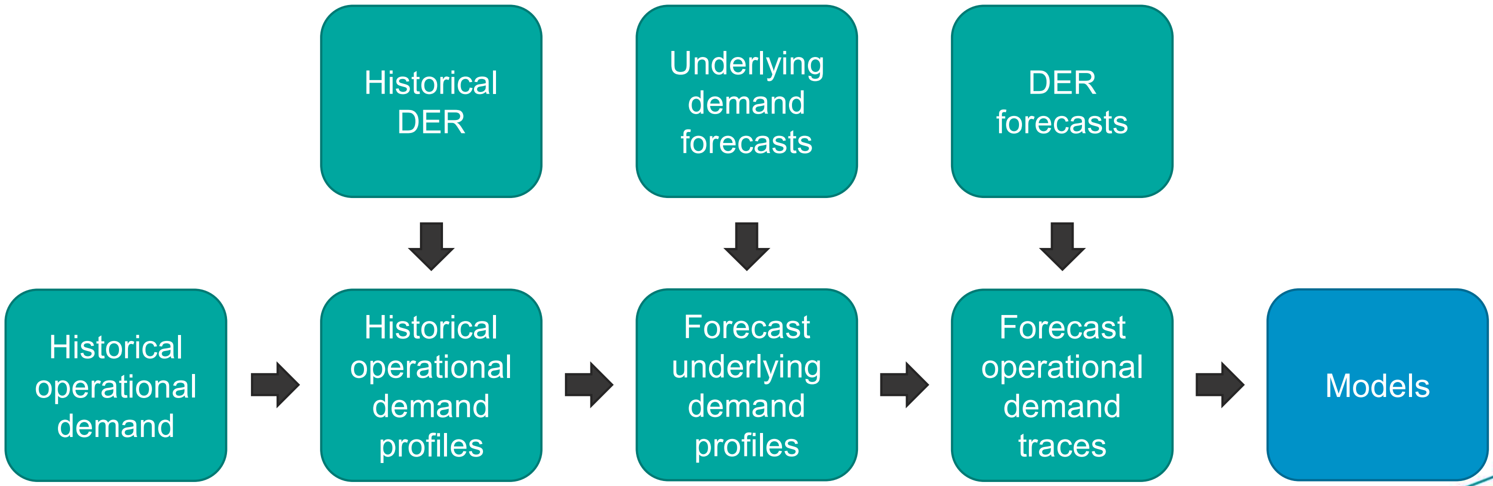
- Two distinct modelling techniques are relevant for this project:
  - Monte Carlo system adequacy modelling – over large number of iterations for accuracy. Limited to calculating system adequacy
  - Economic market dispatch modelling – models a full range of economic and technical market outcomes, including market prices, revenue, emissions etc.
- Common to both is an operational demand model, incorporating:
  - Historical load shapes
  - Demand growth forecasts
  - Evolving demand patterns due to distributed VRE, storage, EVs



Demand Modelling

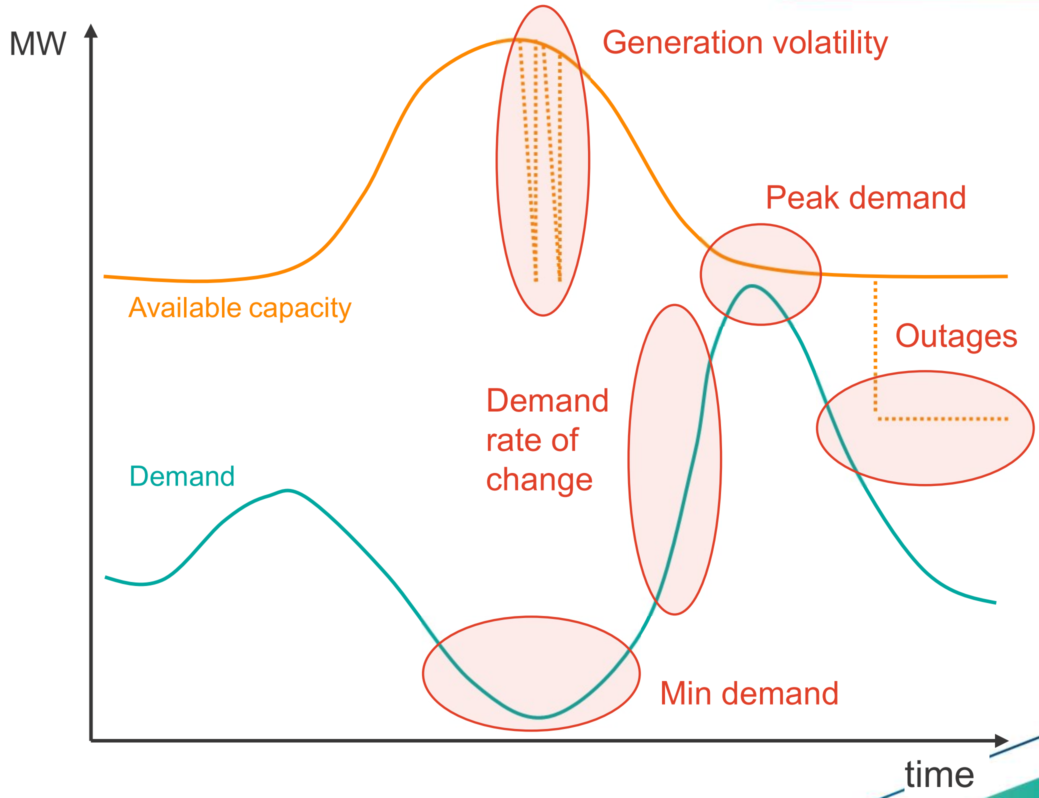
- Underlying demand is the total of all end-user demand, including demand supplied by DER (e.g. rooftop solar)
- Operational demand is demand supplied by the WEM, so excludes demand supplied by DER
- Historical demand data is in the form of operational demand

The underlying demand needs to be determined, so that the evolving impact of DER can be incorporated:



System Stress Modelling - Causes

- Maximum demand
- Minimum demand
- Demand volatility (magnitude and speed)
- Generation volatility (magnitude and speed)
- Planning for and response to outages
- Others – TBD



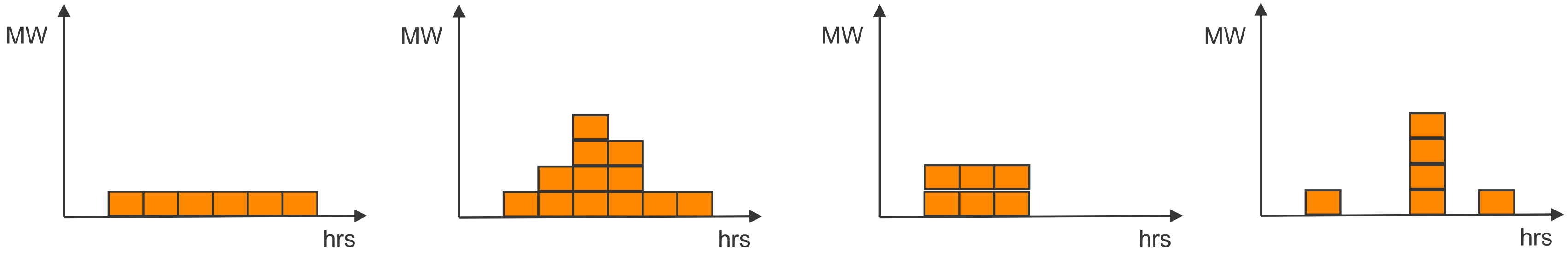
Resource Adequacy Metrics

EUE: Expected Unserved Energy – The total MWh of outage

LOLEv: Loss of Load Events – The number of discrete outages

LOLH: Loss of Load Hours – The number of hours of outage

The various metrics can produce very different results for the same events, or the same results for very different events:



EUE	6	12	6	6
LOLEv	1	1	1	3
LOLH	6	6	3	3

System Stress Modelling – Methodology

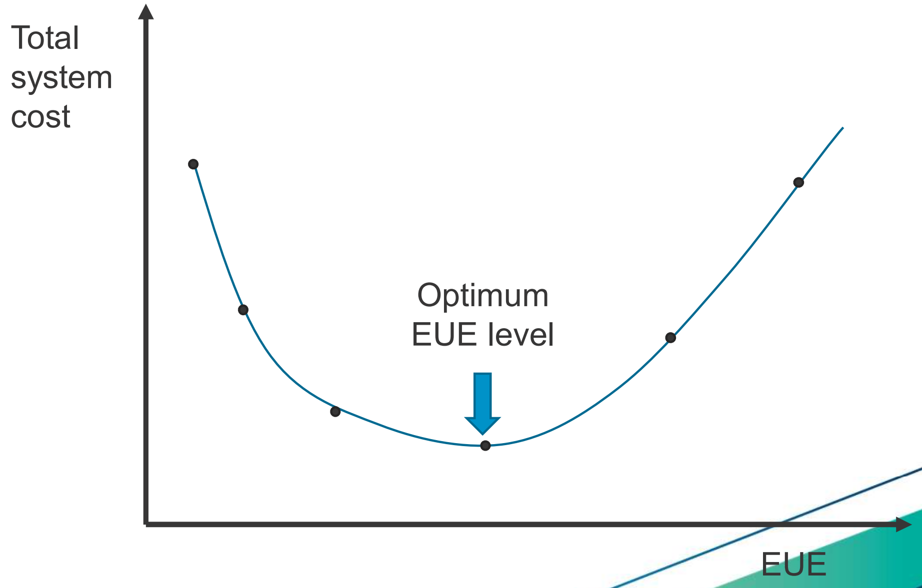
1. Identify causes of system stress and define criteria to identify instances of system stress
2. Identify types of capacity required to accommodate identified causes of system stress
   - e.g. generation increase/load reduction, fast ramping capability, generation decrease/load increase
3. Using existing operational demand model, create demand traces for 2021, 2030 and 2050, for multiple demand scenarios (including 1 in 10 year weather scenario)
4. Similarly, create capacity traces for each capacity type identified in step 2, incorporating forced and planned outages, and intermittent generation profiles
5. Analyse the traces created in steps 3 and 4 to identify instances of system stress using criteria identified in step 1 – quantify frequency, timing and extent of each type of systems stress event
   - Using combination of CAPSIM and bespoke analysis, depending on identified causes of system stress
6. For each instance of system stress, determine if capacity was sufficient to accommodate the instance
7. From the results of this analysis, assess whether the current Planning Criterion is adequate

Revising the Planning Criterion

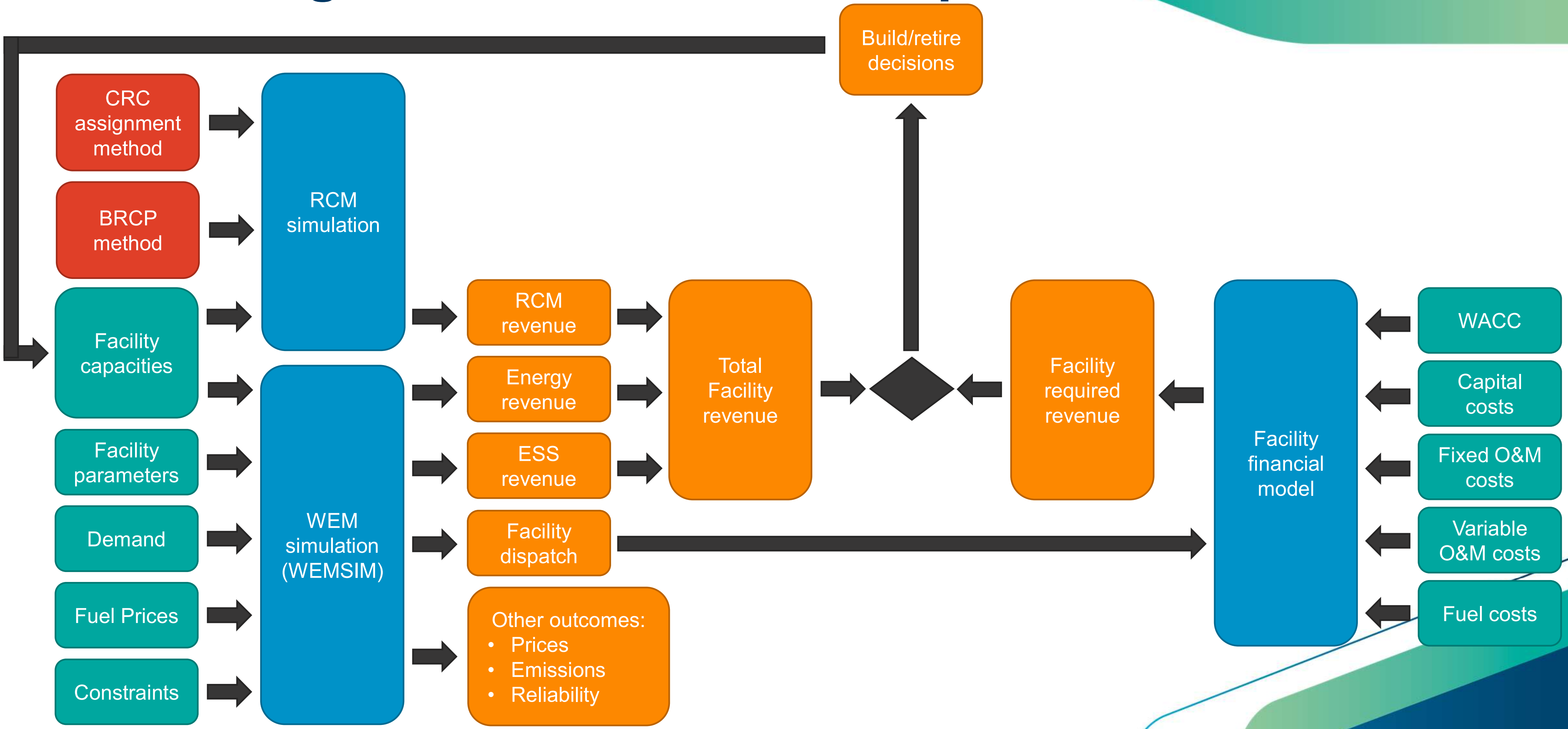
The RCM Review may involve revising the Planning Criterion, depending on the outcome of the preceding analysis. In this case, modelling would be used to support setting new Planning Criterion parameters

The exact nature of this modelling will depend on the form of the revised planning criterion. For example, if a revised Expected Unserved Energy (EUE) target is required (currently 0.002%), the methodology would be as follows:

1. Determine the lowest cost new entrant technology (previous studies assumed an OCGT, could be PV + storage)
2. Determine a Value of Customer reliability (VCR) for the SWIS
3. Perform system adequacy modelling (CAPSIM) with various levels of new capacity of the type determined in step 1 to determine the level of EUE (in MWh)
4. Determine total system cost at each level of new capacity, as EUE x VCR + cost of new capacity
5. Chart total system cost vs EUE, and determine the level of EUE at which minimum total system cost occurs

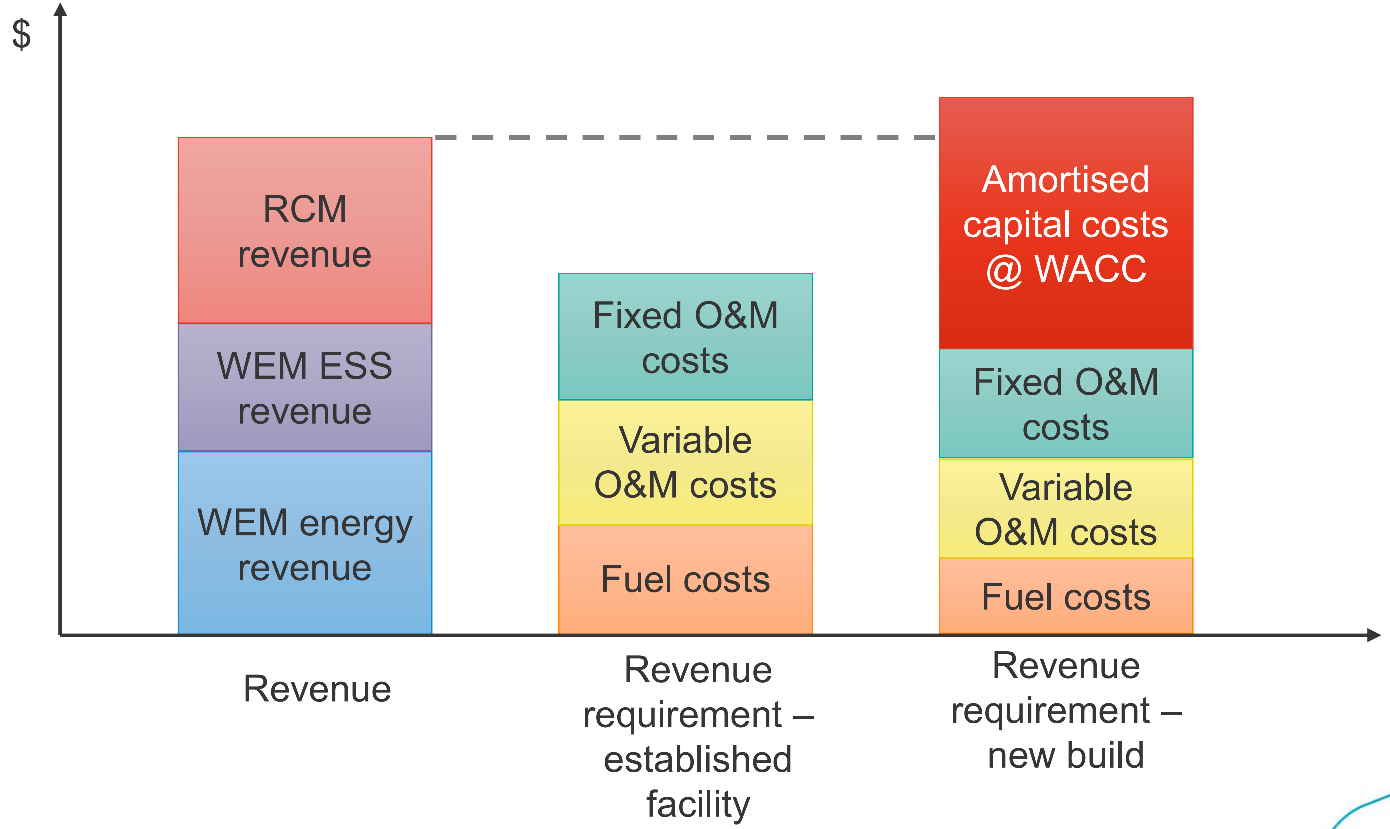


Modelling CRC/BRCP Method Impact



Revenue vs Revenue Requirement

The calculation of the required revenue for a facility depends on whether it is an established facility or a new build:



6. Modelling Assumptions

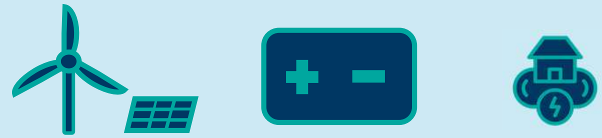
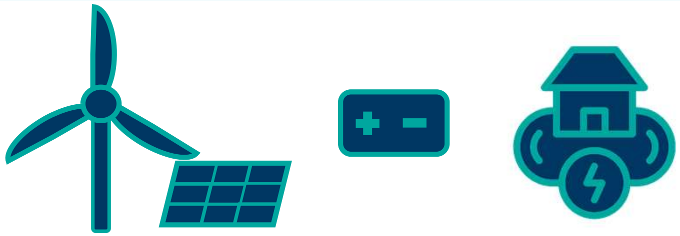
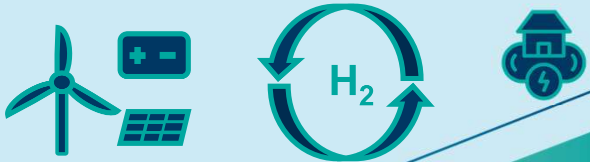
Modelling Input Data Assumptions

Data type	Source
Demand assumptions – profiles and growth (credible scenarios, including 1 in 10 year weather conditions)	• AEMO ESOO • WOSP • Low Load Work Programme (EPWA/AEMO/WP)
WEM Generation/DSP capacities	• AEMO • WOSP
Distributed (BTM) VRE capacity	• AEMO ESOO
Generation characteristics	• WOSP • AEMO Costs and Technical Parameters/ISP
VRE Generation profiles (historical traces for recent years)	• AEMO (Confidential data?)
Transmission constraints	• Request updated data from WP/AEMO
Fuel prices: • Crude oil • Natural gas • Coal • Distillate	 • Consensus of multiple published outlooks • CORE Energy Delivered Wholesale Gas Price Outlook 2020-2050 • DMIRS Major Commodities Resources Data • RBP analysis based on AIP Perth Terminal Gate data & crude oil outlook

Modelling Input Data Assumptions

Data type	Source
Known/assumed retirements of existing facilities	• Muja retires on schedule • A boundary scenario to assume no baseload plant required from 2030
Facility capital costs by technology	• AEMO ISP
New build WACC	• ERA BRCP determination
Value of Lost Load (VoLL)	• AER Value of Customer Reliability (VCR, for NEM) • SWIS demand by customer type (domestic, commercial, small industrial, large industrial, agriculture, mining etc.) to refine for the WEM
Other new build assumptions	• Assume new generation builds in locations where network capacity is available or assume transmission builds out. • Hence no transmission upgrade options

Fleet scenarios for 2050

#	Variable renewables	Flexibility resource	
1	Sufficient PV + wind by 2050 to meet energy requirement	Large storage capacity Some demand flexibility	
2	PV + Wind overbuild by 2050 reducing amount of storage required	Less storage capacity Large demand flexibility	
3	Sufficient PV + wind by 2050 to meet energy requirement	Green H2 thermal Some storage Some demand flexibility	

7. Modelling tools

The System Adequacy Model - CAPSIM

- CAPSIM simulates the capacity gap (available energy producing capacity minus load) for every hour of every year, sequentially, given a specific generation mix, load profile, Planned Outage schedule and random Forced Outages.
- This simulation can be conducted for varying load shapes and intermittent profiles
- CAPSIM is developed in Python, utilising the open-source packages Pandas and NumPy for tabular processing and vectorised operations

CAPSIM simulation overview

1. **Forecast load for each hour for each year of LT PASA horizon** ← Hourly traces calculated using different load shapes (load scenario)

2. **Calculate Unconstrained Available Capacity** ← Equals total capacity less Planned Outages less randomly simulated Forced Outages

   Apply SCED constraints

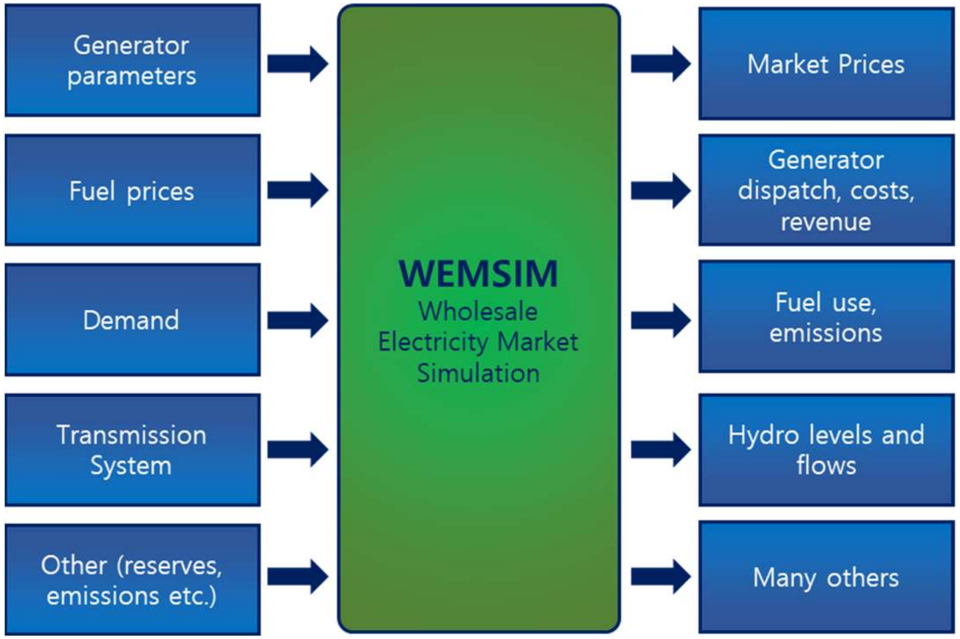
3. **Calculate Constrained Available Capacity** ← Equals Unconstrained Available Capacity less SCED curtailments

4. **Calculate Unserved Energy** ←
   - Hourly Unserved Energy equals (3) minus (1)
   - Annual Unserved Energy equals sum of hourly estimates
   - (2) (3) Is simulated multiple times (random forced outage seeds) per load scenario ((1))

5. **Calculate Expected Unserved Energy** ← Average simulated Unserved Energy estimates

The Market Simulation Model - WEMSIM

- **WEMSIM (Wholesale Electricity Market Simulation):**
  - Simulates the dispatch of thermal and hydro generation resources in a multi-regional transmission framework
  - is an analytical dispatch planning and analysis tool with an optimization engine based on linear and mixed integer programming
  - Simultaneously optimizes generation dispatch, reserve provision (and, in MIP mode, unit commitment)

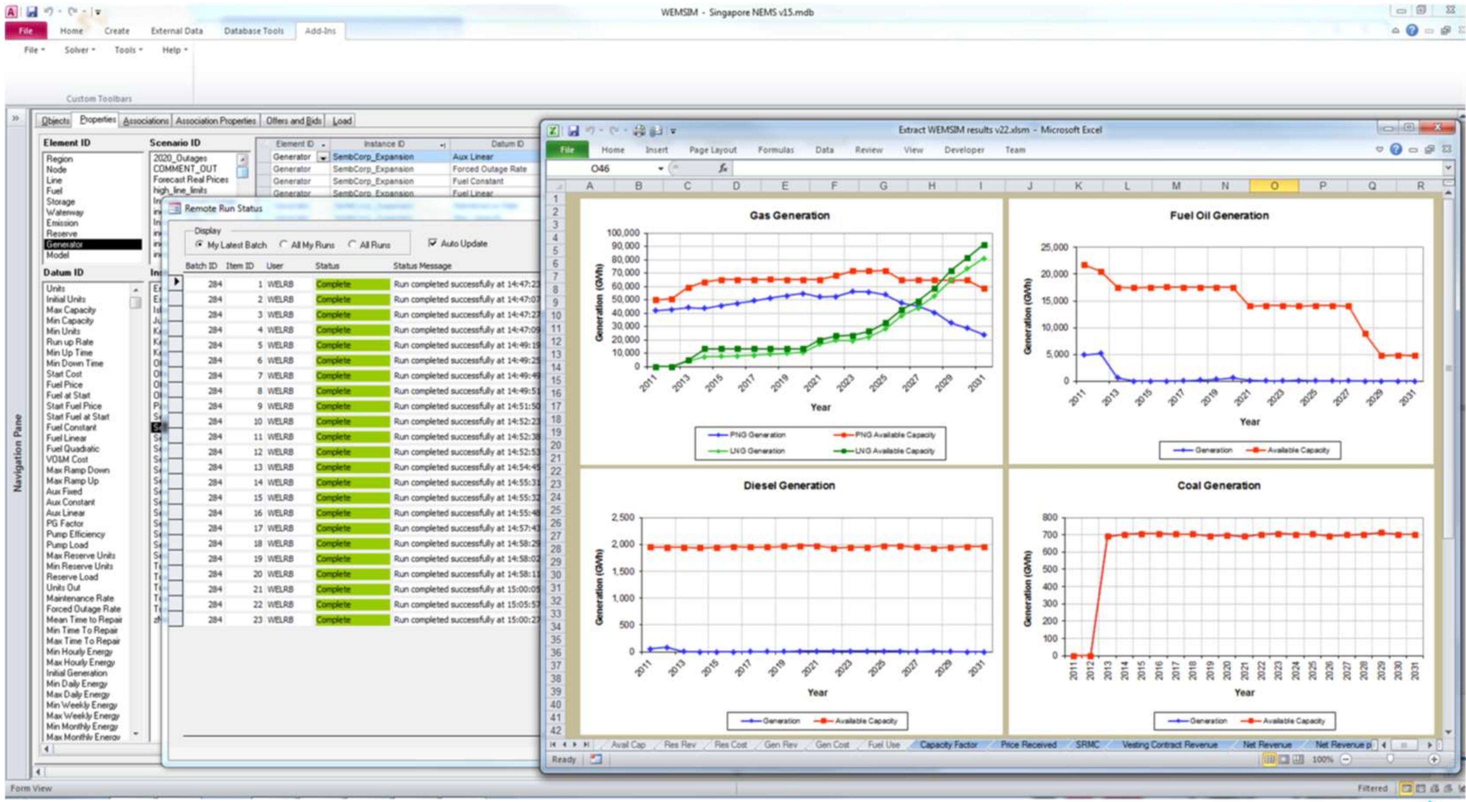


Detailed Modelling Capabilities

- Load representation: time-based load (detailed plant operations, rich outputs, longer solve time) or load duration curve (aggregated data, fast solution, broad-brush analysis)
- Thermal generation: fixed and variable heat rates; multiple fuels; fuel constraints; emissions rates and constraints; unit commitment with start-up costs, minimum uptimes, and downtimes; take-or-pay fuel contracts; scheduled and stochastic outages
- Hydro generation: Detailed modelling of storage, waterways, and inflows, including pumped storage
- Intermittent renewables: Daily and seasonal generation profiles
- Battery and other energy storage technologies: Round trip efficiency, energy and capacity limits
- Transmission: DC load flow and transmission OR NEMDE/WEMDE style constraint equations
- Full nodal pricing, or regional markets with transmission constraint equations (nomograms), or system-wide pricing
- Demand-side participation
- Essential system service requirements, provision, cost, and revenue
- Monthly, daily, and hourly profiles available on all parameters
- Facility forced outage and maintenance simulation

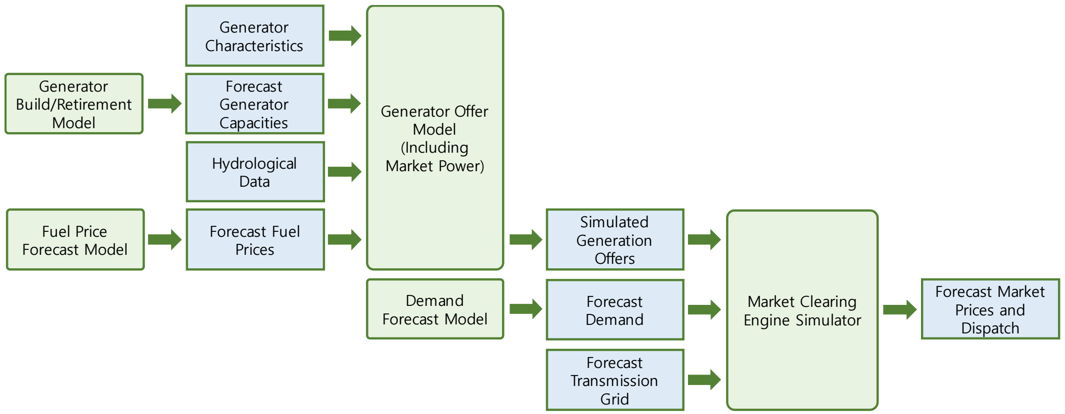
Outputs

Outputs available include: period-by-period energy and ESS prices, dispatch, fuel use, emissions, revenue, capacity factors, unserved energy, storage volumes, network flows, and transmission constraints



Supporting Modules

- The Market Clearing Engine Simulator is the core of the platform, performing security constrained economic dispatch with ESS co-optimization
- The Demand Forecast Model transforms a given demand shape and long-term peak and energy forecasts into realistic demand data that captures both long-term trends and short-term volatility
- The Generator Build/Retirement Model can take manual entries where known or expected, and supplement with economic build/retirement decisions
- The Generator Offer Model can provide for offers based on cost, market power (Bertrand gaming), water values/stored energy values for hydro/storage systems, or derived from historical data



8. Next Steps

Next steps

- **You may wish to provide (by end of Feb) further input on:**
  - Analysis or data relevant to the deliverables (please specify confidentiality)
  - International references, experience and research relevant to the WA Reserve Capacity Mechanism
- **Seek MAC's support for modelling approach/assumptions on 1 March**
- **Next Working Group meeting late March 2022**
  - Relevant international experience
  - Other (?)
- **Questions or feedback can be emailed to energymarkets@energy.wa.gov.au**

9. General Business

We're working for Western Australia.