Government of Western Australia
Energy Policy WA

Meeting Agenda

Meeting Title:	Reserve Capacity Mechanism Review Working Group (**RCMRWG**)
Meeting Number:	2022_03_17
Date:	Thursday 17 March 2022
Time:	9:30 PM to 11:45 PM
Location:	Online, via TEAMS.

Item	Item	Responsibility	Type	Duration
1	Welcome and Agenda	Chair	Noting	5 min
2	Meeting Apologies/Attendance	Chair	Noting	2 min
3	Minutes of Meeting 2022_02_17	Chair	Decision	3 min
4	Actions Items	Chair	Discussion	5 min
5	International Review Scope	RBP	Discussion	10 min
6	Market Summaries	RBP	Discussion	60 min
7	Potential Applications for the WEM	RBP	Discussion	30 min
8	Modelling Assumptions	RBP	Discussion	10 min
9	Next Steps	Chair	Discussion	5 min
10	General Business	Chair	Discussion	5 min
	Next Meeting: TBD			

Please note this meeting will be recorded.

Government of Western Australia
Energy Policy WA

Minutes

Meeting Title:	Reserve Capacity Mechanism Review Working Group (**RCMRWG**)
Date:	20 January 2022
Time:	9:35am – 11:20am
Location:	Microsoft TEAMS

Attendees	Company	Comment
Dora Guzeleva	Chair	
Dimitri Lorenzo	Bluewaters Power	Proxy for Paul Aires
Rhiannon Bedola	Synergy	
Oscar Carlberg	Alinta Energy	Subject matter expert (**SME**) Until 11:00am
Manus Higgins	AEMO	
Sumeet Kaur	Shell Energy	
Sam Lei	Alinta Energy	SME
Mark McKinnon	Western Power	
Wendy Ng	Shell Energy	To replace Sumeet Kaur in the future
Patrick Peake	Perth Energy	
Jacinda Papps	Alinta Energy	
Toby Price	AEMO	SME
Matt Shahnazari	Economic Regulation Authority	
Noel Schubert	MAC Small-Use Consumer representative	Observer
Andrew Stevens	Clear Energy	
Dev Tayal	Tesla Energy	
Andrew Walker	South32 (Worsley Alumina)	
Dale Waterson	Merredin Energy	
Rebecca White	Collgar Wind Farm	
Richard Bowmaker	Robinson Bowmaker Paul (**RBP**)	
Isaac Grumbrell	RBP	
Ajith Sreenivasan	RBP	

Tim Robinson	RBP	
Stephen Eliot	Energy Policy WA (**EPWA**)	
Laura Koziol	EPWA	

Apologies	From	Comment
Peter Huxtable	Water Corporation	
Paul Arias	Bluewaters Power	

Item	Subject	Action
1	**Welcome** The Chair opened the meeting at 9:30am.	
2	**Meeting Apologies/Attendance** The Chair noted the attendance as listed above.	
3	**Minutes of RCMRWG meeting 2022_01_20** Draft minutes of the RCMRWG meeting held on 20 January 2022 were circulated on 4 February 2022. The Chair noted that a revised draft of the minutes showing some changes was distributed in the meeting papers. The RCMRWG accepted the revised minutes as a true and accurate record of the meeting. **Action:** RCMRWG Secretariat to publish the minutes of the 20 January 2021 RCMRWG meeting on the RCMRWG web page as final.	**RCMRWG Secretariat**
4	**Reliability, resource adequacy and the RCM** Mr Tim Robinson presented a slide on grid reliability. The following key points were discussed: • Mr Robinson noted that the lack of flexibility could be addressed by incentivising flexible facilities. The question is if such incentives should be facilitated via the Essential System Services (**ESS**) market or the Reserve Capacity Mechanism (**RCM**). Mr Matt Shahnazari noted that capacity mechanisms conventionally aim to address system adequacy, not flexibility and indicated that it is questionable whether the conventional approach should change. Mr Shahnazari cautioned against using a single market mechanism to address different services. The Chair noted that the scope of the RCM Review included assessing the potential lack of flexibility and whether it should be addressed through the RCM.	

Item	Subject	Action
	Mrs Jacinda Papps noted that the ESS markets do not currently include a ramping service or fast frequency response and that those services need to be captured either in the ESS or in the RCM. Mrs Papps considered that the RCM would provide more long-term certainty for investors. Mr Shahnazari commented that the WEM Rules allow for the addition of new ESS, including ramping services, either through proposing new services or procuring those services through the supplementary ESS mechanisms. • Ms Rebecca White suggested adding resource location to the elements of resource adequacy.	
5	**Modelling methodology** Mr Richard Bowmaker presented the proposed modelling methodology. The following key points were raised: • Mr Bowmaker clarified that changes in demand including those driven by climate change would be considered as part of the underlying demand forecast. Mr Bowmaker clarified that the RCMRWG will discuss the assumptions for adjusting historic demand to derive future demand profiles before the modelling is commenced. The Chair noted that it is intended for the modelling to test and inform RCM Review decisions and that it is not practical to repeat the Whole of System Plan or to predict the outcomes of multiple scenarios based on multiple future drivers (i.e. climate change, electrification, etc.) within the timeframe of the RCM Review. Ms White noted that different scenarios for charging electric vehicles (EVs) may lead to very different outcomes. Ms Rhiannon Bedola noted that the behaviour of distributed energy resources (DER) would largely be driven by the tariff structure. The Chair emphasised that the timeline for the RCM Review would not allow modelling of all permutations of plausible scenarios. The Chair noted that the objective is to assess how the RCM can cope with a small number of key scenarios. However, demand will play an important role in the analysis. • Mr Manus Higgins noted that AEMO is preparing a document for the working group to provide detailed insights into the system stresses that AEMO is observing. • Mr Bowmaker indicated that start-up times will be considered when setting the modelling inputs and assumptions.	

Item	Subject	Action

- Mr Bowmaker clarified that the system adequacy modelling will assess if there is sufficient capacity for each Trading Interval and the dispatch model will then look at the availability of types of capacity on an interval-to-interval basis.
- Mr Patrick Peake noted that the objective of the RCM Review is to find a mechanism to ensure the required reliability.
- Mr Lei noted that any modelling using historic generation data will need to be adjusted for any dispatch of the Generator Interim Access (**GIA**) facilities.
- Mr Bowmaker clarified that the goal of the analysis is to identify the system needs based on the demand forecast and then to assess how much of the needed capabilities are available and how to model them. The model will assess each type of facility separately without any grouping.
- Mr Lei suggested to include a scenario with extremely high volatility in DER / demand, not only scenarios with extremely high peak demand. Mr Robinson noted that DER was modelled separately from underlying demand.
- Mr Shahnazari suggested that the RCM Review should first define the capacity product and then assess how the capacity of the current fleet would address the identified system stress events. The other question is if the system stress events can be addressed while meeting the net zero emissions target.
- The Chair noted that one objective of the RCM Review is to define the required capacity product.
- Mr Peak noted that year-to-year Reserve Capacity Price fluctuations may disincentivise investment. Mr Robinson noted that an option that may be investigated is to allow new facilities to lock in a price for several years.
- The Chair clarified that the analysis will be based on current policy. Therefore, a proxy carbon price will not be considered.

6 Modelling assumptions (including scenarios)

Mr Bowmaker presented the modelling assumptions and scenarios. The following points were made:

- The Chair clarified that:
  - the references to solar and wind generation should be replaced with references to low-emissions generation; and
  - any references to storage did not necessarily mean batteries but could include any type of storage.

Item	Subject	Action
	• Mr Bowmaker confirmed that all assumptions and inputs will be adjusted to reflect the latest information available. • Mrs Papps considered that the certification requirement for Scheduled Generators to demonstrate sufficient fuel contracts and transport arrangements to maintain 14 hours of continuous operation imposes unnecessary high costs on Market Generators, as run-times are currently shorter. Mrs Papps asked if this requirement would be assessed as part of the review. • The Chair noted that the 14-hour fuel requirement will be assessed as part of the development of the method(s) to assign Certified Reserve Capacity (**CRC**). The Chair noted that the ideal is to design one method to assign CRC for all technologies. • Mr Bowmaker noted that the modelling would assume that any needed transmission network augmentation will be built as required, so it will not need to be modelled. • Mrs Papps indicated that Alinta is willing to confidentially share with EPWA some of the recent experience about the costs of connecting a new facility to the network. • There was discussion about different studies on the value of lost load (**VOLL**). Mr Mark McKinnon agreed to report Western Power's assumptions about VOLL from the recent access arrangements to EPWA. Mrs Papps noted that the Brattle Group had published a relevant report few years ago. Mr Shahnazari noted that the Public Utilities Office had published a relevant report a few years ago. Mr Shubert noted that the political value of lost load is different than the economic value of lost load.	
	Action: Mark McKinnon to share Western Power's assumptions about VOLL from the recent access arrangement submission with the MAC Secretariat.	Mark McKinnon (March 2022)
7	**Modelling tools** The RCMRWG agreed to ask any questions regarding the modelling tools offline.	
8	**Next Steps** The RCMRWG agreed to hold a meeting on 17 March 2022 to discuss the outcome of the international review and an update on the detailed modelling assumptions.	
11	**General Business** No general business was discussed. The next RCMWG meeting is scheduled for 17 March 2022.	

The meeting closed at 11:30am.

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Agenda Item 4: RCMRWG Action Items

Reserve Capacity Mechanism Review Working Group (**RCMRWG**) Meeting 2022_03_17

Shaded	Shaded action items are actions that have been completed since the last MAC meeting.
Unshaded	Unshaded action items are still being progressed.
Missing	Action items missing in sequence have been completed from previous meetings and subsequently removed from log.

Item	Action	Responsibility	Meeting Arising	Status
1	All RCMRWG members to provide the MAC Secretariat with: • any analysis and data that is relevant to the deliverables for this review; and • any international references or experience relevant to the RCM in WA.	RCMRWG members	2022_01_20	**Closed** EPWA received information form Dev Tayal.
2	RCMRWG Secretariat to publish the minutes of the 20 January 2021 RCMRWG meeting on the RCMRWG web page as final.	RCMR Secretariat	2022_02_17	**Closed** The minutes were published on the RCMRWG web page on 17 February 2022.
3	Mark McKinnon to share Western Power's assumptions about VOLL from the recent access arrangements with the MAC Secretariat.	Mark McKinnon	2022_02_17	**Open**

Government of **Western Australia**
Energy Policy WA

Reserve Capacity Mechanism Review Working Group

Meeting 2022_03_17

17 March 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

5. International review scope

Scope and purpose

Review selected capacity markets to identify:

- **What issues they aim to address**
- **Issues they are facing or expected to face in the future**
- **Identified solutions**
- **How these issues relate to WEM**

Types of capacity mechanism

#	Capacity mechanism	Description	Jurisdictions
1	Strategic reserve – Quantity based - Targeted	Dispatched in the DAM or intraday market when all other services have been exhausted	Belgium, Finland, Sweden
2	Tenders for new capacity - Quantity based - Targeted	Tenders are provided by the regulator and/or market operator to the participant developing the capacity	Bulgaria and Croatia
3	Central buyer capacity auction – Quantity based – market wide mechanism	SO assigns overall capacity based on capability of each resource and auction determines the amount of capacity each resource is allocated	ISO-NE, PJM – Centralized Electricity Market
			UK, Ireland – Decentralized Electricity Market
4	De-centralized capacity auction - Quantity based – market wide mechanism	No central auction in this mechanism and LSEs are obliged to secure a part of the necessary total capacity for covering the demand	France, CAISO, NEM
5	Target capacity payment – Price based	They correspond to the fixed prices set by the regulatory authority for selected technologies to be built or newly built capacity	Spain and Portugal

WEM has elements of 4 and 5: central allocation of obligations, mixture of centralised and decentralised procurement.

Jurisdictions reviewed

Jurisdiction	Capacity mechanism
Pennsylvania, New Jersey, and Maryland Regional Transmission Organization (PJM RTO)	Reliability Pricing Model
New England Independent System Operator (ISO-NE)	Forward Capacity Auctions
France	De-centralized capacity obligations
Colombia	Firm Energy Obligation Auction
UK	Capacity market with auctions
Ireland	Capacity Renumeration Mechanism – Reliability Options
NEM	Design in process, three options under investigation.

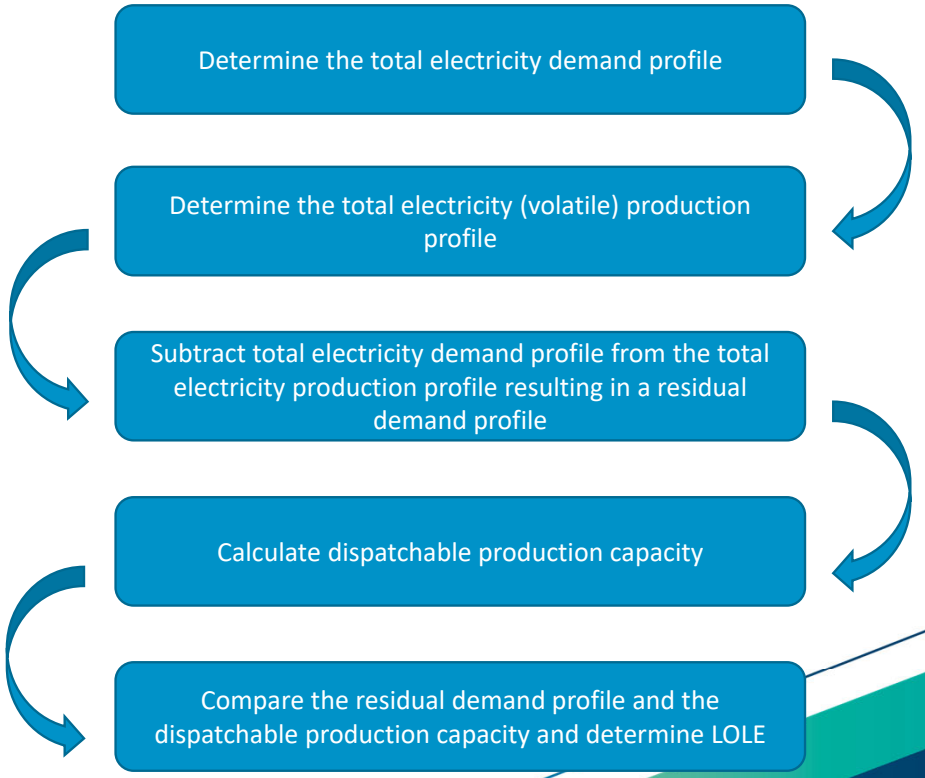
Capacity market overviews

- **PJM and ISO-NE** are among the most sophisticated wholesale energy markets in the world. Centralized auction for procurement of capacity with interties with neighboring markets. Capacity market from an American perspective.
- **UK** introduced a capacity market in 2014 and was explicitly identified in the project ToR.
- **Ireland** is a small market (though with interconnection), with high renewable penetration.
- **France** uses decentralized capacity obligations, though the generation fleet is very different from the WEM.
- **Colombia** is one of the few markets which seeks to address reliability over a longer period, mainly due to hydro risk.
- **NEM** design is currently underway.

6. Market summaries

Loss of Load Expectation

- LOLE represents the number of hours per annum in which, over the long-term, it is statistically expected that supply will not meet demand. E.g. LOLE of 3 hours means 3 hours during the year; supply may not meet demand.
- LOLE is a probabilistic approach – that is, the actual amount will vary depending on the circumstances in a particular year, for example how cold the winter is; potential for an unusually large number of power plants to suffer simultaneous forced outage; all the other factors which affect the balance of electricity supply and demand.
- LOLE does not mean power blackouts are expected. It is a metric for Transmission System Operators to use instruments such as temporary voltage reductions or the selective disconnection of large industrial users to prevent blackouts.
- LOLE does not measure the total shortfall in capacity which is measured by Expected Energy Not Served (EENS). LOLE only measures the number of hours supply will not meet demand.



PJM – market summary

MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Gross pool
Trading interval	5 minutes
Locational pricing	Yes
Day ahead market	Yes
Real time market	Yes
Interties	Yes
Capacity Market	
Procurement structure	Reliability Pricing Model
Additional features	Bilateral trading
Auction type	Mandatory centralized uniform price auction
Resource adequacy requirement	Systemwide and local requirements set by 0.1 LOLE study (i.e.) 1 event in 10 years
Timeline	3 years in advance. Incremental auctions are held up to the delivery year.
Price information	Sloped demand curve is used based on the system capacity requirement, the net-CONE, and demand reservation prices.
Intermittent in capacity market	Can receive RE support from state as well as partake in capacity market

2019 Installed Capacity vs Peak demand	
Installed Capacity	182 GW
Peak demand	150 GW
Difference	22%

PJM – capacity mechanism overview (1)

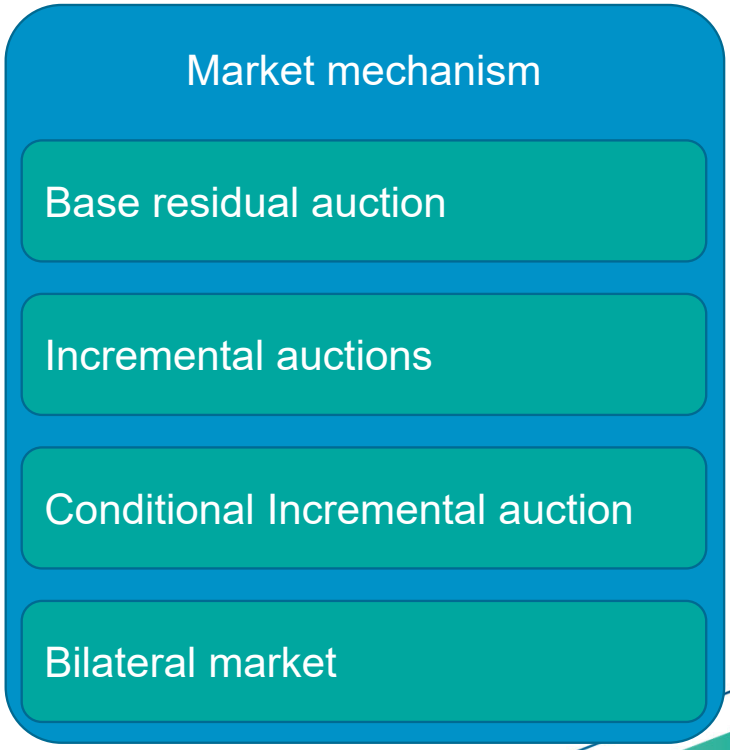
Reliability Pricing Model

- **0.1 LOLE (i.e. 1 event in 10 years)**
- Merchant transmission developers can offer transmission upgrades into the capacity market
- Elements of RPM to achieve reliable capacity procurement are
  - **Locational Capacity Pricing** to recognize and quantify the locational value of capacity
  - **VRR** is the auction mechanism to determine the capacity required and adjust price based on the level of resources procured
  - **Forward Commitment of Supply** to commit supply by generation, demand resources, energy efficiency resources, and qualified transmission upgrades cleared in a multi-auction structure
  - **Reliability Backstop Mechanism** to ensure that sufficient generation, transmission and demand response solutions will be available to preserve system reliability. The Office of the Interconnection shall conduct each Reliability Backstop Auction to commit additional Generation Capacity Resource if enough capacity is not procured

PJM – capacity mechanism overview (2)

Reliability Pricing Model

- **Base Residual Auction (VRR)** - The Base Residual Auction (BRA) is a mandatory centralized forward uniform price auction which is held three years prior to the start of the Delivery Year through a Locational Reliability Charge.
- **Incremental Auctions** – At least three Incremental Auctions (First, Second and Third) are conducted after the Base Residual Auction to procure additional resource commitments. **Conditional Incremental Auction** may be conducted if a Backbone transmission line is delayed and results in the need for PJM to procure additional capacity in a LDAs to address the corresponding reliability issues.
- **Bilateral Market** – The bilateral market provides resource providers an opportunity to cover any auction commitment shortages



PJM – Resource adequacy

Reliability Pricing Model

- Determines resource adequacy every year for a 11-year future period.
- Reliability depends on – installed capacity of resource and probability that a resource will not be available due to forced outages.

Conventional generation	Wind, solar and storage capacity	Energy Efficiency resources
Nameplate capacity around the year	Unforced capacity calculated as the average hourly output of these resource during expected performance hours in summer (15:00 - 20:00 - June, July, and August) and winter (6:00 - 9:00 and 18:00 - 21:00 - January and February).	Achieve a continuous reduction in energy consumption at the end customer's retail site which will be calculated during EE performance hours (15:00 - 18:00 during all days from June 1 - August 31, inclusive, of Delivery Year, that is not a weekend or federal holiday)

PJM – issues and solutions

1. **Reliability criterion needs to evolve**. Current measure is 1-in-10 LOLE or 0.1 LOLE. Does not account for magnitude or duration of the LOLE event. Looking to account for duration and amount of load shed in determining the reliability criterion.
2. **Reliability contribution of renewable resources**. Currently, unforced capacity of intermittent resources is evaluated for a fixed duration in expected performance hours. Lately, performance of units can vary across periods which were previously not considered. Proposed to use Effective Load Carrying Capability (ELCC) (probabilistic analysis which considers the contribution of the resource during hours of high risk).
3. **Minimum offer price rule**. Instituted to stop net consumers from offering capacity into auction below cost, and also used for renewable resources receiving state subsidies. Not so relevant for WEM.

ISO-NE – market summary

MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Gross pool
Trading interval	5 minutes
Locational pricing	Yes
Day ahead market	Yes
Real time market	Yes
Interties	Yes
Capacity Market	
Procurement structure	Forward Capacity Auctions
Additional features	Bilateral trading
Auction type	Mandatory centralized descending clock auction
Resource adequacy requirement	Systemwide and local requirements set by 0.1 LOLE study
Timeline	3 years in advance. Incremental auctions are held annually and monthly
Price information	Sloped demand curve is used based on LOLE and net-CONE
Intermittent in capacity market	Can receive RE support from state as well as partake in capacity market

2019 Installed Capacity vs Peak demand	
Installed Capacity	31.5 GW
Peak demand	23.9 GW
Difference	32%

ISO-NE – capacity mechanism overview (1)

Forward Capacity Market

- **0.1 LOLE study (i.e.) 1 event in 10 years.**
- Interties are allowed to participate in the capacity market
- First capacity is procured for meeting system wide requirements followed by the modelled capacity zone followed by monthly and annual auctions for parties to procure/provide resources.
- Three year ahead auction with a bilateral arrangement for trading capacity outside the auction among resource providers and buyers. There are also monthly and annual reconfiguration auctions for parties to procure/provide resources based on the market condition closer to the delivery year.
- FCA is organized in a descending clock format basis where the market is cleared when supply offered by the resource providers (generating resources and demand participants) meets the demand which is based on the resource adequacy requirement.

ISO-NE – Resource adequacy

Forward Capacity Market

Existing conventional generation	Intermittent	Demand capacity resources
Median of the existing generating capacity resource's summer or winter seasonal claimed capability rating for the previous five years.	• Median of net output in the summer intermittent reliability hours (14:00 - 18:00 between June and September) and winter hours (18:00 -19:00 each day between October and May) for the previous five years • Output also measured during scarcity conditions (when reserve price equals reserve price cap - Reserve Constraint Penalty Factors	• Consists of Load management measure, distributed generation measures, an energy efficiency measure or a combination • Resource's estimated demand reduction value as submitted and reviewed • Reliability measured during historical peak demand or system stress periods

ISO-NE – issues and solutions

1. **Method of assigning capacity credits**. Currently, the compensation by ISO-NE for provision of capacity is inconsistent with the marginal impact on reliability. These include conventional generators having low flexibility, large generators whose outage leads to large and more impactful fall in supply, gas units that lack backup fuel, intermittent resources, and energy storage.

   In the calculation of qualified capacity for conventional generators, the following factors are not considered:

   - Lower flexibility of some of the resources due to longer start time and limited operational flexibility. This is not accounted for in the qualified capacity for the unit.
   - The size of the resource is not accounted for in assigning qualified capacity.

2. **Over-reliance on natural gas**. One supply issue with the provision of natural gas is that most of the gas generators do not have firm contracts with suppliers and tend to buy on the spot market.

France – market summary

MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Net pool
Trading interval	30 minutes
Locational pricing	No
Day ahead market	Yes
Real time market	Yes
Interties	Yes
Capacity Market	
Procurement structure	Decentralized capacity procurement
Additional features	Optional participation with obligation
Auction type	Optional auction
Resource adequacy requirement	Local requirements based on LOLE which is 3 hours per year
Timeline	Market operates on a continuous basis until delivery. Trades can take place in OTC or organized exchanges
Price information	Certificates are traded with a price cap of €60 000/MW (2020)
Intermittent in capacity market	Diminishes RE revenue when participating in the capacity mechanism

2019 Installed Capacity vs Peak demand	
Installed Capacity	96.8 GW
Peak demand	88.5 GW
Difference	9%

France – capacity mechanism overview (1)

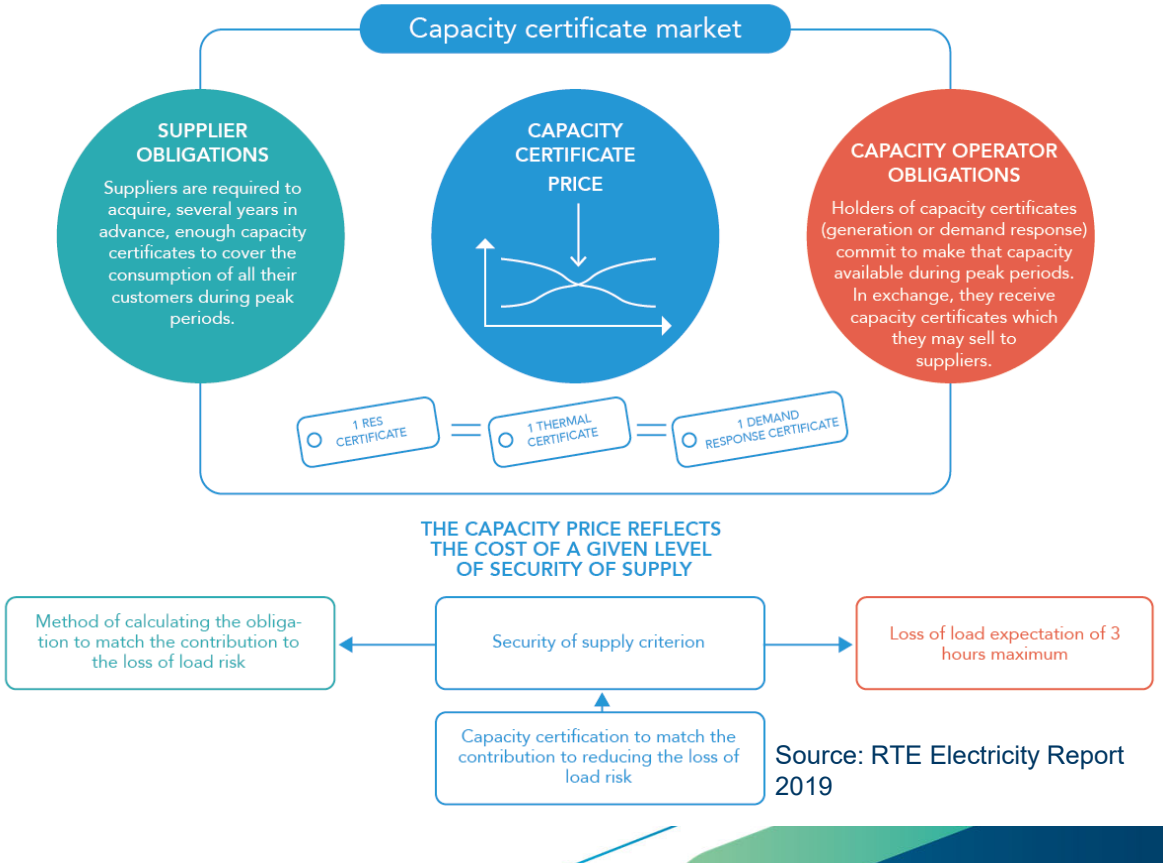
Decentralized capacity procurement

- **3-hour LOLE.**
- France’s capacity market is intended to meet peak load, not average load.
- Interties are allowed to participate in the capacity market
- Under a decentralized model, it is the actors like suppliers who are responsible for system adequacy for matching the supply and demand instead of a central party.
- Conventional generators are offered 1- year contracts while new low emission facilities and energy storage are offered 7-year contracts.
- The capacity mechanism first creates a capacity requirement which obligates suppliers to obtain energy certificates to meet their expected peak demand based on their end customer energy usage. This way the suppliers are held responsible to contain their peak demand by providing incentives to limit consumption.

France – capacity mechanism overview (2)

Decentralized capacity procurement

- Market participants can exchange guarantees either bilaterally on the OTC market or enter auctions organized by EPEX SPOT market.
- During the delivery year, RTE determines the peak demand days the day before for the next day, which is:
  - **15 PP1 days** for suppliers – Jan-Mar, Nov-Dec.
  - **15-25 PP2 days** for generators and capacity operators - 15 PP1 days which are also PP2 days and 0 to 10 days which are PP2 days excluding PP1 days.
- Demand-side response can be used by two different methods: either by reducing a supplier's capacity obligation by reducing consumption ('implicit demand-side response') or by certifying demand-side response capacity ('explicit demand-side response'). The obligations for the two types of demand-side response capacity are different: 'implicit demand-side response' must actually be activated during PP1 hours, whereas 'explicit demand-side response' must be available during PP2 hours.
- PP1 and PP2 days are differentiated based on a threshold of expected demand.



Source: RTE Electricity Report 2019

France – Resource adequacy

Decentralized capacity procurement

- The capacity mechanism does not explicitly distinguish between different capacity sources for providing capacity certificates and there are no locational distinctions.
- RTE issues certificates, calculated on the basis of the original data, together with corrections reflecting the risk of non-availability, for example in the case of wind, hydro or solar generation.
- Suppliers acquire enough capacity certificates to meet the peak consumption of their customers. Producers committed to make their capacities available during consumption peaks are granted certificates, which they can sell to retailers.
- Intermittent energy providers are allowed to participate in the capacity market, but their renewable subsidy is reduced equivalent to the capacity revenue from the market to avoid double subsidization.

France – issues and solutions

1. **Market concentration**. In France, nuclear power dominates the electricity mix in terms of energy delivered. Further, all the nuclear generation facilities in France are owned by Électricité de France (EDF) owning a substantial share in the generation portfolio.

    - Recent technical problems in the reactors owned by EDF (5 plants with simultaneous unplanned outage) means that nuclear output has dropped significantly, and France is now a net importer. This issue highlights the importance of diversifying generation sources so that instead of relying on a single large resource of electricity, several small generators can be commissioned to provide the same capacity to minimize the risk of fall short of supply.

Colombia – market summary

MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Gross pool
Trading interval	1 hour
Locational pricing	No
Day ahead market	Yes
Real time market	Yes
Interties	Yes
Capacity Market	
Procurement structure	Firm energy obligation auction
Additional features	Call option and bilateral trading through a reliability mechanism
Auction type	Centralized descending clock auction
Resource adequacy requirement	Local requirements set by CONE and LOLE
Timeline	3 years in advance. but this will increase by six months in each successive auction, until it reaches 4 years
Price information	Sloped demand curve with firm energy price having a ceiling of two times CONE and a floor of one-half times CONE.
Intermittent in capacity market	Tenders occur in parallel but do not overlap

Colombia – capacity mechanism overview (1)

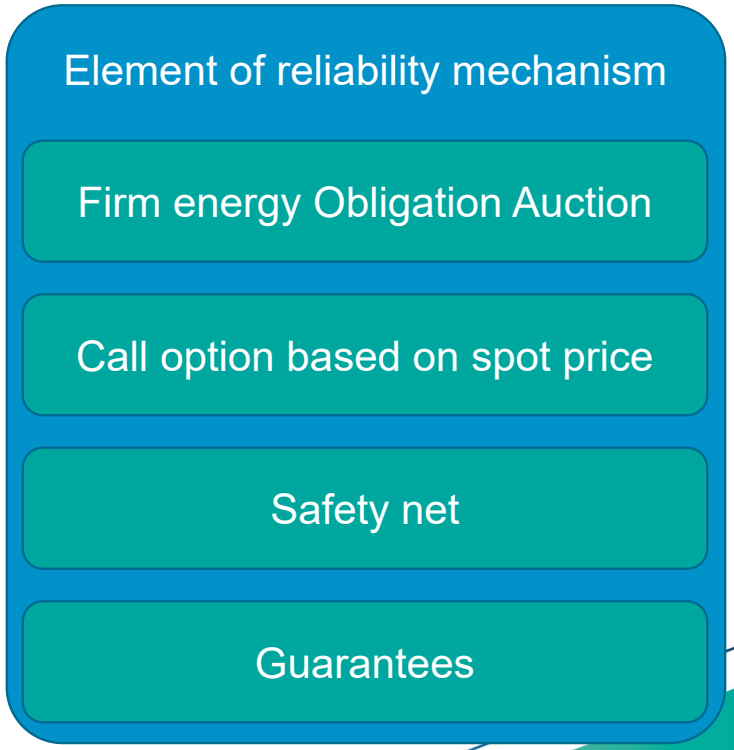
Firm energy obligation auction

- Held 3 year before delivery period.
- Initially capacity payment was used to promote new power capacity in order to guarantee security of supply. This was an administrative capacity payment rather than an auction-based market mechanism.
- The capacity price was set conservatively making the generators reliant on energy prices and due to high volume of hydro capacity leading to low prices, investment was subject to uncertain revenue.
- Due to its failure, reliability charge was created. This new market-based mechanism was largely dependent on auctions for new capacity and was designed to guarantee payments to generators for being available when needed.
- A descending clock auction design is adopted for awarding Firm Energy Obligation.
- Bilateral contracts can be agreed between parties to allow trading of obligations, voluntary interruptible demand can participate.

Colombia – capacity mechanism overview (2)

Firm energy obligation auction

- Firm Energy Obligations are allocated and priced in these auctions. Winning Gencos receive a stable and continuous reliability revenue for:
  - Existing plants – 1 year
  - New plants (not under construction during auction) – Between 1 and 20 years
  - New plants (under construction during auction) – Between 1 and 10 years.
- Capacity providers must offer their service during scarcity periods when the spot price exceeds the call price called the scarcity price.
- If the generator produces more or less than the firm energy obligation, it must be settled in the spot market either by purchasing the required energy or get paid for the excess energy generated respectively.
- Safety net include secondary/reconfiguration auctions. Generation assets purely and exclusively used to fulfill Firm Energy Obligations
- Guarantee include contracting fuel supply, and natural gas transportation required to back-up the compliance of obligation.



Colombia – issues and solutions

1. **Penalty regime**. Hydro power plants were found to generate electricity using their hydro reserves for honoring their bilateral sales commitments and were not conserving water in preparation for dry hydrological year.
    - The appropriate penalties were not in place for under performance. Hydro generators preferred the risk of future non-performance against immediate economic loss which they would have incurred if they had purchased power in the market to meet the bilateral obligations.
2. **Appropriate scarcity prices**. Obligation trigger prices were artificially increased when there was an oil supply shortfall due to higher oil prices and increased demand due to droughts caused by the El Niño event.
    - As the variable costs were higher than the trigger price at that time, CREG had to increase the trigger price to reduce operating losses from fulfilling firm energy obligations.

UK – market summary

MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Net pool
Trading interval	30 minutes
Locational pricing	No
Day ahead market	Yes
Real time market	Yes
Interties	Yes
Capacity Market	
Procurement structure	Capacity market with auctions
Additional features	Bilateral trading
Auction type	Voluntary centralized descending clock auction
Resource adequacy requirement	Local requirements based on LOLE which is 3 hours per year
Timeline	There is a four-year-ahead auction followed by a year-ahead auction
Price information	Sloped demand curve with a price cap of GBP 75/kW (2014). 95% target capacity at price cap and 105% target capacity where price reaches zero
Intermittent in capacity market	Prohibits RE support when participating in the capacity market

2019 Installed Capacity vs Peak demand	
Installed Capacity	77.92 GW
Peak demand	60 GW
Difference	31%

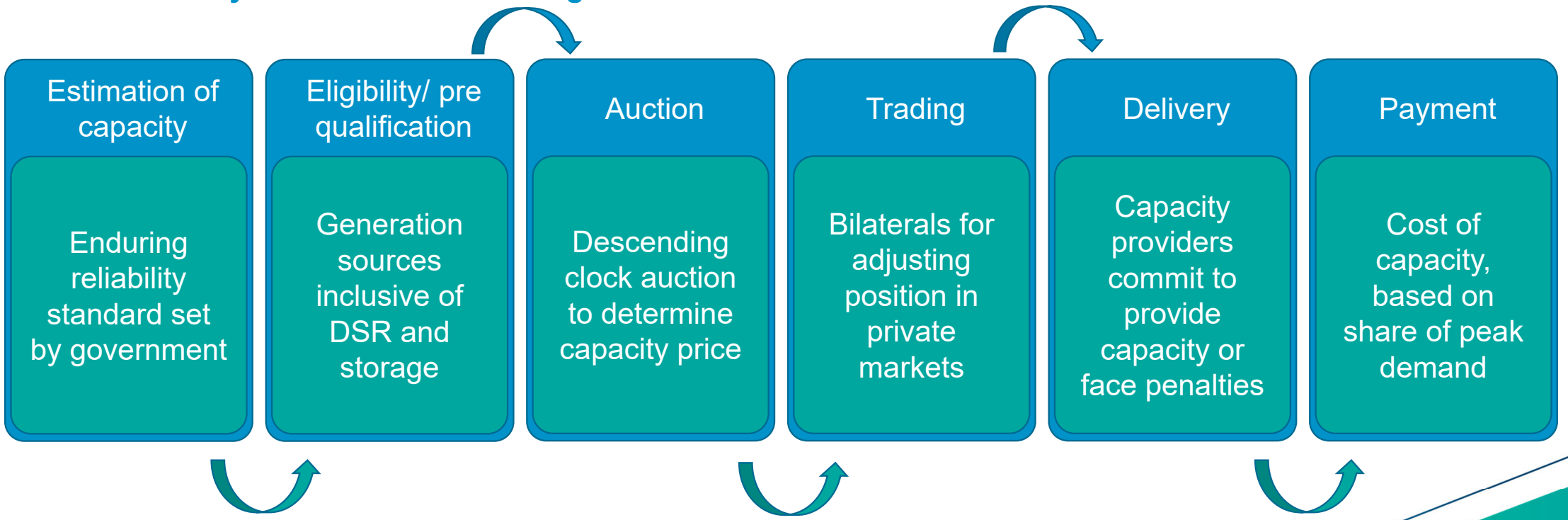
UK – capacity mechanism overview (1)

Voluntary centralized descending clock auction with bilateral

- **3 hour LOLE.**
- Descending clock format with ‘pay-as-clear’ structure.
- Interties are allowed to participate in the capacity market
- First auction for capacity year is held 4 years prior followed by 1 year ahead supplementary auction.
- In the capacity mechanism, a perfect network is assumed to exist where power can always flow across uninterrupted. Hence, locational constraints are not taken into account for procuring capacity.
- National Grid will have the capability to run zonal auctions, if necessary, to manage constraints, but no such zones will be created unless approved by Ofgem

UK – capacity mechanism overview (2)

Voluntary centralized descending clock auction with bilateral



Source: Adapted from DECC site

UK – Resource adequacy

Voluntary centralized descending clock auction with bilateral

- Capacity market in UK is technology neutral in that it does not differentiate between technology types (i.e.) does not seek to procure allocated volumes from specific technology types.
- Intermittent renewable generators cannot participate in the capacity mechanism if they receive subsidies from other state funded schemes.
- Demand response is eligible to participate in intermediate auctions before the main auction to stimulate investment in this types of resource.
- All capacity facilities are derated to account for unplanned plant closure or maintenance. This derating factor is based on the ability of the resource to provide during periods of system stress
- Intermittent facilities are assessed based on historical performance.

Fuel Type	Winter Availability	Summer Availability
Coal (and Biomass)	87%	61%
Gas CCGT	86%	69%
OCGT[17]	77%	63%
Gas CHP	86%	89%
Hydro	92%	84%
Pumped Storage	95%	95%
Nuclear[18]	83%	71%
Oil	81%	47%
Wind	20-22%	11%

Adjusted every year based on historic performance

Wind availability calculated using Equivalent Firm Capacity (EFC) method

UK – issues and solutions

Voluntary centralized descending clock auction with bilateral

The two major issues that were identified were over-procurement of capacity due to low clearing prices and the dampening of on-peak load pricing in the wholesale energy market which is the main source of income for demand-side management technologies.

1. **Favoring incumbent generators**. Several OCGT and diesel power plants connected to the distribution network cleared the market as they avoided paying (TNUoS) charge leading to higher emitting resources clearing the auction.
    - While the capacity mechanism was able to procure the necessary capacity at a very low price, the mix of capacity that cleared the auctions were not the most efficient in terms of true economic cost.
2. **Participation of demand response**. New generators are provided longer contracts while demand response providers can bid into the auction for only one-year contract and cannot win a long-term contract.
    - Long contracts provide the required assurance and stability of revenue to build a business case and secure investment in development of new technology. But a shorter one-year contract does not provide the necessary timeframe to develop and install a new demand response technology.

Ireland – market summary

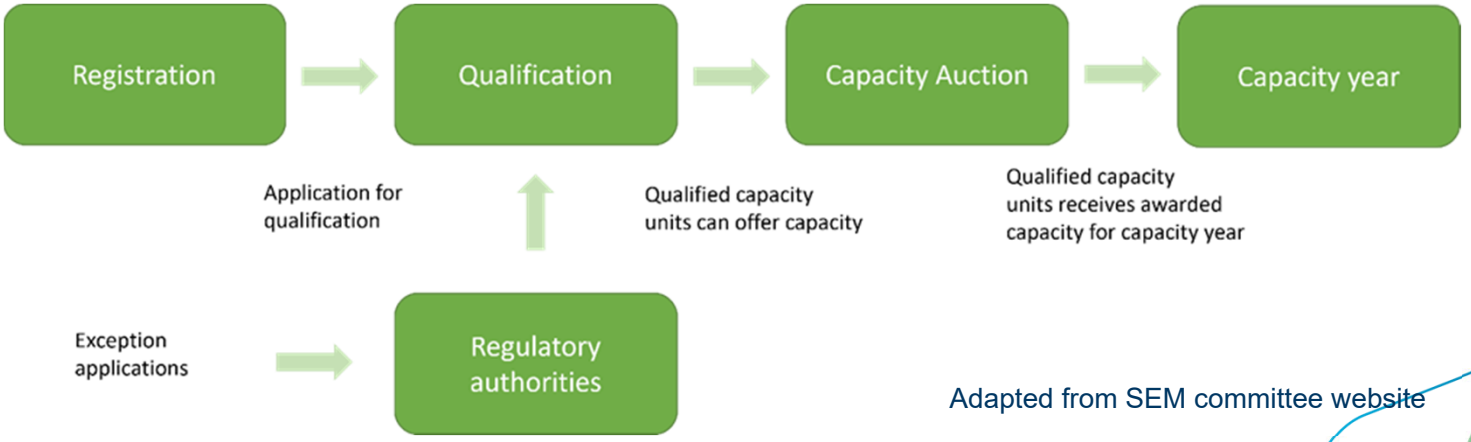
MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Gross pool
Trading interval	30 minute
Locational pricing	No
Day ahead market	Yes
Real time market	Yes
Capacity Market	
Procurement structure	Capacity Renumeration Mechanism – Reliability Options
Additional features	Bilateral trading with reliability options
Auction type	Central buyer uniform price sealed bid auction with locational network constraints
Resource adequacy requirement	Local requirements based on LOLE which is 8 hours for Ireland and 4.9 hours for Northern Ireland
Timeline	There is a four-year-ahead auction followed by a year-ahead auction
Price information	Sloped demand curve with price cap at 150% of CONE. 100% of target capacity at price cap, then target capacity at 100% CONE and finally zero price at 115% target capacity
Intermittent in capacity market	Diminishes RE revenue when participating in the capacity mechanism

2019 Installed Capacity vs Peak demand	
Installed Capacity	16.7 GW
Peak demand	6.8 GW
Difference	145.6%

Ireland – capacity mechanism overview (1)

Capacity Renumeration Mechanism – Reliability Options

- **Local requirements based on LOLE which is 8 hours for Ireland and 4.9 hours for Northern Ireland.**
- Interties are allowed to participate in the capacity market
- Auctions are conducted as a sealed bid combinational auction with uniform clearing price where one participant does not know the other participant's bid.
- First auction for capacity year is held 4 years prior followed by 1 year ahead supplementary auction.



Adapted from SEM committee website

Ireland – capacity mechanism overview (2)

Capacity Renumeration Mechanism – Reliability Options

- CRM is locationally constrained. More expensive and additional capacity may be procured in order to address locational constraints than otherwise would be if the network was considered unconstrained.
- SEM operates with reliability option which is a one-sided Contract for Differences (CfD). Reliability option bundles a call option to each unit the provider sells to the capacity market. The capacity provider is committed to a payment that is the difference between the market price and a set strike price.
- The strike price is set such that it is at or slightly higher than the marginal cost of the peaking plant so that the cash flow captures the scarcity rent that would be earned by the providers with the capacity of the peaking unit is exhausted.
- This means the participants will never earn more than the marginal peaking price in the wholesale or balancing market.

Ireland – Resource adequacy

Capacity Renumeration Mechanism – Reliability Options

- Derating is based on historic performance data and sometimes expected changes in future performance (based on projections) can be taken account of. Facilities with higher reliability will have a smaller derating, meaning they can offer a larger share of their installed capacity into the auction.
- Interconnectors, demand response, existing capacity, new capacity and storage can bid in the auction. All qualified capacity, except intermittent and new resources **must** bid into the auction.
- For variable intermittent like solar and wind, whose outage pattern is highly correlated, the derating is based on entire class of the resources rather than individual units. Derating is based on technology and **unit size**. The exception is energy storage where de-rating factors have been provided for storage, based on duration as well.
  For all resources except wind & storage: $\{\sum_{unit}\sum_{year} (\text{Annual Run Hours})_{unit} \times (\text{Average Forced Outage Rate})_{unit}\} / \{\sum_{unit}\sum_{year} (\text{Annual Run Hours})_{unit}\}$,
  The **availability of the wind** technology class is based on the actual output of all wind units relative to their installed capacity and defines a profile of wind generation for a year.
  Set of de-rating curves for pumped hydro **storage units** (based on its historical outage statistics) and another set of de-rating curves for other new storage types (such as batteries, compressed air and flywheels) that are based on system wide outage statistics.
- For renewables in the Republic of Ireland, the Renewable Energy support is diminished on capacity revenue generated through CRM while in Northern Ireland, Renewable Obligation Certificate holders cannot participate in the capacity mechanism in order to prevent double subsidization.

Ireland – issues and solutions

1. **Market concentration**. Given the very small size of Ireland market and the relatively large size of each generator, the market power each capacity provider in the area holds is quite high.
   - In 2018, one of the largest generators in Dublin did not clear the capacity auction and hence wished to exit the market. Since no new capacity was procured in that auction and the generation unit formed a significant source of supply for that area, it was necessary to keep the generating unit running for ensuring the operational viability in Dublin.

2. **Incentivizing renewable intermittent**. Under the current CRM arrangement, generators are rewarded based on their availability to generate during periods of high demand. If they are not able to provide capacity, they must pay back the entire market reference price for the RO volume promised for that period. Some intermittent generators choose not to participate in the capacity mechanism to avoid the risk of not being able to deliver their (centrally set) derated capacity quantity during those periods.

NEM – market summary

MARKET INFORMATION	
Energy Market	
Gross vs Net pool	Gross pool
Trading interval	5 minutes
Locational pricing	5 zones
Day ahead market	No
Real time market	Yes
Capacity Market – emerging design	
Procurement structure	Three approaches under consideration:
Additional features	1a. Fully decentralised – retailers forecast demand and procure capacity 1b. Hybrid decentralised – AEMO forecasts demand, retailers procure capacity 2. Centralised – AEMO forecasts demand and procures capacity
Auction type	Auction possible under any approach, format TBC.
Resource adequacy requirement	Currently <0.002% unserved energy (interim off-market RRO <0.0006% USE)
Timeline	TBC
Price information	Pricing at same locations as energy market.
Intermittent in capacity market	Derating based on 'at risk' periods. TBC whether forward or historic

2021 Installed Capacity vs Peak demand	
Installed Capacity	51.6 GW
Peak demand	31.8 GW
Difference	162%

NEM – options under consideration

Option 1a – fully decentralised

- Liable entities:
  - Forecast their own load
  - Determine the quantity of capacity certificates they need
  - Procure certificates bilaterally
  - Assessed ex-post based on actual demand
  - Penalties for under-procurement include payment of RERT costs as well as AER enforcement
- Potential for exchange-based trading and/or central auction, but all supply/demand would be determined by liable entities

NEM – options under consideration

Option 1b – hybrid decentralised

- AEMO:
  - Forecasts load
  - Allocates a capacity requirement to each liable entity
- Liable entities:
  - Procure certificates bilaterally
  - Assessed ex-ante based on forecast demand
  - Penalties for under procurement at various points in time, with 100% coverage not required until one year ahead.
- Potential for exchange-based trading and/or central auction, either with:
  - All supply/demand determined by liable entities
  - AEMO to procure shortfall where liable entities have not procured to meet their allocation

NEM – options under consideration

Option 2 – centralised

- AEMO:
  - Forecasts load
  - Procures capacity in an auction with an administered demand curve
  - Allocates capacity costs to liable entities based on actual demand

Supply side incentives

- Two approaches:
  - Explicit penalties for non-performance in ‘at risk’ period (per WEM and elsewhere)
  - Cap contract reliability options, where providers are exposed to difference between spot price and some cap (e.g. $300/MWh). ‘at risk’ periods are implicit, as spot price used instead

NEM – issues

- Transmission constraints – intra-regional constraints mean challenges for derating
- Market power – decentralized procurement puts pure-play retailers at a disadvantage to gentailers
- Incentives for under- or over-estimation of demand forecast.
- Interplay with extremely high market price caps, and potential scarcity pricing.

7. Potential applications for the WEM

Summary – Reliability criterion

Jurisdiction	Reliability criterion
PJM	0.1 events per year
ISONE	0.1 events per year
France	LOLE of 3 hours per year
Colombia	-
UK	LOLE of 3 hours per year
Ireland	LOLE which is 8 hours for Ireland and 4.9 hours for Northern Ireland
NEM	Currently <0.002% USE
WEM	Greater of: (a) 7.6% margin or largest contingency above 90/10 peak load, plus load following, or (b) 0.002% unserved energy

Summary – Demand curve

CONE = capital investment costs plus operational and maintenance expenses incurred during the first year of operation of the new entrant

Net-CONE = CONE less an estimate of the energy/ancillary services market profits for the entrant. It is an estimate of capacity revenue needed by a new generator in its first year of operation to make it economically viable to build a power plant.

Jurisdiction	Price cap	Determination of CONE
PJM	$\frac{\text{Max (CONE,1.5 x net−CONE)}}{1 - Poolwide\ Equivalent\ FOR}$	Entry of a Combustion Turbine (CT) generating station, configured with a single General Electric Frame 7HA turbine
ISONE	Max (CONE,1.6 x net-CONE)	Gas-fired simple-cycle combustion turbine, or CT
Colombia	2 x CONE	Initially set administratively based on a study of the cost of a new efficient peaking unit (gas)
UK	1.5 x Net-CONE	New Combined Cycle Gas Turbine (CCGT)
Ireland	1.5 x CONE	CCGT using GE9FB.05 model turbine
NEM	TBC	TBC
WEM	1.3 x BRCP	BRCP - capital costs of a 60 MW open-cycle gas turbine generation

Potential lessons for the WEM (1)

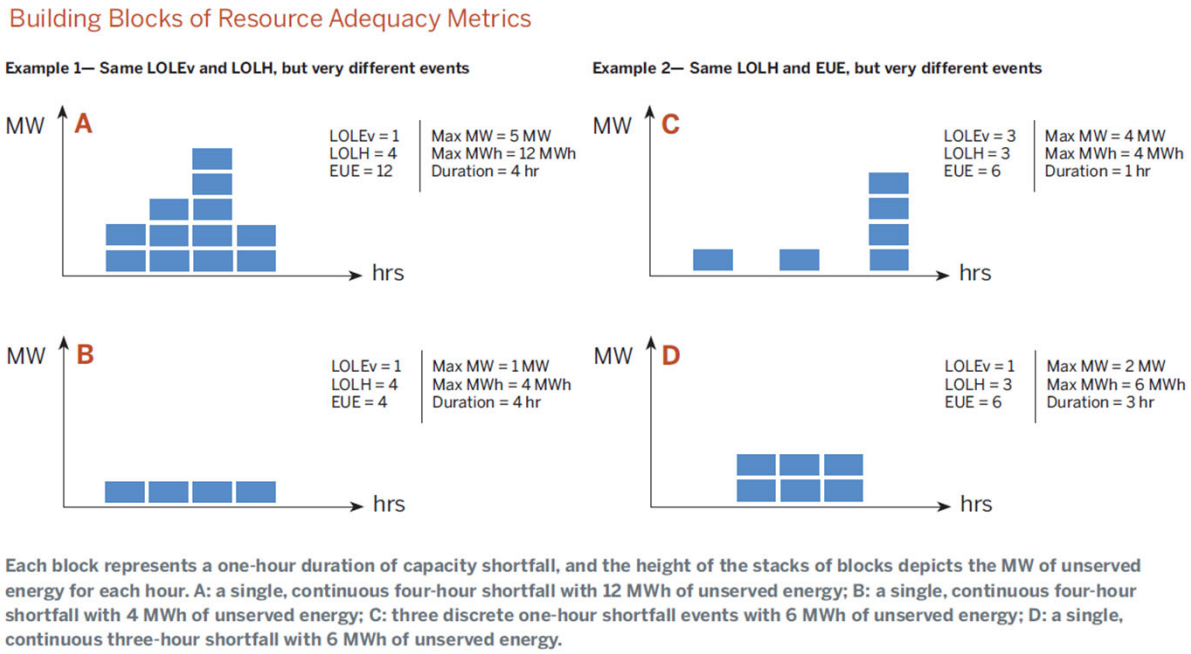
Expect longer lives for existing resources

- Capacity payments act to extend the life of existing facilities. Current arrangements mean suppliers earn capacity payments regardless of the size of capacity surplus.
- New entrants are likely to be allocated NAQ only when locating in unconstrained areas.
- This will temper the transition to increasing amounts of renewable generation.
- In the UK where incumbent non-renewable generators had an advantage, strict environmental and emission regulations helped address the issue.

Potential lessons for the WEM (2)

The WEM planning criterion is already more flexible than other markets

- Other markets are finding that a reliability criterion focused solely on a 1 in 10 year event are not flexible enough to cope with new fleet characteristics. The 2 limbed WEM approach is more flexible, though we note that the previous RCM review recommended the second limb be dropped.
- No other markets consider low load in their reliability criterion, and none of these jurisdictions were considering it as an issue – though they were concerned about the afternoon ramp.



Each block represents a one-hour duration of capacity shortfall, and the height of the stacks of blocks depicts the MW of unserved energy for each hour. A: a single, continuous four-hour shortfall with 12 MWh of unserved energy; B: a single, continuous four-hour shortfall with 4 MWh of unserved energy; C: three discrete one-hour shortfall events with 6 MWh of unserved energy; D: a single, continuous three-hour shortfall with 6 MWh of unserved energy.

Potential lessons for the WEM (3)

New methods for certifying capacity are available

- Using different methods to assign capacity to different technologies and doing so without considering output correlation or lack of correlation means that CRC (particularly for renewables) doesn't necessarily reflect the actual contribution to system reliability.
- ELCC method looks promising, using the marginal reliability value of the resource instead of its nameplate capacity or just capacity during periods of typical system stress.

Considers the availability of renewables during each hour of the day for the capacity year

Allows consideration of correlation of output or contingency for factors like location, weather conditions, and time of day

Allows consideration of the size and flexibility of the resource (start time, ramp ability)

Allows impact of storage resources to be based on not just the size of the resource, but also the factors like availability of intermittent, charge-discharge rates, etc.

Potential lessons for the WEM (4)

Reliance on one type of technology or fuel source can be a problem

- Currently SWIS is highly reliant on gas and coal (80%).
- Too much reliance on gas could pose a threat when intermittent renewables are not able to generate enough to meet the demand
- This poses a similar kind of risk as observed in other markets. France: nuclear, Colombia: hydro, others: gas.
- By 2050, variable renewables will dominate the fleet with other technologies providing firming services.
- These factors mean that medium-term fuel security is an important consideration, and that demand side participation will be critical.

Potential lessons for the WEM (5)

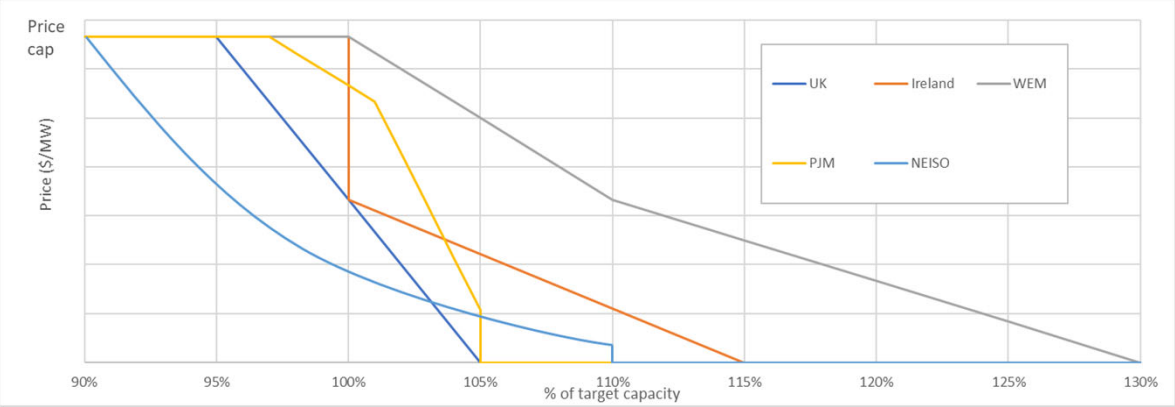
Additional design features from other markets

- Capacity mechanism opt out (PJM FRR) with extremely high penalties for non-performance.
- Resource adequacy standard: onus on retailers to prove their estimated peak load rather than setting centrally.
- Dedicated procurement volumes to encourage specific types of supply (e.g. renewables, DSM).
- Temperature dependence for low temperatures as well as high temperatures.
- Setting the benchmark capacity price to account for expected energy revenues (CONE/Net CONE).
- Length of guarantees for new build (PJM rate lock is 3yrs, ISO-NE was 7yrs but FERC rejected it as too long, Brazil as long as 15 years in renewable supply auction).
- Obligation timing - all hours; only when SO gives notice; only when energy price goes above a threshold (reliability option).
- Penalty payments distributed to those who overdeliver rather than consumers or other capacity holders.

Potential lessons for the WEM (6)

Shape of demand curve is out of scope for this review, but we note different shapes used elsewhere

- The demand curve used in the WEM has a shallow slope, meaning that the RCP is still quite high even when there is surplus capacity available.
- Other curves (in chart below) have procurement quantity right-shifted at the price of net CONE. Price caps need to be high enough to reach net CONE on a long-run average basis, and a slope flat enough to mitigate price volatility but steep enough to prevent significant excess quantity.



Bonus: Hawai'i "Load build" service

- Service hours 10am-2pm, notified 8 hours ahead
- Events are typically two to four hours and occur only a few times per year
- Managed through aggregators, with automated notification (primarily electric hot water).
- Procured through direct contract with HECO (SO)
- Same portfolio also provides:
  - Load reduce service (5-9pm, notified 10 minutes ahead)
  - Fast frequency response
  - Regulating reserve (AGC response)
  - Replacement reserve (10-30 minute response, 1-2 hour duration)

8. Modelling Assumptions Update

Generator retirements assumptions

Scenarios:

Two scenarios defined for 2030:

- **Scenario 1 - Muja retires on schedule; other coal, gas and distillate remains until at least 2030:** According to this scenario, Muja G5 and G6 retire as per planned schedule while the remaining plants retire according to their maximum technical asset life (see following slide) or by 2050 at the latest
- **Scenario 2 - All non-renewable baseload retires by 2030:** In this scenario, there is a rapid decarbonization where all non-renewable baseload generators (defined as all coal plant and all CCGTs) exit the market by 2030 and the lost capacity is replaced by battery storage. Remaining plants retire according to their maximum technical asset life (see following slide) or by 2050 at the latest.

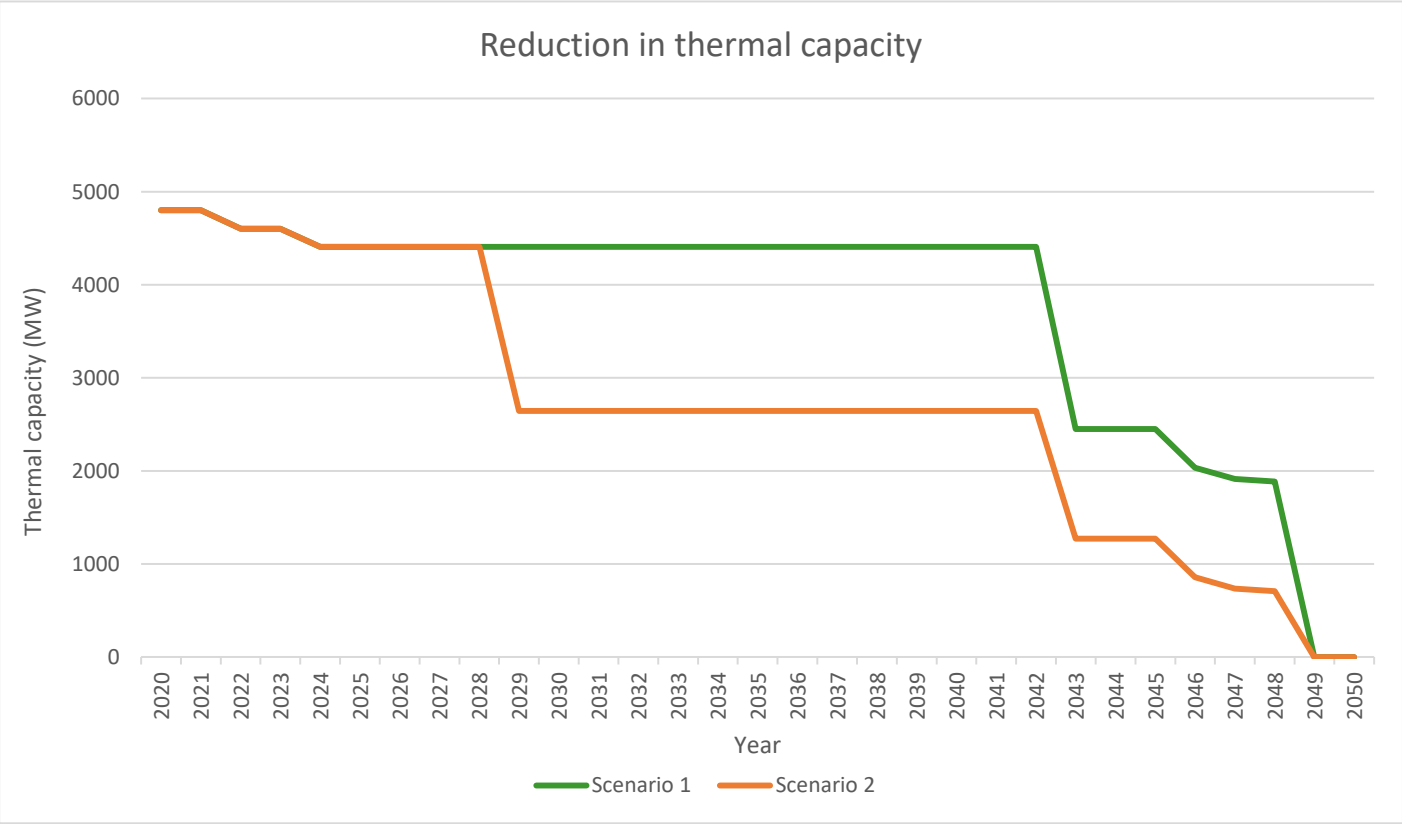
Generator retirements assumptions

Technical asset life:

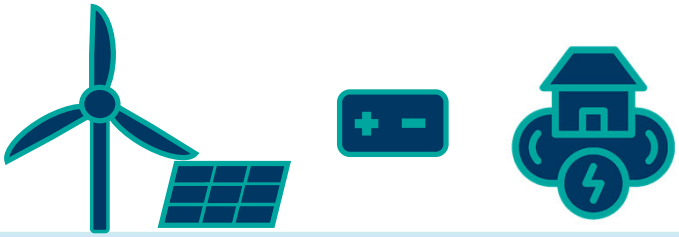
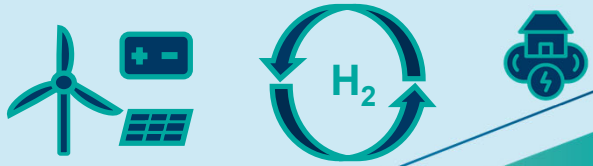
Technology Type	Maximum asset life (years)
Black Coal	50
OCGT	40
CCGT	40
Liquid	35
Cogeneration	40

Generator retirements assumptions

Remaining thermal capacity

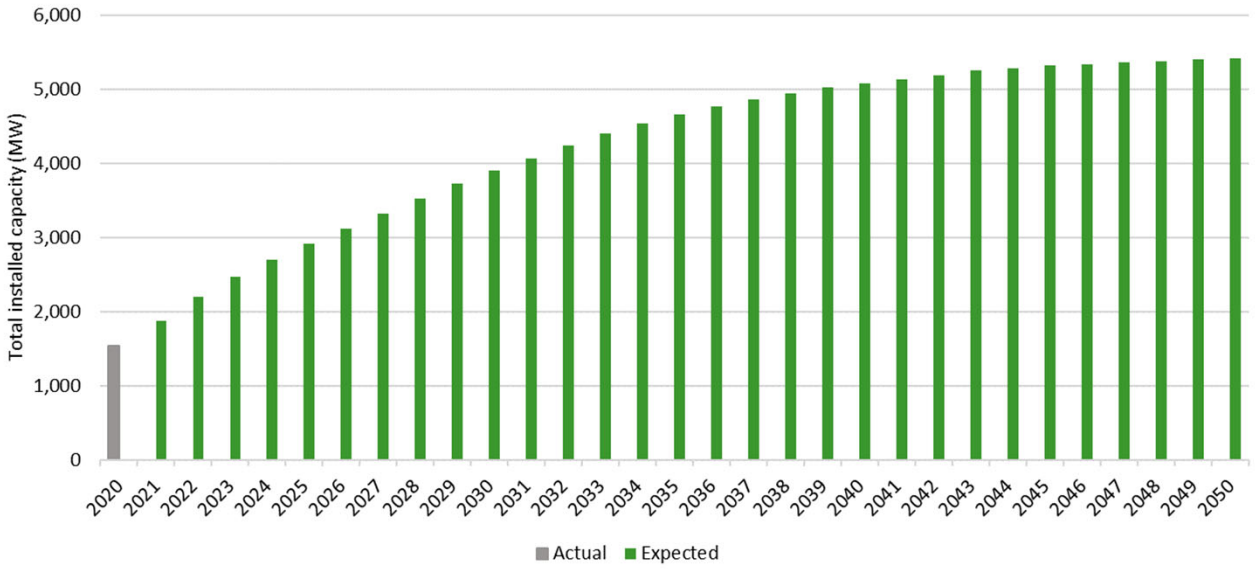


Fleet scenarios for 2050

#	Variable renewables	Flexibility resource	
1	Sufficient low emissions variable generation capacity by 2050 to meet energy requirement	Large storage capacity Some demand flexibility	
2	Low emissions variable generation overbuild by 2050 reducing amount of storage required	Less storage capacity Large demand flexibility	
3	Sufficient low emissions variable generation capacity by 2050 to meet energy requirement	New low emissions flexible technology (e.g. H_2) Some storage Some demand flexibility	

Note: Storage not necessarily battery – could be pumped hydro etc.

Distributed (BTM) Solar capacity and capacity factors

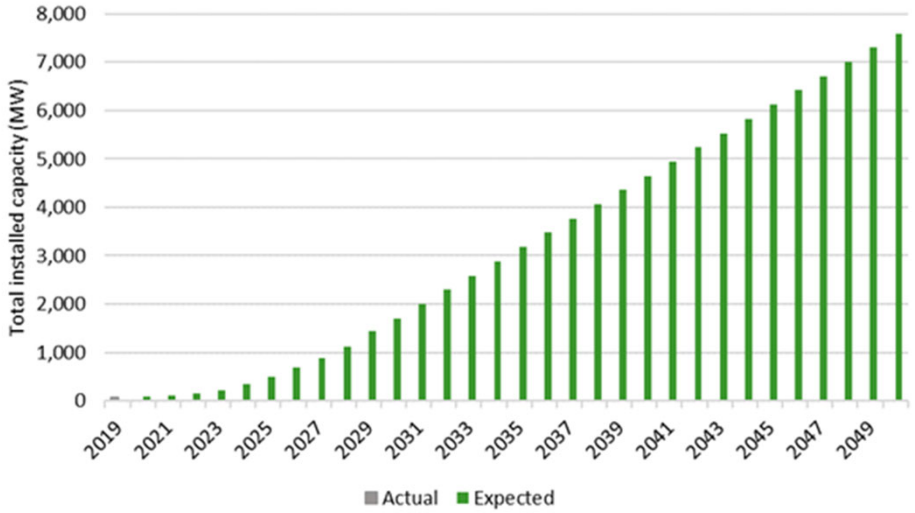


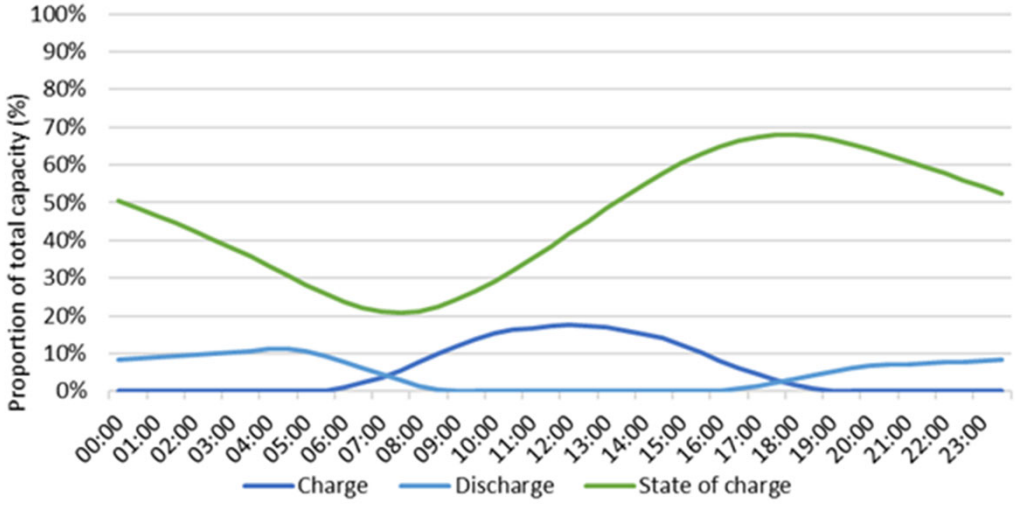
Approx. 5kW on every roof.

To be modelled as a separate facility (to allow curtailment), using scaled historical generation profiles to account for weather volatility.

Source: AEMO ESOO to CY 2030/31; RBP projection beyond that date

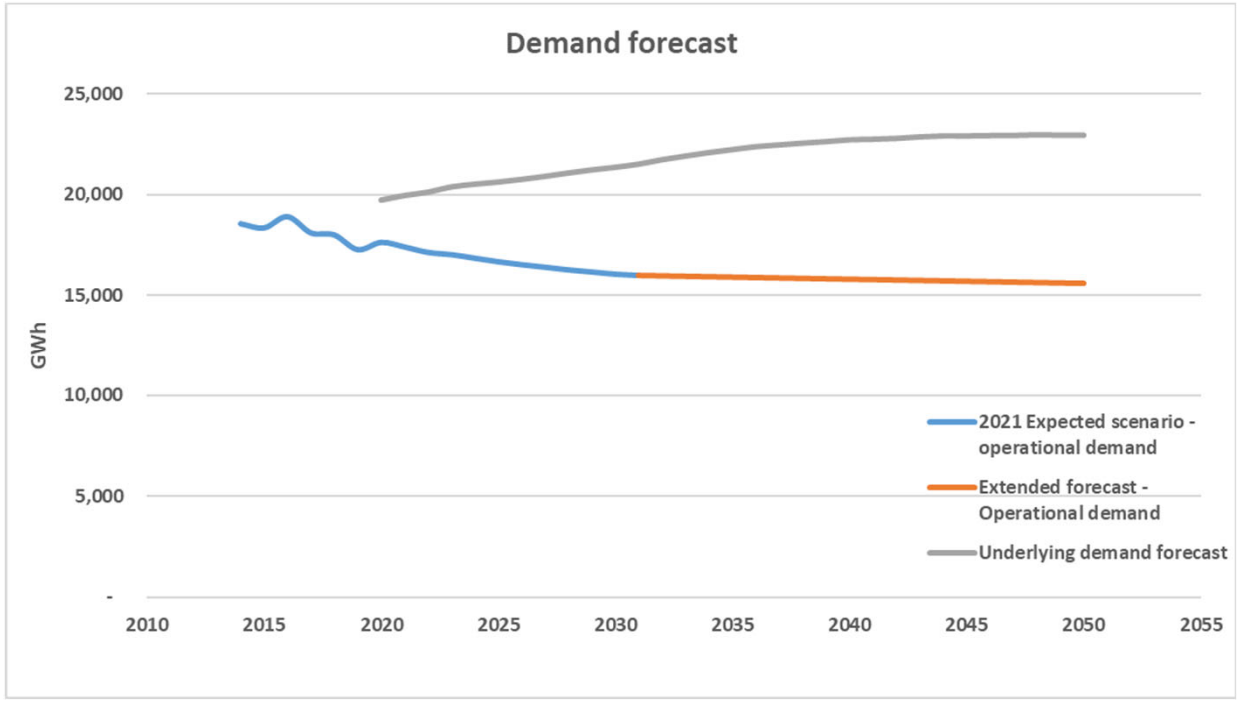
Distributed (BTM) Battery capacity and charge/discharge profile





Source: AEMO ESOO to CY 2030/31; RBP projection beyond that date

Operational and Underlying demand forecast



- The forecasts for operational demand and BTM PV uptake are based on ESOO 2021.
- The underlying demand was calculated based on forecasted Capacity factors, daily capacity factors for BTM Solar PV.
- At this stage the underlying demand forecast is an estimate, pending more detailed analysis

9. Next Steps

Next steps

- **Next Working Group meeting early May 2022**
  - System stress draft modelling findings
  - Discussion: required capacity services and planning criterion
- **Questions or feedback can be emailed to energymarkets@energy.wa.gov.au**

10. General Business


We're working for
Western Australia.