Government of Western Australia
Energy Policy WA

Reserve Capacity Mechanism Review Working Group

Meeting 2022_12_15

15 December 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 EPWA - Energy Markets energymarkets@dmirs.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	2 min
2	Meeting Apologies/Attendance	Chair	Noting	2 min
3	Minutes of meeting 2022_10_13	Chair	Decision	2 min
4	Action Items	Chair	Discussion	2 min
5	Purpose of the session	RBP	Discussion	2 min
6	Determining the Fleet ELCC	RBP	Discussion	20 min
7	Determining Facility ELCCs	RBP	Discussion	40 min
8	Impact of new entry	RBP	Discussion	20 min
9	Proposed methodology	RBP	Discussion	20 min
10	Next Steps	Chair	Discussion	5 min
11	General business	Chair	Discussion	3 min

5. Purpose of this Session

Purpose of this Session

Presenting additional analysis conducted on options for CRC allocation to intermittent generators:

- Comparing:
  - Delta method
  - Hybrid method (Collgar)
  - Hybrid method (EPWA)
- Options to mitigate volatility from volatile facility output across years:
  - Averaging individual year Fleet ELCCs
  - Averaging individual year facility ELCCs
  - Removing year with lowest peak load

Proposing an option for CRC allocation to intermittent generators

Goal

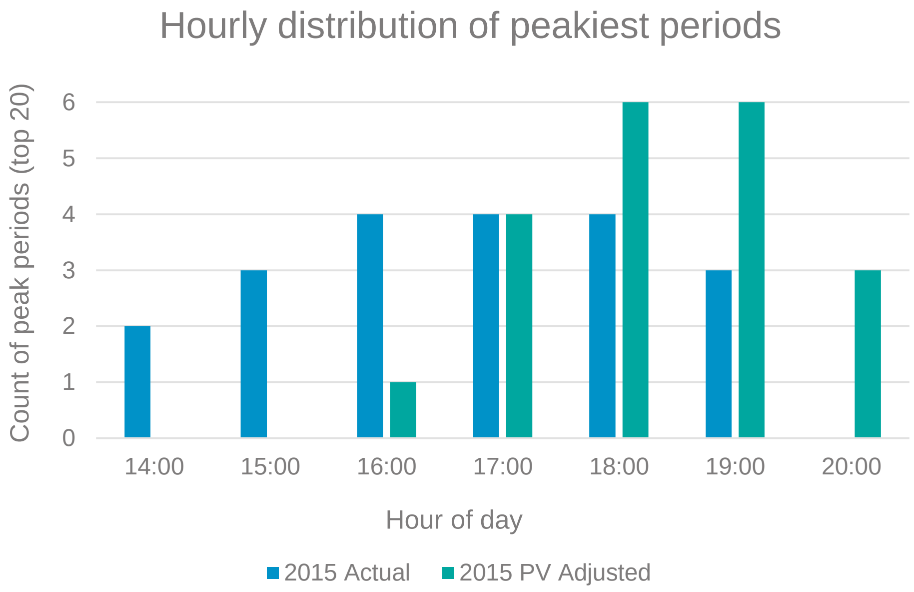
To identify a Certified Reserve Capacity (**CRC**) allocation method for intermittent generators that:

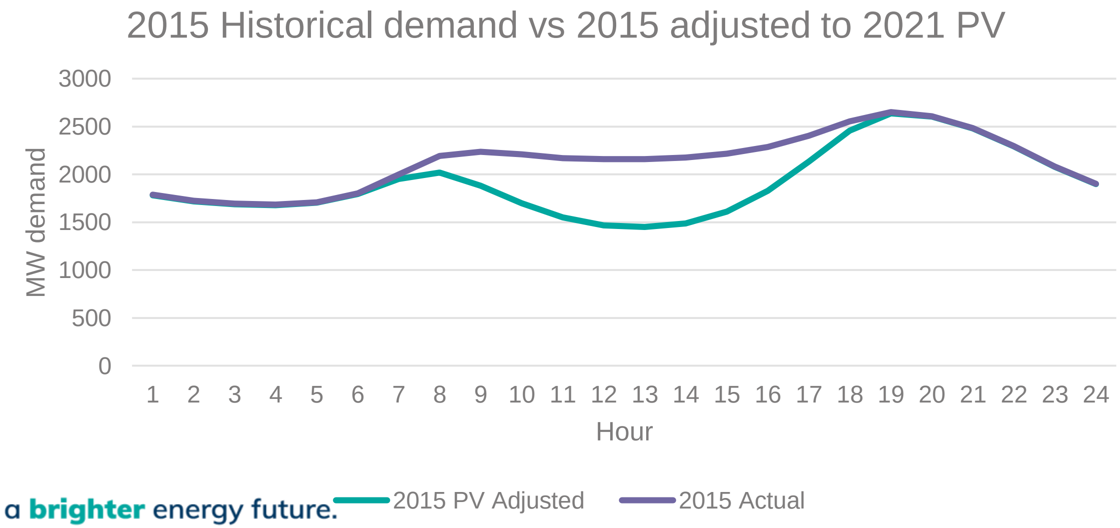
1. ensures that the system reliability objective is met;
2. adequately assesses facilities' contribution to system reliability;
3. minimises year-to-year volatility for investors;
4. is simple and easy to understand;
5. ideally can be replicated by potential investors and other stakeholders; and
6. ideally can be adapted for use on Demand Side Programmes (**DSPs**) and is consistent with Individual Reserve Capacity Requirement (**IRCR**).

6. Determining the Fleet ELCC

Effect of DPV Adjustment to Load

- The first step in all methodologies is to adjust historical load to account for DER growth.
- 2015 is the earliest year in our dataset, and is affected the most by this adjustment.
- Without the DPV adjustment the Fleet ELCC would be significantly higher due to more peaks occurring during the middle of the day.
- The DER adjustment is important to ensuring the Fleet ELCC accurately reflects expected conditions in the relevant capacity year.





Determination of Fleet ELCC

There is more than one way to implement an ELCC calculation. The approach used in this analysis is focused on expected unserved energy. This approach is much less reliant on firm facilities than a cumulative outage probability table, so is more suitable for systems with high intermittent penetration.

1. Using historical load (adjusted for DER penetration)
2. Remove all intermittent facilities
3. Increase or decrease demand (by adding or subtracting the same MWh quantity in each interval) until EUE is at 0.002%*
4. Return all intermittent facilities to the fleet (historical facility output for each interval)
5. Increase load until EUE is the same as it was in step 3 (0.002% of the total demand in step 3)
6. Added load (MW) = Fleet ELCC

Each run consists of 50 iterations with forced outages sampled randomly based on historical outage rates.

* This approach to calibrating the target used to set the fleet ELCC will be further considered during detailed design, to ensure that each individual year meets the EUE target.

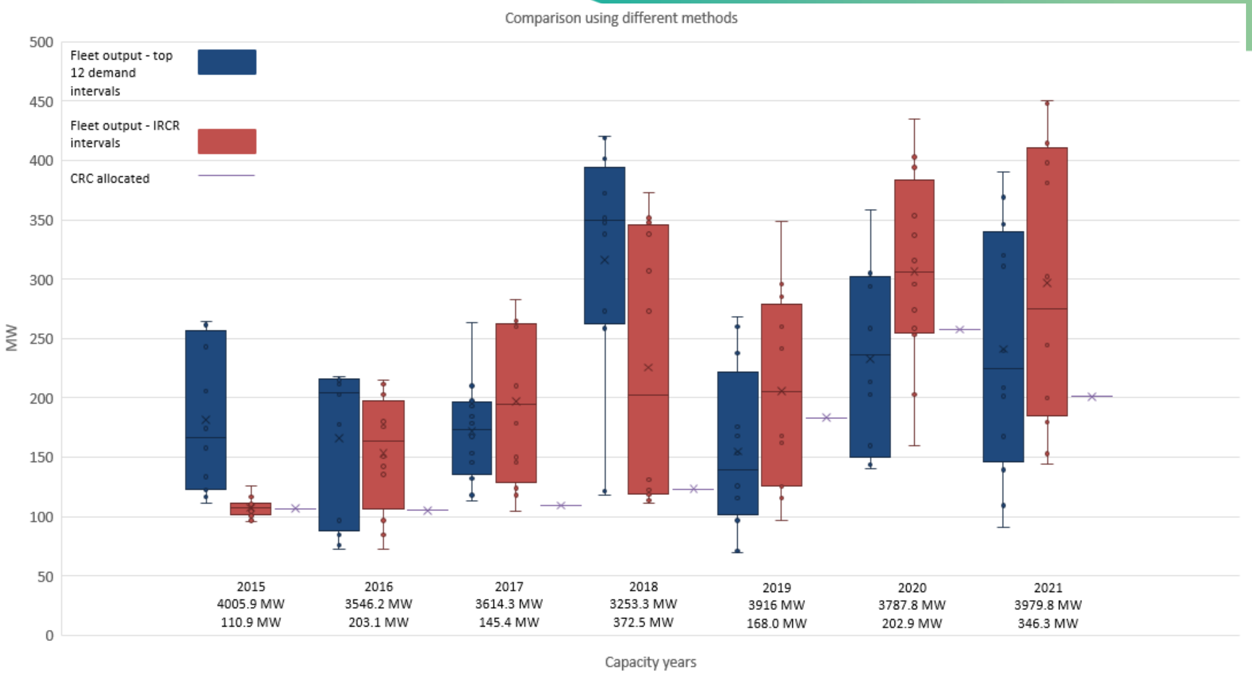
Volatility in Fleet Performance

All methods currently under consideration determine the collective ELCC for the fleet of intermittent generators (the Fleet ELCC), and then allocate CRC to individual facilities to a total of the Fleet ELCC.

The chart shows that:

- Fleet performance varies significantly between years
- Fleet performance varies significantly between high stress intervals
- The year with best performance is the year with lowest peak demand

This volatility in facility output is the underlying factor driving volatility in CRC allocation under any method.



Note:

- Whiskers show maximum and minimum fleet performance in the intervals
- Circles show other data points
- Boxes show 25th and 75th percentile range, with a line across the middle for the median.
- Crosses show the mean
- Text below the capacity year labels is:
  - MW demand during the peak interval of the year
  - MW fleet performance in that interval

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Determining the Fleet ELCC

Working group discussions on mitigating volatility have included proposals to calculate ELCC values for individual years and average the results, rather than calculating ELCC values for the entire period at once.

At fleet level, the % difference between the two methods is minimal in 2016-2020.

For 2015-2019, the difference is greater, as averaging reduces the impact of the relatively high fleet performance in 2015.

While averaging the annual fleet ELCC could reduce volatility in the fleet ELCC from year to year, EPWA is concerned that doing so increases the weight of years without significant stress events.

At the same time, considering a whole five-year period at once provides scope for poor performance in some stress intervals to be offset by good performance in others, and a period value which is higher than any individual year – as is the case in the 2015-2019 period.

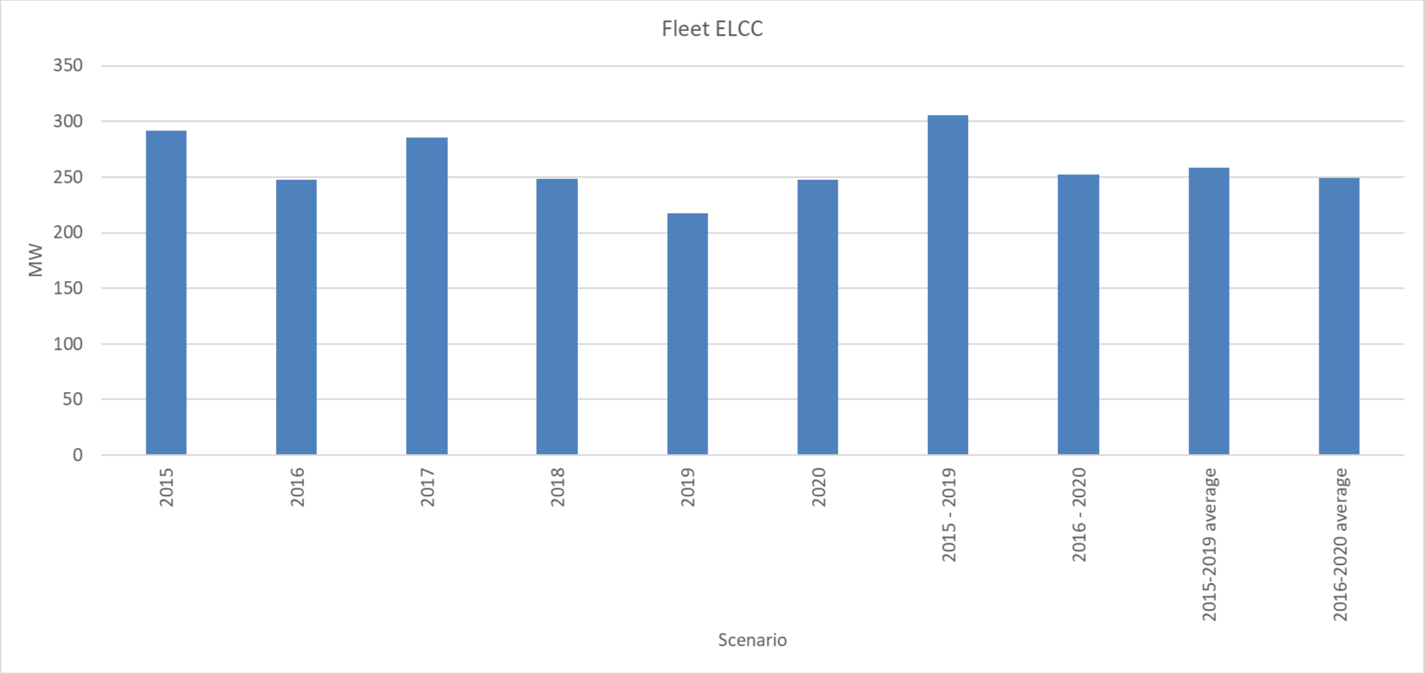


Chart shows Fleet ELCC calculated for each individual year in the dataset, and each five-year period considered as a whole and averaged.

Removing Non-stress Periods from Historical Data

In our dataset, 2018 has the lowest peak demand of any year – approx. 300MW lower than any other year, and 750MW lower than the highest peak interval.

Removing this period from the data means that there are fewer modelled periods. If all else remained unchanged, this would result in higher EUE as a proportion of overall load. Because our methodology scales the load to 0.002% before calculating ELCC, the result is to modify the amount by which the UE periods are binding, slightly increasing the influence of the peakiest periods.

	2015-2019 combined	2015-2019 average	2016-2020 combined	2016-2020 average
Include all years	305.7	258.1	252.2	249.2
Drop lowest peak year	298.3	260.6	245.6	249.4

Conclusion

Adjusting historical year load to account for changes in DER penetration is a key part of the process.

Smoothing out year-to-year volatility in Fleet ELCC could improve certainty for investors, but EPWA is concerned that any method for reducing volatility should not cause CRC allocations to overstate performance due to lower stress periods:

- Volatility due to unusually high performance in a single year can be mitigated by setting the fleet ELCC to the lower of:
  - The fleet ELCC calculated for the whole period
  - The average of the fleet ELCCs calculated for each individual year of the period
- The effect of low stress periods can be mitigated by removing the year with the lowest peak from the data used to calculate CRC.

The approach to scaling load will be further considered in the detailed design.

7. Determining the Facility ELCC

Methods assessed

EPWA considered three methods (with various permutations):

- The Delta ELCC method, where first-in and last-in Facility ELCCs are calculated, and used to distribute the Fleet ELCC.
- The EPWA Hybrid method, where the Fleet ELCC is distributed based on facility performance in stressed intervals, using Load for Scheduled Generation (LSG) as the metric for which intervals to consider.
- The Collgar Hybrid method, where the Fleet ELCC is distributed based on facility performance in stressed intervals, using total demand as the metric for which intervals to consider.

All calculations in this section use fleet ELCC as follows, except where noted otherwise:

2015	2016	2017	2018	2019	2020	2015-2019	2016-2020
291.8	247.8	285.5	248.3	217.1	247.3	305.7	252.2

Delta ELCC methodology for facilities

The process to determine the ELCC for each individual facility is the same as that used to determine the Fleet ELCC (see slide 9), except that:

- For the last-in calculation, step 2 only removes the candidate facility, and step 4 only returns the candidate facility
- For the first-in calculation, step 2 removes all intermittent facilities, but step 4 only returns the candidate facility.
- Wind facilities less than or equal to 5 MW are aggregated and assessed as a single facility
- The only small solar facility is AMBRISOLAR_PV1. The ELCC value for this facility is calculated as the average ELCC value of other solar facilities scaled to the nameplate capacity of AMBRISOLAR_PV

Delta Method – Facility ELCCs

Row Labels	Nameplate (MW)	2015	2016	2017	2018	2019	2020	2015 - 2019	2016 - 2020
ALBANY_WF1	21.60	19.53	9.45	16.94	6.82	10.41	9.57	16.19	11.25
ALINTA_WWF	89.10	8.26	20.24	16.28	22.38	8.86	21.91	14.03	17.19
AMBRISOLAR_PV1	0.96	0.03	0.02	0.02	0.01	0.02	0.03	0.03	0.03
Badgingarra Solar Farm	17.50	2.39	1.56	2.06	1.04	1.81	2.43	2.69	1.96
BADGINGARRA_WF1	130.00	18.65	33.38	24.35	21.72	16.01	33.29	23.85	27.83
BIOGAS01	2.00	1.14	1.41	1.50	1.29	1.16	1.04	1.21	1.20
BLAIRFOX_BEROSRD_WF1	9.25	0.02	0.00	0.08	0.03	0.48	1.17	0.11	0.86
BLAIRFOX_KARAKIN_WF1	5.00	0.83	0.85	0.57	0.60	0.59	0.43	0.82	0.61
BLAIRFOX_WESTHILLS_WF3	5.00	0.83	0.85	0.57	0.60	0.59	0.43	0.82	0.61
BREMER_BAY_WF1	0.60	0.10	0.10	0.07	0.07	0.07	0.05	0.10	0.07
DCWL_DENMARK_WF1	1.44	0.24	0.24	0.17	0.17	0.17	0.12	0.24	0.17
EDWFMAN_WF1	80.00	3.53	10.03	10.71	9.46	12.45	14.93	7.97	14.02
Emu Downs Solar Farm	20.00	2.67	1.71	2.37	1.12	2.09	2.77	3.07	2.39
GRASMERE_WF1	13.80	12.23	6.97	11.00	5.47	6.76	6.88	10.24	7.73
GREENOUGH_RIVER_PV1	40.00	3.12	1.71	4.92	0.51	0.50	6.33	3.03	3.67
HENDERSON_RENEWABLE_IG1	3.00	1.70	2.12	2.24	1.94	1.74	1.55	1.82	1.80
INVESTEC_COLLGAR_WF1	206.00	128.25	46.24	34.48	50.88	39.30	36.48	89.60	37.46
KALBARRI_WF1	1.60	0.27	0.27	0.18	0.19	0.19	0.14	0.26	0.19
MERSOLAR_PV1	100.00	15.29	10.27	13.25	8.15	16.86	18.87	18.45	16.38
MWF_MUMBIDA_WF1	55.00	0.62	11.29	28.27	10.77	4.02	11.13	7.62	13.54
NORTHAM_SF_PV1	9.80	1.22	0.36	1.05	0.64	0.96	1.65	1.34	1.26
RED_HILL	3.64	2.07	2.57	2.72	2.35	2.11	1.88	2.21	2.18
ROCKINGHAM	4.00	2.27	2.82	2.99	2.59	2.32	2.07	2.43	2.39
SKYFRM_MTBARKER_WF1	2.00	0.29	0.30	0.20	0.21	0.21	0.15	0.28	0.21
SOUTH_CARDUP	4.16	2.36	2.94	3.11	2.69	2.41	2.15	2.52	2.49
TAMALA_PARK	4.80	2.72	3.39	3.59	3.10	2.78	2.49	2.91	2.87
WARRADARGE_WF1	180.00	20.27	33.86	35.90	44.51	45.49	37.67	39.19	39.88
YANDIN_WF1	214.20	40.88	42.81	65.86	49.03	36.74	29.66	52.71	41.96

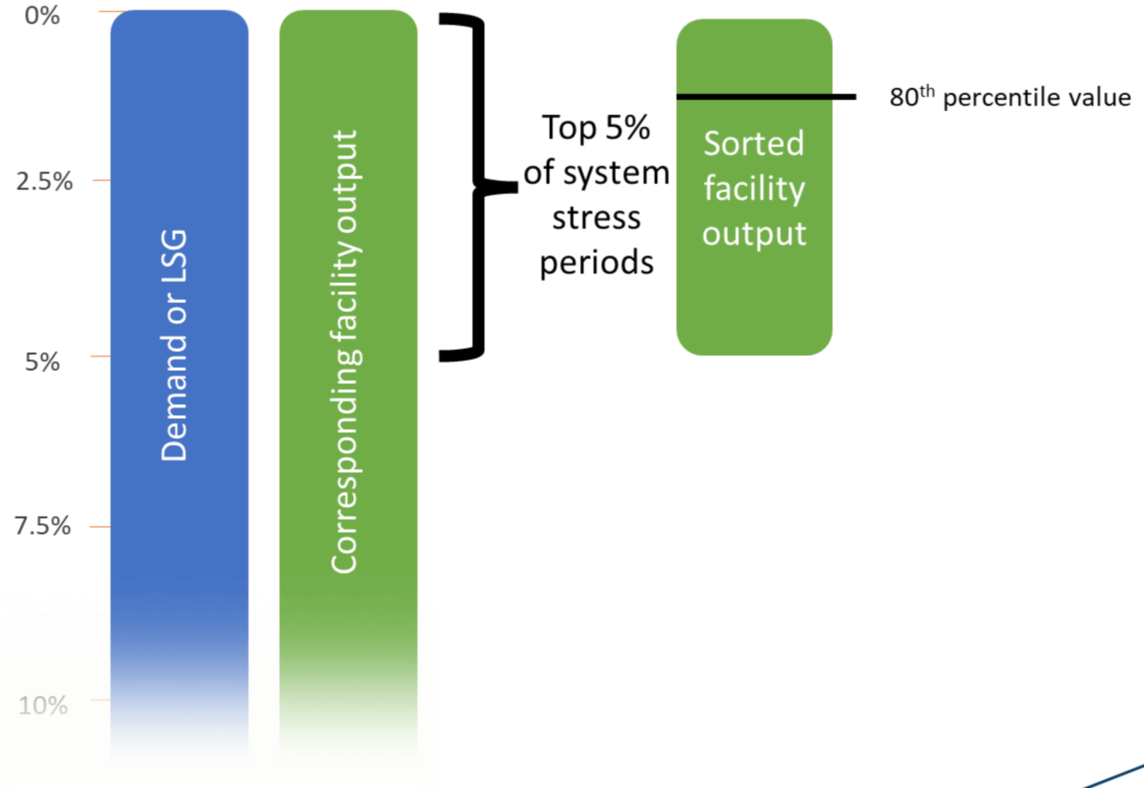
- Volatility in facility output drives volatility between years.
- Collgar 2015 value is a particular outlier:
  - 2015 has only a few peak intervals
  - Collgar output during those few intervals was high compared to other years
- 2015 and 2019 had the highest peaks, so they have the most influence on the 5-year period ELCCs

Small solar
Small bio
Small wind

Hybrid Method (EPWA)

The Hybrid Method allocates that fleet ELCC based on comparative facility performance in selected intervals, using a combination of percentage and percentile as follows:

1. Calculate system stress for each historical period using either:
    a) **Load for scheduled generation** (LSG): demand – total intermittent generation + candidate facility generation **(LSG =** SySt**)**
    b) **Peak demand, (Demand =** SySt**)**
2. Sort trading periods by system stress (highest to lowest)
3. Take a **percentage** of trading intervals from the start of the list (for example the top 5%)
4. Take the facility's un-curtailed output in the selected trading intervals, and sort the facility's output from highest to lowest
5. The facility's output at the chosen **percentile** of ordered periods is the facility's CRC



Hybrid Method results are very sensitive to the choice of parameters

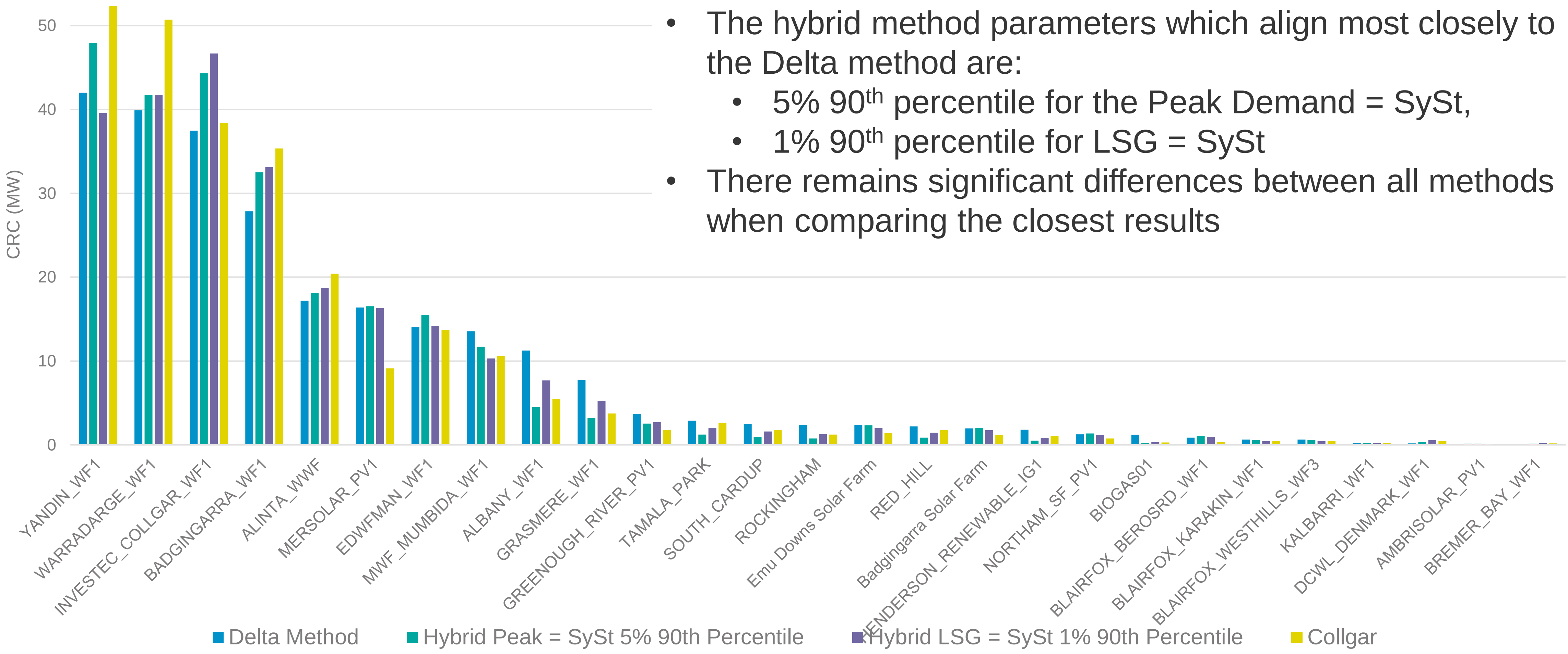
The Hybrid Method can yield significantly different results depending on the choice of LSG or demand, and the selected percentage/percentile combinations

Hybrid Method (Collgar)

The Collgar hybrid method allocates the Fleet ELCC based on facility performance during 48 trading intervals of each year, selected as the four highest demand trading intervals from each of the twelve days with the highest peak demand intervals.

As proposed, the method uses seven years of historical data. Analysis presented here uses five years of data at a time.

Methods



- The hybrid method parameters which align most closely to the Delta method are:
  - 5% 90th percentile for the Peak Demand = SySt,
  - 1% 90th percentile for LSG = SySt
- There remains significant differences between all methods when comparing the closest results

Base fleet ELCC: 2016-2020 (252.2)

Hybrid Methods are Sensitive to Parameter Choice

- The hybrid method tables show that different parameters result in different winners and losers:
  - using LSG favours biogas facilities
  - using demand allocates less to biogas facilities, and less to solar (except in a handful of specific cases)
- Results for wind are relatively insensitive to using LSG or Demand, and wind allocation is higher than the Delta method in all cases.
- High percentages favour wind, while low percentages favour solar.

Load for scheduled generation

Total allocated CRC (MW)

Wind		Percentile						
		60	65	70	75	80	85	90
Percentage	0.05	233.1	231.2	225.1	218.2	219.7	221.0	221.5
	0.1	232.6	227.3	222.6	218.5	219.3	218.8	219.1
	1	233.0	235.2	237.6	236.5	231.6	227.1	220.7
	5	232.3	236.5	238.3	239.0	236.5	232.1	226.5

Solar		Percentile						
		60	65	70	75	80	85	90
Percentage	0.05	1.7	5.4	12.6	21.4	21.1	20.4	20.6
	0.1	1.5	8.0	14.9	20.8	21.1	22.4	23.5
	1	0.0	0.1	0.4	3.1	9.4	15.9	24.0
	5	0.0	0.1	0.4	1.7	6.0	11.9	18.9

Other		Percentile						
		60	65	70	75	80	85	90
Percentage	0.05	17.4	15.6	14.5	12.6	11.4	10.7	10.0
	0.1	18.0	16.8	14.7	12.9	11.8	11.0	9.5
	1	19.2	16.9	14.2	12.7	11.1	9.2	7.5
	5	19.8	15.6	13.4	11.5	9.7	8.2	6.7

Demand

Total allocated CRC (MW)

Wind		Percentile						
		60	65	70	75	80	85	90
Percentage	0.05	222.9	226.0	226.5	231.8	232.6	233.7	224.8
	0.1	224.9	225.3	227.1	217.3	210.6	211.6	211.6
	1	242.9	240.3	237.7	236.1	233.4	223.3	219.7
	5	244.9	245.4	244.7	241.6	237.6	233.6	222.8

Solar		Percentile						
		60	65	70	75	80	85	90
Percentage	0.05	18.5	16.8	17.1	14.1	13.7	13.3	22.8
	0.1	18.7	19.2	18.3	29.1	36.6	36.0	36.4
	1	2.7	6.0	9.2	11.2	14.2	24.5	28.4
	5	0.0	0.2	1.4	4.9	9.3	13.8	24.9

Other		Percentile						
		60	65	70	75	80	85	90
Percentage	0.05	10.8	9.5	8.6	6.2	5.9	5.2	4.6
	0.1	8.6	7.8	6.8	5.8	5.0	4.6	4.2
	1	6.6	5.9	5.4	4.9	4.7	4.4	4.2
	5	7.2	6.5	6.1	5.7	5.3	4.8	4.5

Base fleet ELCC: 2016-2020 (252.2)

All methods – comparison of 2015-19 and 2016-20

	LSG 2015-19 1% 90th Percentile	LSG 2016-20 1% 90th Percentile	Peak 2015-19 1% 90th Percentile	Peak 2016-20 1% 90th Percentile	Collgar 5-years 2015-19	Collgar 5-years 2016-20	Collgar 6-years 2016-20	Delta 2015-19 combined	Delta 2016-20 combined
ALBANY_WF1	15.63	14.66	5.83	4.69	5.30	5.02	5.45	14.96	10.77
ALINTA_WWF	27.79	18.90	22.47	17.10	20.56	19.92	20.42	18.01	18.15
AMBRISOLAR_PV1	0.05	0.03	0.17	0.13	0.06	0.06	0.07	0.02	0.02
BADGINGARRA_WF1	29.22	20.84	36.97	32.13	33.67	34.90	35.36	27.04	26.06
BIOGAS01	1.70	1.50	0.21	0.19	0.25	0.29	0.26	1.54	1.29
BLAIRFOX_BEROSRD_WF1	0.19	0.61	0.68	1.22	0.16	0.39	0.33	0.14	0.36
BLAIRFOX_KARAKIN_WF1	0.34	0.22	0.70	0.58	0.47	0.47	0.46	0.82	0.62
BLAIRFOX_WESTHILLS_WF3	0.34	0.22	0.70	0.58	0.47	0.47	0.46	0.82	0.62
BREMER_BAY_WF1	0.72	0.63	0.16	0.13	0.17	0.16	0.17	0.10	0.07
Badgingarra Solar Farm	0.74	0.55	3.09	2.30	1.11	1.10	1.20	2.10	1.80
DCWL_DENMARK_WF1	2.23	2.10	0.44	0.35	0.47	0.43	0.45	0.24	0.18
EDWFMAN_WF1	6.65	3.97	17.96	16.10	12.92	14.68	13.69	10.94	11.65
Emu Downs Solar Farm	0.85	0.63	3.53	2.63	1.27	1.26	1.37	2.36	2.04
GRASMERE_WF1	12.55	11.73	3.91	3.31	3.62	3.55	3.74	10.05	7.50
GREENOUGH_RIVER_PV1	3.81	2.89	2.40	3.37	1.04	1.87	1.77	2.55	2.83
HENDERSON_RENEWABLE_IG1	4.68	4.12	0.64	0.49	1.05	0.99	1.02	2.31	1.94
INVESTEC_COLLGAR_WF1	51.32	42.70	51.87	43.98	39.57	36.26	38.39	70.88	41.97
KALBARRI_WF1	1.02	0.70	0.25	0.17	0.22	0.19	0.19	0.26	0.20
MERSOLAR_PV1	7.01	5.28	22.89	18.27	8.26	8.66	9.12	15.12	13.64
MWF_MUMBIDA_WF1	14.63	12.60	12.99	10.86	10.58	10.87	10.60	13.02	13.25
NORTHAM_SF_PV1	0.43	0.30	1.98	1.65	0.64	0.73	0.74	1.00	0.94
RED_HILL	8.20	7.00	1.09	0.82	1.84	1.71	1.74	2.80	2.36
ROCKINGHAM	7.31	6.32	0.94	0.65	1.34	1.18	1.22	3.08	2.59
SKYFRM_MTBARKER_WF1	2.74	2.49	0.57	0.46	0.63	0.59	0.63	0.28	0.21
SOUTH_CARDUP	9.11	7.95	1.05	0.82	1.92	1.72	1.77	3.20	2.69
TAMALA_PARK	11.27	9.94	1.52	1.18	2.74	2.57	2.62	3.69	3.11
WARRADARGE_WF1	36.69	33.81	52.00	40.99	52.99	47.36	50.70	42.66	39.96
YANDIN_WF1	48.54	39.46	58.74	47.03	54.78	51.79	52.35	55.75	45.36

Comparing Methodology Output to Actual Output (1)

In order to assess the extent to which methodology output accurately considers performance during system stress intervals, we seek to understand whether the CRC calculated by the method matches facility output during periods of known system stress. There is no perfect comparison, but we seek an indication by:

- Calculating Facility ELCC using data for each single year, considering only facilities which were actually present in that year (so excluding expert report data).
- Distributing the annual Fleet ELCC according to the Delta and Collgar methods in the specific year.
- Comparing the Facility CRC allocations to their average facility output during the 12 intervals with highest demand in each capacity year from 2015 to 2020. These are not the only intervals with system stress, but will definitely be among the intervals where stress occurs.
- Applying a least squares analysis to weight the magnitudes of the differences.
- The differences are not large, but Delta outperforms the Collgar method in four of six years.

Comparing Methodology Output to Actual Output (2)

Facility	2015 Delta	2015 Collgar method	2015 Actual performance	2015 Squared difference: Actual vs Delta	2015 Squared difference: Actual vs Collgar	2016 Delta	2016 Collgar method	2016 Actual performance	2016 Squared difference: Actual vs Delta	2016 Squared difference: Actual vs Collgar
ALBANY_WF1	11.1	12.7	15.9	23.3	10.4	8.6	5.9	12.6	16.1	45.1
ALINTA_WWF	34.2	33.9	24.7	90.5	84.9	29.5	29.7	33.0	12.7	11.0
AMBRISOLAR_PV1										
BADGINGARRA_WF1										
BIOGAS01										
BLAIRFOX_BEROSRD_WF1										
BLAIRFOX_KARAKIN_WF1	1.3	1.0	0.7	0.3	0.1	1.2	0.8	0.4	0.6	0.2
BLAIRFOX_WESTHILLS_WF3	1.3	1.0	0.7	0.3	0.1	1.2	0.8	0.4	0.6	0.2
BREMER_BAY_WF1	0.2	0.3	0.4	0.1	0.0	0.1	0.1	0.3	0.0	0.0
DCWL_DENMARK_WF1	0.4	0.8	0.8	0.2	0.0	0.3	0.5	0.9	0.3	0.1
EDWFMAN_WF1										
GRASMERE_WF1	7.3	7.6	11.2	15.2	12.9	6.6	4.5	10.4	14.5	35.5
GREENOUGH_RIVER_PV1										
HENDERSON_RENEWABLE_IG1	1.8	1.7	1.2	0.4	0.3	2.3	1.6	1.9	0.1	0.1
INVESTEC_COLLGAR_WF1	55.7	49.7	89.9	1163.7	1612.9	40.4	48.8	59.7	375.4	120.3
KALBARRI_WF1	0.4	0.4	0.2	0.1	0.0	0.4	0.4	0.4	0.0	0.0
MERSOLAR_PV1										
MWF_MUMBIDA_WF1	7.2	10.6	4.8	6.0	34.6	15.5	13.2	19.4	15.2	38.8
NORTHAM_SF_PV1										
RED_HILL	2.2	2.8	2.2	0.0	0.3	2.7	2.5	2.9	0.0	0.1
ROCKINGHAM						0.0	0.0	2.5	6.2	6.2
SKYFRM_MTBARKER_WF1	0.6	1.2	1.4	0.5	0.0	0.6	0.6	0.9	0.1	0.1
SOUTH_CARDUP										
TAMALA_PARK										
WARRADARGE_WF1										
Sum of difference				1300.5	1756.5				442.0	257.7

Facility	2017 Delta	2017 Collgar method	2017 Actual performance	2017 Squared difference: Actual vs Delta	2017 Squared difference: Actual vs Collgar	2018 Delta	2018 Collgar method	2018 Actual performance	2018 Squared difference: Actual vs Delta	2018 Squared difference: Actual vs Collgar
ALBANY_WF1	15.4	9.3	19.9	20.4	112.2	4.4	5.0	6.9	6.3	3.5
ALINTA_WWF	22.7	32.4	18.0	21.9	208.4	43.5	42.7	60.8	296.4	325.1
AMBRISOLAR_PV1										
BADGINGARRA_WF1										
BIOGAS01						1.2	0.3	0.4	0.7	0.0
BLAIRFOX_BEROSRD_WF1										
BLAIRFOX_KARAKIN_WF1	1.0	0.9	0.0	1.0	0.9	1.5	1.3	3.0	2.4	3.1
BLAIRFOX_WESTHILLS_WF3	1.0	0.9	0.0	1.0	0.9	1.5	1.3	3.0	2.4	3.1
BREMER_BAY_WF1	0.1	0.2	0.4	0.1	0.0	0.2	0.2	0.3	0.0	0.0
DCWL_DENMARK_WF1	0.3	0.7	0.8	0.3	0.0	0.4	0.6	1.1	0.5	0.3
EDWFMAN_WF1						32.3	28.3	58.6	690.7	917.5
GRASMERE_WF1	9.9	6.1	12.5	6.9	41.0	3.9	4.2	7.0	9.4	7.5
GREENOUGH_RIVER_PV1										
HENDERSON_RENEWABLE_IG1	2.2	1.5	1.8	0.1	0.1	1.8	1.3	1.7	0.0	0.2
INVESTEC_COLLGAR_WF1	40.3	53.3	36.8	12.0	269.6	52.3	60.1	121.9	4849.5	3820.5
KALBARRI_WF1	0.3	0.4	0.1	0.0	0.1	0.5	0.5	0.7	0.0	0.0
MERSOLAR_PV1										
MWF_MUMBIDA_WF1	32.2	19.9	37.6	29.4	315.1	22.3	20.1	35.7	179.8	244.6
NORTHAM_SF_PV1										
RED_HILL	2.6	2.6	3.2	0.3	0.3	2.2	2.2	2.4	0.0	0.0
ROCKINGHAM	2.9	2.1	2.8	0.0	0.5	2.5	1.8	2.0	0.2	0.1
SKYFRM_MTBARKER_WF1	0.5	0.9	1.2	0.5	0.1	0.7	0.8	1.2	0.2	0.1
SOUTH_CARDUP						2.6	2.6	3.2	0.4	0.3
TAMALA_PARK						3.0	3.4	3.9	0.9	0.2
WARRADARGE_WF1										
Sum of difference				93.9	949.2				6040.0	5326.2

Facility	2019 Delta	2019 Collgar method	2019 Actual performance	2019 Squared difference: Actual vs Delta	2019 Squared difference: Actual vs Collgar	2020 Delta	2020 Collgar method	2020 Actual performance	2020 Squared difference: Actual vs Delta	2020 Squared difference: Actual vs Collgar
ALBANY_WF1	13.4	6.6	15.6	4.9	80.9	11.3	7.5	15.0	13.7	56.2
ALINTA_WWF	13.9	21.8	10.5	11.5	128.1	26.2	24.7	24.1	4.6	0.4
AMBRISOLAR_PV1	0.2	0.2	0.2	0.0	0.0	0.2	0.1	0.2	0.0	0.0
BADGINGARRA_WF1	24.3	37.5	12.2	145.8	638.6	49.7	54.4	54.4	22.3	0.0
BIOGAS01	1.1	0.2	0.3	0.6	0.0	1.0	0.4	0.1	0.7	0.1
BLAIRFOX_BEROSRD_WF1						2.1	1.5	2.5	0.2	1.0
BLAIRFOX_KARAKIN_WF1	1.1	0.7	-0.3	1.9	0.9	1.1	0.5	0.4	0.5	0.0
BLAIRFOX_WESTHILLS_WF3	1.1	0.7	-0.3	1.9	0.9	1.1	0.5	0.4	0.5	0.0
BREMER_BAY_WF1	0.1	0.2	0.4	0.1	0.0	0.1	0.2	0.3	0.0	0.0
DCWL_DENMARK_WF1	0.3	0.6	1.1	0.6	0.3	0.3	0.4	0.7	0.2	0.1
EDWFMAN_WF1	20.3	25.2	15.8	20.4	89.7	21.1	22.3	22.7	2.4	0.1
GRASMERE_WF1	8.5	4.3	9.9	1.9	31.3	7.9	5.3	11.2	10.3	34.5
GREENOUGH_RIVER_PV1						5.4	6.8	4.4	1.0	5.7
HENDERSON_RENEWABLE_IG1	1.7	1.0	1.3	0.1	0.1	1.5	1.0	1.4	0.0	0.1
INVESTEC_COLLGAR_WF1	51.1	34.5	43.8	54.4	85.3	31.0	39.3	9.8	452.6	873.3
KALBARRI_WF1	0.4	0.2	0.1	0.0	0.0	0.3	0.1	0.1	0.0	0.0
MERSOLAR_PV1						21.8	18.3	26.2	19.3	63.3
MWF_MUMBIDA_WF1	6.4	10.8	4.2	4.9	44.4	14.5	13.4	11.9	6.7	2.1
NORTHAM_SF_PV1	1.8	2.1	1.4	0.2	0.4	2.1	1.7	2.7	0.3	0.8
RED_HILL	2.1	1.9	2.4	0.1	0.3	1.8	1.6	2.5	0.5	0.8
ROCKINGHAM	2.3	1.4	1.7	0.4	0.1	2.0	0.9	1.4	0.3	0.3
SKYFRM_MTBARKER_WF1	0.6	0.9	1.5	0.9	0.4	0.5	0.8	1.4	0.7	0.3
SOUTH_CARDUP	2.4	2.0	2.6	0.1	0.3	2.1	1.4	1.9	0.1	0.2
TAMALA_PARK	2.7	3.0	3.9	1.3	0.8	2.4	2.6	3.5	1.2	0.7
WARRADARGE_WF1						49.0	50.7	50.5	2.4	0.0
Sum of difference				252.1	1103.1				540.6	1040.3

Mitigating volatility by Averaging Facility ELCCs

Five-year period vs individual year average

- Our dataset allows us to assess the effects of averaging across two sets of five years: 2015-2019 and 2016-2020, and to explore the effects of averaging the facility ELCCs.
- The table in the next slide has three columns for each five-year set, where "Average" refers to the average of the individual year results, and "Combined" refers to the result for the five-year period considered as a block.
- While this is only a small number of data points, this reduces the year-to-year change for most facilities, the exceptions being the small facilities which had been aggregated together.

Effects of Averaging Facility Results across years

		2015-2019			2016-2020		
Facility	Nameplate (MW)	Averaged	Combined	ELCC difference %	Averaged	Combined	ELCC difference %
ALBANY_WF1	21.6	14.96	16.19	8.20%	10.77	11.25	4.48%
ALINTA_WWF	89.1	18.01	14.03	22.10%	18.15	17.19	5.29%
AMBRISOLAR_PV1	0.96	0.02	0.03	23.58%	0.02	0.03	20.71%
Badgingarra Solar Farm	17.5	2.10	2.69	28.27%	1.80	1.96	8.72%
BADGINGARRA_WF1	130	27.04	23.85	11.82%	26.06	27.83	6.79%
BIOGAS01	2	1.54	1.21	21.10%	1.29	1.20	7.49%
BLAIRFOX_BEROSRD_WF1	9.252	0.14	0.11	21.57%	0.36	0.86	140.62%
BLAIRFOX_KARAKIN_WF1	5	0.82	0.82	0.03%	0.62	0.61	1.49%
BLAIRFOX_WESTHILLS_WF3	5	0.82	0.82	0.03%	0.62	0.61	1.49%
BREMER_BAY_WF1	0.6	0.10	0.10	0.03%	0.07	0.07	1.49%
DCWL_DENMARK_WF1	1.44	0.24	0.24	0.03%	0.18	0.17	1.49%
EDWFMAN_WF1	80	10.94	7.97	27.19%	11.65	14.02	20.26%
Emu Downs Solar Farm	20	2.36	3.07	30.36%	2.04	2.39	17.48%
GRASMERE_WF1	13.8	10.05	10.24	1.89%	7.50	7.73	3.01%
GREENOUGH_RIVER_PV1	40	2.55	3.03	19.04%	2.83	3.67	29.79%
HENDERSON_RENEWABLE_IG1	3	2.31	1.82	21.10%	1.94	1.80	7.49%
INVESTEC_COLLGAR_WF1	206	70.88	89.60	26.42%	41.97	37.46	10.76%
KALBARRI_WF1	1.6	0.26	0.26	0.03%	0.20	0.19	1.49%
MERSOLAR_PV1	100	15.12	18.45	21.99%	13.64	16.38	20.04%
MWF_MUMBIDA_WF1	55	13.02	7.62	41.48%	13.25	13.54	2.17%
NORTHAM_SF_PV1	9.8	1.00	1.34	33.35%	0.94	1.26	32.99%
RED_HILL	3.64	2.80	2.21	21.10%	2.36	2.18	7.49%
ROCKINGHAM	4	3.08	2.43	21.10%	2.59	2.39	7.49%
SKYFRM_MTBARKER_WF1	2	0.28	0.28	0.03%	0.21	0.21	1.49%
SOUTH_CARDUP	4.158	3.20	2.52	21.10%	2.69	2.49	7.49%
TAMALA_PARK	4.8	3.69	2.91	21.10%	3.11	2.87	7.49%
WARRADARGE_WF1	180	42.66	39.19	8.13%	39.96	39.88	0.20%
YANDIN_WF1	214.2	55.75	52.71	5.46%	45.36	41.96	7.49%

Conclusion

EPWA considers that the ELCC Delta method is more appropriate than a hybrid method:

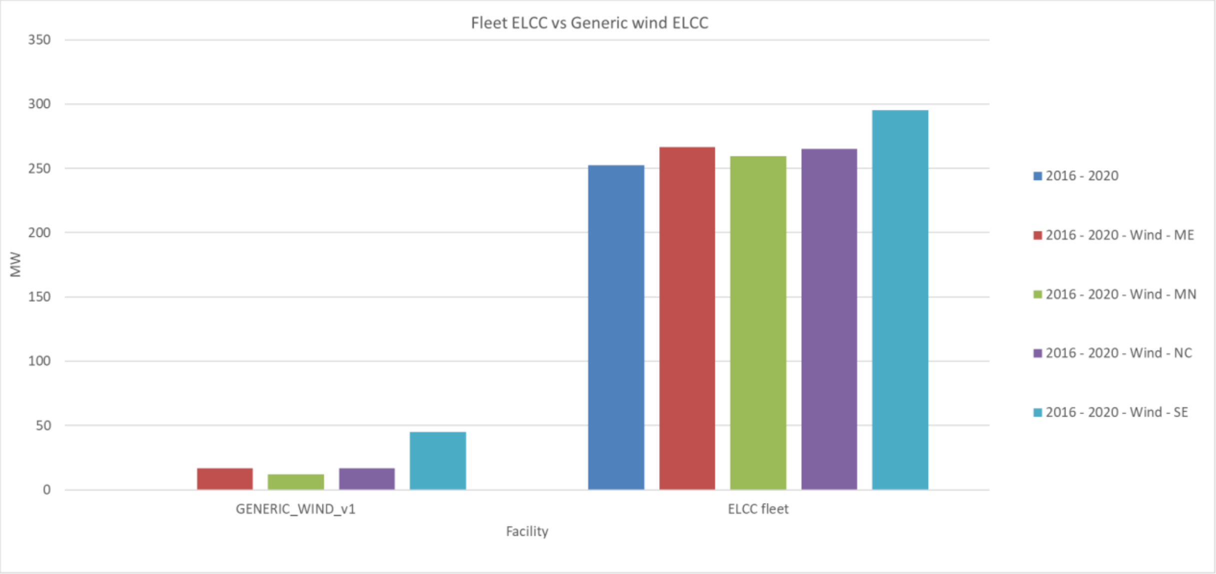
- Hybrid method results are very sensitive to the choice of parameters, and the selection of parameters will favour some participants over others.
- The Delta method is a better approximation of actual contribution to system reliability in known hours of system stress, while considering the potential for stress in other time periods.

Year-to-year facility volatility can be smoothed by averaging ELCC at a facility level. This would mean distributing Fleet ELCC based on the average first-in and last-in ELCCs for each facility from each individual year.

8. Impact of New Entry

Effect of New Wind Facility on Fleet ELCC

- When a new intermittent facility is commissioned, it could potentially affect the CRC allocation of existing facilities with a similar output profile.
- To explore the effect, we ran four scenarios in which a new 100 MW generic wind facility is added in each of four different zones (ME, MN, NC, SE). The output profile of the new facility is generated by taking the average profile of the existing wind facilities in that region.
- In all cases, adding a new wind facility proportionately increases the overall Fleet ELCC as there is one more facility in the intermittent fleet
- The increase in fleet ELCC is the highest for a facility added in the Southeast, and lowest in the Mid-North (MN).



Facility Name	Zone
INVESTEC_COLLGAR_WF1	ME
BADGINGARRA_WF1	MN
BLAIRFOX_KARAKIN_WF1	MN
EDWFMAN_WF1	MN
WARRADARGE_WF1	MN
YANDIN_WF1	MN
BLAIRFOX_BEROSRD_WF1	MN
BLAIRFOX_WESTHILLS_WF3	MN
ALINTA_WWF	NC
KALBARRI_WF1	NC
MWF_MUMBIDA_WF1	NC
BREMER_BAY_WF1	SE
DCWL_DENMARK_WF1	SE
GRASMERE_WF1	SE
SKYFRM_MTBARKER_WF1	SE
ALBANY_WF1	SE

Effect of New Wind Facility on Existing Facilities - Delta

- The effect on nearby facilities can be seen by looking at a representative facility in each zone.
- The table below shows the change in ELCC with the addition of a new 100 MW facility in that zone as a % of nameplate capacity.

Zone Representative facility	ME INVESTEC_COLLGAR_WF1	MN YANDIN_WF1	NC ALINTA_WWF	SE ALBANY_WF1
2015	-0.16%	-0.28%	-0.09%	0.22%
2016	-1.83%	-0.60%	-1.31%	-3.02%
2017	-0.67%	-0.36%	-0.41%	-1.78%
2018	-2.87%	-0.67%	-0.85%	-1.50%
2019	-1.93%	-0.72%	-0.58%	-3.89%
2020	-1.26%	-0.30%	-0.51%	-1.88%
2016-2020	-1.55%	-0.65%	-0.61%	-2.70%

- The effect on facilities in other regions is smaller, but in some cases is positive.

Effect of New Wind Facility on Existing Facilities - Collgar

- As the Collgar method distributes the Fleet ELCC based on average performance in selected periods:
  - the effect of additional facilities is shared across the entire fleet rather than concentrated in facilities with a similar output profile
  - The new facility gets a smaller proportion of the increase in the Fleet ELCC, so the overall effect is to increase the CRC of existing facilities rather than decrease it.

Collgar Method Results				
Zone	ME	MN	NC	SE
Representative Facility	INVESTEC_COLLGAR_WF1	YANDIN_WF1	ALINTA_WWF	ALBANY_WF1
Difference in CRC (MW)	0.0	1.0	1.0	0.9

Conclusion

New facilities affect the CRC allocation of existing facilities.

- A new facility with an output profile similar to an existing facility will reduce the Delta method ELCC of the existing facility. Under the hybrid methods, the decrease will be spread across the whole fleet.
- A new facility with a output profile complementary to an existing facility will increase the Delta method ELCC of the existing facility. Under the hybrid methods, the new facility could receive a smaller proportion of the increase in Fleet ELCC, with the increase being spread across existing facilities.

Similarly, exiting facilities will also affect CRC of remaining facilities.

In the current fleet, the effects appear relatively small – less than 2% of nameplate capacity for affected facilities.

EPWA considers that the change is not large enough to warrant the additional complexity of caps and floors for existing facilities.

9. Proposed Method

Proposed CRC Allocation Method for Intermittent Facilities

EPWA proposes to determine CRC for intermittent facilities as follows:

1. Use historical load for the most recent 5 capacity years, adjusted for DER penetration
2. Remove data from the capacity year with the lowest peak demand
3. Calculate Fleet ELCC over the remaining historical data
4. Calculate fleet ELCC for each remaining year of historical data
5. Take the average of the fleet ELCC for each individual year
6. Set the fleet CRC for the next capacity year as the lower of 3 and 5
7. Calculate first-in and last-in ELCC for each facility in each historical capacity year. Treat all facilities with nameplate capacity < 5MW as a single aggregate facility.
8. Calculate average first-in and average last-in ELCC for each facility from the output of 7.
9. Calculate facility CRC by distributing the Fleet ELCC (6) using the average facility ELCCs (8).
10. Calculate CRC for small facilities by distributing the group ELCC in proportion to the average of total annual generation (MWh) in the remaining historical years.

8. Next steps

Next Steps

- DSP CRC and IRCR methods
- Financial analysis (as part of overall assessment of package)
- Questions or feedback can be emailed to energymarkets@dmirs.wa.gov.au

11. General Business

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Comparing Delta outputs for 2015 and 2015-19

- The upper chart shows that DPV adjusted load (both peak and total) is highest in 2015, with 2019 close behind.
- Per slide 15, ELCC is calculated by adding load to get to 0.002% EUE. Then the intermittent fleet is removed and load is reduced until the EUE is the same amount as it was before the removal. The MW of load reduced is the fleet ELCC.
- The lower chart shows the MW quantity originally added to the load to get EUE to 0.002%, as well as the amount reduced when removing the intermittent fleet.
- More load is added to each interval in the 2015-2019 case than the 2015 case, resulting in a higher overall demand curve.
- While the majority of EUE in the 2015-2019 case is still driven by 2015, there are more intervals affecting the result.