Analysis of response to Individual Reserve Capacity Requirement in 2020-21 Hot Season

A 2021 Wholesale Electricity Market Electricity Statement of Opportunities supplementary analysis

The Individual Reserve Capacity Requirement (IRCR) financially incentivises Market Customers[1] and Customers[2] to reduce consumption during peak demand periods and hence reduce their exposure to Reserve Capacity costs. At the time of peak demand[3] for the 2020-21 Hot Season[4], AEMO estimates that 42 (8%) of the sampled National Metering Identifiers (NMIs)[5] reduced consumption, resulting in a total reduction of 146 megawatts (MW). This represents the highest IRCR response to date.

This IRCR analysis is supplementary to the *2021 Wholesale Electricity Market (WEM) Electricity Statement of Opportunities* (ESOO)[6].

This analysis investigates Customers' response to the IRCR mechanism in the WEM during the 12 Peak SWIS Trading Intervals[7] (IRCR Trading Intervals) specific to the Hot Season for 2012-13 to 2020-21.

1. Analysis of response to IRCR

The IRCR mechanism allocates the cost of Capacity Credits acquired through the Reserve Capacity Mechanism to Market Customers. Typically, the IRCR is a quantity (in MW) and determined based on the median consumption of each metered load in a Market Customer's portfolio during the IRCR Trading Intervals from the previous Hot Season. As a result, the IRCR financially incentivises Market Customers and Customers to reduce their consumption during peak demand periods and consequently reduces their exposure to capacity charges.

AEMO analysed the sampled NMIs to determine a representative response to the IRCR mechanism during the IRCR Trading Intervals, for the period 2012-13 to 2020-21.

The analysis compared each NMI's consumption during each IRCR Trading Interval with their baseline consumption[8] to determine whether a targeted reduction in consumption occurred.

The response was evaluated in terms of:

- The estimated total reduction in NMIs' consumption due to their consumption deviating from the baseline consumption (IRCR reduction),
- The number/percentage of NMIs which responded to reduce consumption, and
- The average percentage reduction among NMIs that responded in the IRCR Trading Interval.

Given a Customer is incentivised to reduce cost using the IRCR mechanism, several factors contributed to an IRCR response; this is discussed further in Section 2.

Note that for Figures 2 to 10 the average (red dot) and the maximum and minimum (grey dots) are taken among the IRCR Trading Intervals for each Hot Season.

[1] A Rule Participant who is registered as a Market Customer under clauses 2.28.10, 2.28.11 or 2.28.13 of the Wholesale Electricity Market Rules (WEM Rules). A Market Customer represents a person who sells or intends to sell electricity to Customers.

[2] A person to whom electricity is sold for the purpose of consumption.

[3] The peak demand is identified as the highest operational demand calculated for a Capacity Year. Operational demand refers to network demand met by utility-scale generation and excludes demand met by behind-the-meter photovoltaic (PV) generation. Operational demand is measured in MW and averaged over a 30-minute period. It is reported on a "sent-out" basis and calculated as the highest Total Sent Out Generation (TSOG) x 2 to convert non-loss-adjusted megawatt hours (MWh) to MW for a Trading Interval.

[4] Hot Season is defined in the WEM Rules as the period commencing at the start of the Trading Day beginning on 1 December and ending at the end of the Trading Day finishing on the following 1 April. References in this analysis in relation to the definition of Hot Season refer to the 2020-21 Hot Season (1 December 2020 to 1 April 2021).

[5] The sample NMIs are the selected as the top 500 NMIs with the highest consumption in the relevant Hot Season and this represents 46% of the total energy consumption for the 2020-21 Hot Season.

[6] At https://www.aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2021/2021-wholesale-electricity-market-electricity-statement-of-opportunities.pdf.

[7] The 12 Peak SWIS Trading Intervals means the three Trading Intervals with the highest TSOG on each of the four Trading Days with the highest maximum demand in that Hot Season, as published by AEMO in accordance with clause 4.1.23A of the WEM Rules. Current and historical IRCR Trading Intervals are at http://data.wa.aemo.com.au/#peak-intervals.

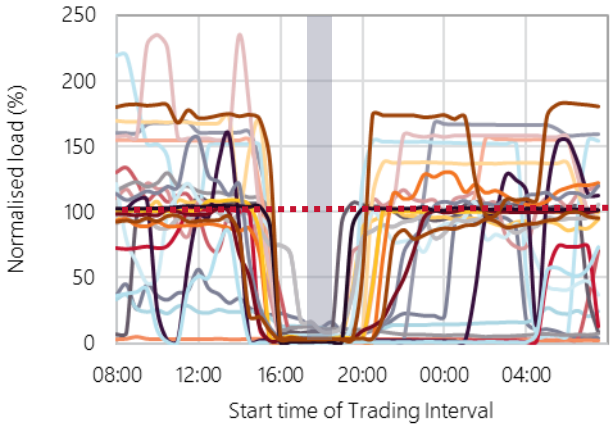
[8] The baseline consumption is calculated for each Trading Interval as the median consumption recorded at that Trading Interval for each Trading Day in the relevant Hot Season. A NMI is considered to have responded if its consumption is less than a threshold below than the baseline consumption.

2020-21 summer peak demand

Peak demand for the 2020-21 Hot Season was 3,789 MW, which occurred on 8 January 2021, during the 18:00 to 18:30 Trading Interval. The IRCR reduction at peak demand is 146 MW and the estimated number of NMIs responded out of the sample is 42 (8%).

Figure 1 captures the intraday variation in normalised load[9] of the responded NMIs on the peak demand day in the 2020-21 Hot Season, showing a consistent drop in their consumption from their baseline consumption levels typically between 17:30 and 19:00.

Figure 1 Intraday normalised load for NMIs that responded at least 9 of 12 IRCR Trading Intervals on 8 January 2021



A. The red dotted line marks the normalised load (100%) in which consumption equals to the baseline (median) consumption.
B. The grey shaded area covers the period of three IRCR Trading Intervals (17:30-18:00, 18:00-18:30, and 18:30-19:00) occurred on 8 Jan 2021.

Historical response to IRCR mechanism

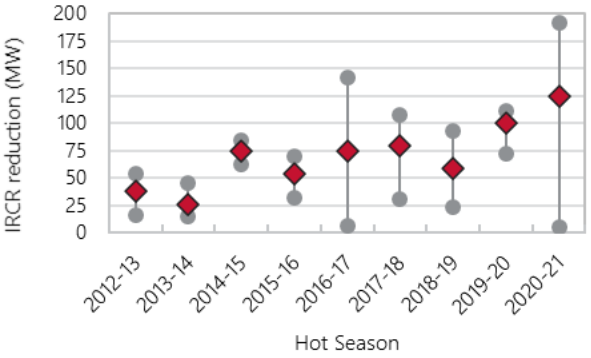
Over the analysis period, the IRCR reduction increased significantly over time, from an average of 38 MW during the 2012-13 Hot Season to 125 MW in 2020-21, as shown in Figure 2.

A large variance in IRCR reduction is observed for the Hot Seasons in 2016-17 (range of 6 MW to 142 MW) and 2020-21 (5 MW to 192 MW).

In both cases, the highest IRCR reduction occurred within the typical summer holiday period (on 4 January 2017 and 24 December 2020), suggesting the timing of these IRCR Trading Intervals may have benefited Customers who shut down or reduced their operation over the holiday period.

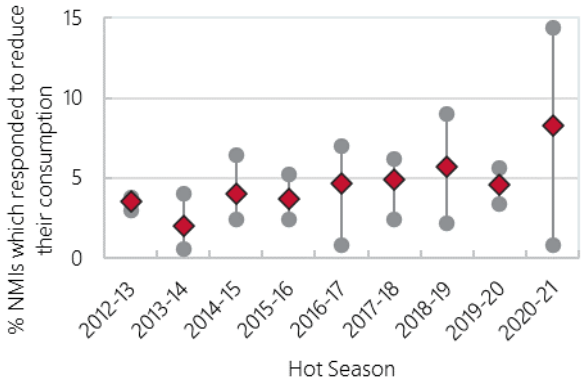
The lowest values within the ranges typically coincided with lower-than-average temperatures (33.3°C for 3 March 2017 and 35.3°C on 23 February 2021 – see Figure 7). A plausible explanation is that Customers failed to respond if they considered high temperature forecasts as an indicator to reduce consumption.

Figure 2 IRCR reduction



The increase in IRCR reduction is attributed to the increasing percentage of NMIs that responded to the IRCR mechanism, from an average of 3.6% in 2012-13 to 8.2% in 2020-21 (see Figure 3).

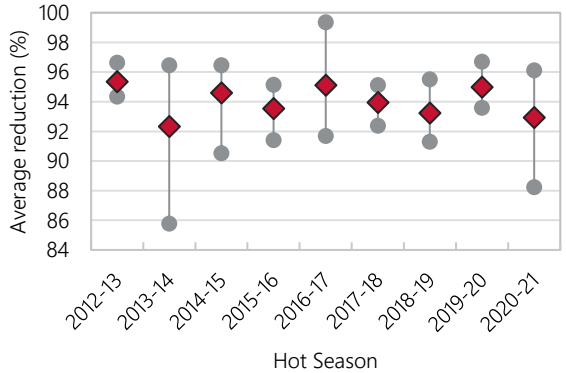
Figure 3 Percentage of NMIs which responded to reduce their consumption



For the 2020-21 Hot Season, it is estimated that, within the pool of NMIs that responded in any of the 12 IRCR Trading Intervals, approximately 0.4% reduced consumption in all 12 of the IRCR Trading Intervals, and 17.8% reduced consumption in at least one of the IRCR Trading Intervals.

The average reduction of responding NMIs over the IRCR Trading Intervals remains steady with an average between 92-95% among all nine Hot Seasons (see Figure 4).

Figure 4 Average percentage reduction among NMIs that responded



[9] Normalised load is defined as the ratio calculated as the consumption over the baseline consumption.

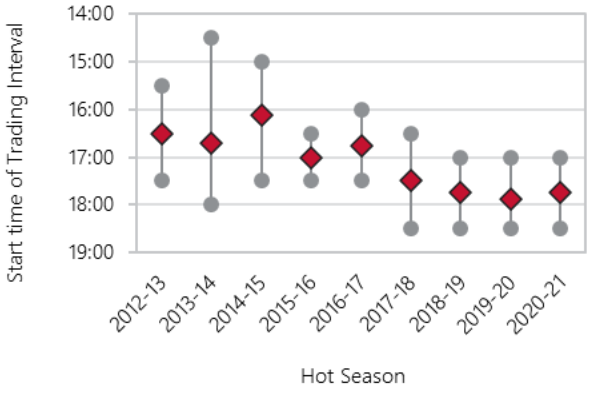
2. Predicting IRCR Trading Intervals

The following sections examine factors that may help predict the IRCR Trading Intervals – time of the day, day of the week, temperature, and load forecasts.

Time of the day

The occurrence of peak demand is highly dependent on the time of the day. Figure 5 shows the shift of the time of IRCR Trading Intervals to later in the afternoon over the analysis period[10]. In the last three Hot Seasons, the start time of all IRCR Trading Intervals has been between 17:00 and 18:30.

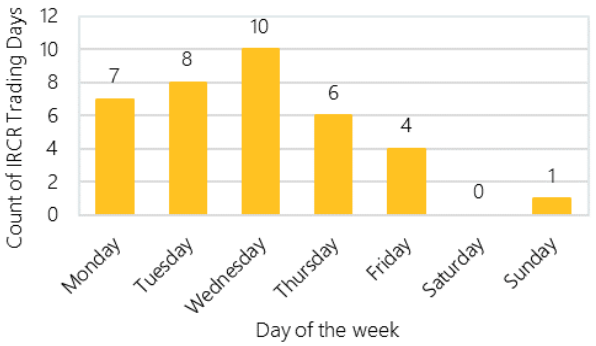
Figure 5 Start time of IRCR Trading Intervals



Day of the week

IRCR Trading Days[11] are more likely to occur on weekdays than weekends, with only one occurrence of weekend in the past nine Hot Seasons (see Figure 6). The occurrence was a Sunday during a relatively mild summer of the 2018-19 Hot Season. Wednesday is the day of the week with the highest occurrence of IRCR Trading Days.

Figure 6 Count of the IRCR Trading Days on different days of the week for 2012-13 to 2020-21 Hot Seasons



Temperature

Temperature is an important factor to determine the IRCR Trading Intervals since summer peak demand is primarily driven by high air temperature in the Perth metropolitan area, with increased energy consumption from the operation of cooling equipment in response to hot weather conditions.

In the last nine Hot Seasons, the maximum temperature at 15:00 on IRCR Trading Days was consistently at or above 33°C (shown in Figure 7).

For the three-day rolling average maximum temperature[12] on IRCR Trading Days (Figure 8), a narrower range of no more than 6°C difference is observed (for any given Hot Season), and the minimum stayed above 31°C for all Hot Seasons.

For the 90-minute rolling average maximum temperature at IRCR Trading Intervals[13] (Figure 9), a similar minimum value of about 31°C is observed.

Figure 7 Maximum temperature at 15:00 on IRCR Trading Days

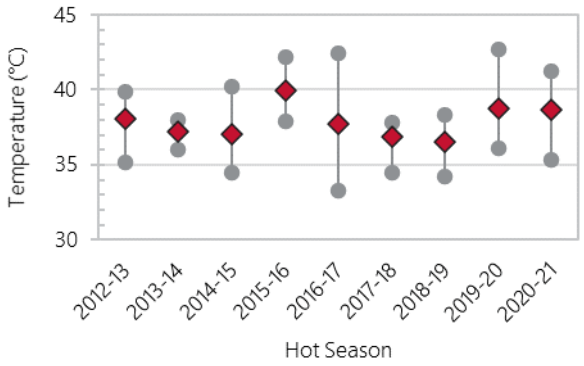
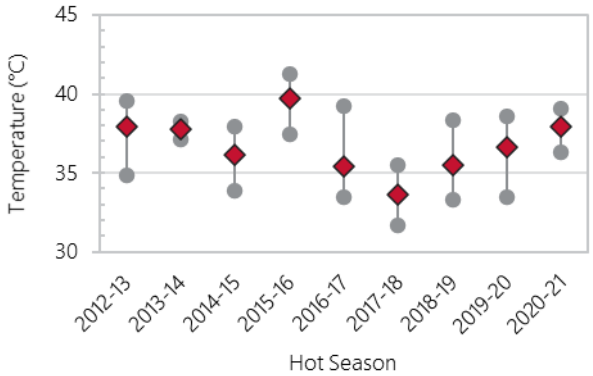


Figure 8 3-day rolling average maximum temperature on IRCR Trading Days



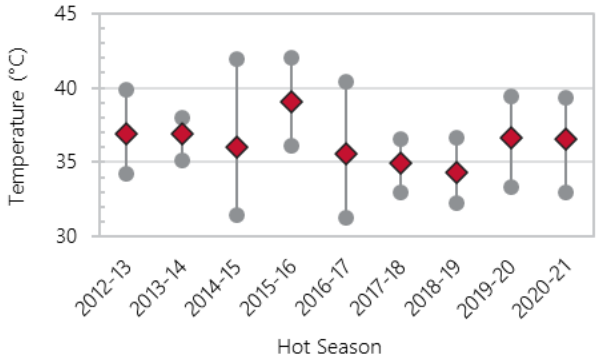
[10] For a more in-depth discussion of the phenomenon, see Section 3.1 in the 2021 WEMS ESOO, at https://www.aemo.com.au/-/media/files/electricity/wem/planning_and_forecasting/esoo/2021/2021-wholesale-electricity-market-electricity-statement-of-opportunities.pdf.

[11] IRCR Trading Day is a Trading Day in which one or more IRCR Trading Intervals occurred.

[12] Three-day rolling average maximum temperature refers to the average of maximum temperatures on the specified day and the two preceding days.

[13] The 90-minute rolling temperature refers to the average of maximum temperature at the IRCR Trading Interval of each day and the two preceding Trading Intervals.

Figure 9 90-minute rolling average maximum temperature at IRCR Trading Intervals



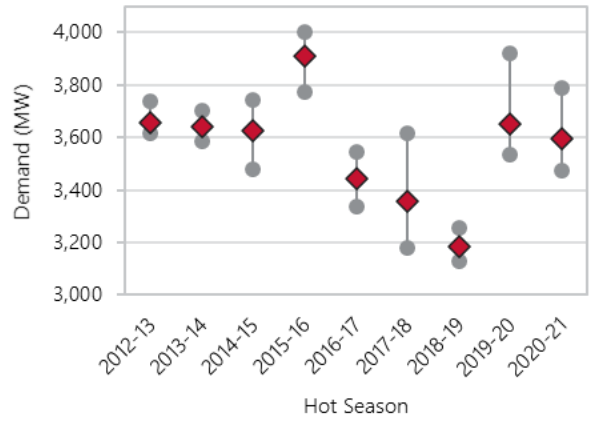
Load forecast[14]

AEMO publishes the 'Historical Load Forecast[15] report at 07:30 on each Trading Day[16].

The analysis below presents the historical value range of demand during the IRCR Trading Intervals and a comparison of the Load Forecast and actual load[17].

The lowest demand in any of the IRCR Trading Intervals in the last nine Hot Seasons was 3,130 MW, which occurred in 2018-19. For the majority of the IRCR Trading Intervals, demand exceeded 3,500 MW (Figure 10).

Figure 10 Demand during the IRCR Trading Intervals

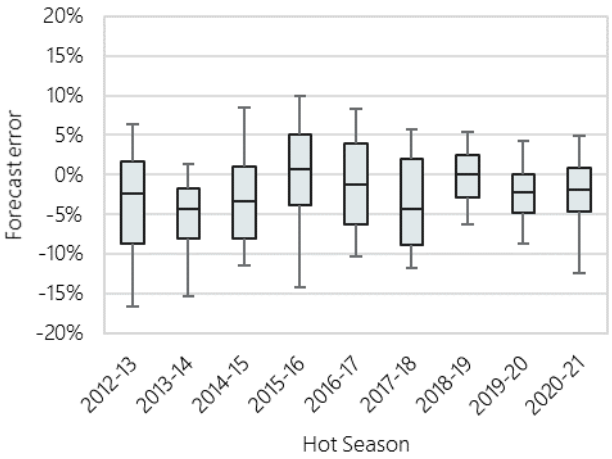


Figures 11 is a box plot of the estimated percentage forecast error[18], showing that the values between the first and third quantiles ranged from -8.9% to 5.1% and the forecast predicting lower than actuals most of the time.

The forecast errors in general are confined to a narrower range in the last three Hot Seasons (values between the first and third quantile varied from -4.8% to 2.4%), suggesting an improvement in forecast accuracy. Explanation for accuracy improvement is that the Historical Load Forecast includes load forecast data only for D+1 after 23 May 2018. Forecasts considered solar irradiance to capture the impact of rooftop PV as well as other minor changes just before the start of 2020-21 Hot Season.

The dominant factors that contributed to these variances are likely to be temperature forecast error, forecast modelling limitations and PV forecast error, while other factors may include humidity forecast error, variability in large industrial load operation, and forecast modelling error.

Figure 11 Box plot of the estimated forecast error for actual load above 3,000 MW



A. Horizontal lines within each box denote median values; boxes extend from the 25th to the 75th percentiles; vertical extending lines denotes the 5th and 95th percentile.

Future analysis

AEMO welcomes stakeholders' feedback on this analysis and suggestions for future refinements can be provided to the Reserve Capacity (WA) team at wa.capacity@aemo.com.au.

[14] Load Forecasts are published by AEMO in accordance with clause 7.2.1 of the WEM Rules. This is based on total market load, which is measured using SCADA data on a 'sent-out' basis and adjusted for network losses. This is not the same as TSOG, which is non-loss adjusted meter data.

[15] Available at https://aemo.com.au/energy-systems/electricity/wholesale-electricity-market-wem/data-wem/market-data-wa. Note that all of the 'Historical Load Forecast' reports prepared prior to 23 May 2018 contain D+2 load forecast data. As of 23 May 2019, the 'Historical Load Forecast' report contain D+1 load forecast data for each completed Trading Day (the latest load forecast data for a particular Trading Day). AEMO also publishes the 'Load Forecast' (for the upcoming Trading Day and the following Trading Day, at https://aemo.com.au/energy-systems/electricity/wholesale-electricity-market-wem/data-wem/market-data-wa) and 'Extended Load Forecast' (beyond the next two Trading Days and up to the seventh Trading Day, at https://aemo.com.au/energy-systems/electricity/wholesale-electricity-market-wem/data-wem/market-data-wa) at 07:30 on each Trading Day.

[16] A Trading Day is a period of 24 hours commencing at 8:00 AM.

[17] Actual load is the total market load, which is measured using SCADA data on a 'sent-out' basis and adjusted for network losses.

[18] Forecast percentage error is calculated as (forecast load – actual load)/actual load.

Important notice

Purpose

The purpose of this publication is to provide supplementary analysis to the 2021 Wholesale Electricity Market Electricity Statement of Opportunities.

Disclaimer

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