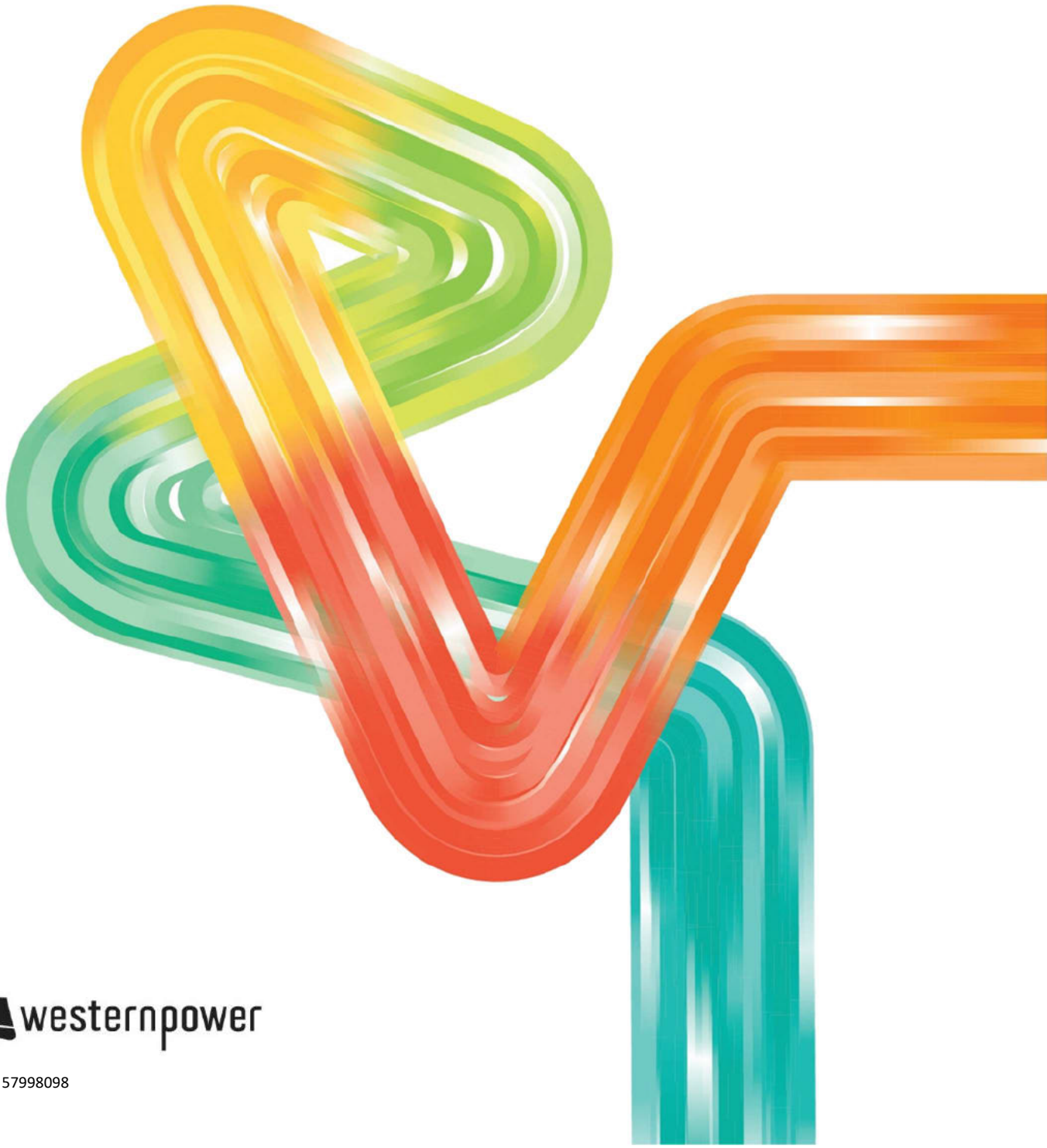
Attachment 6.3

Estimation of value of customer reliability for Western Power's network

Access Arrangement Information

1 February 2022



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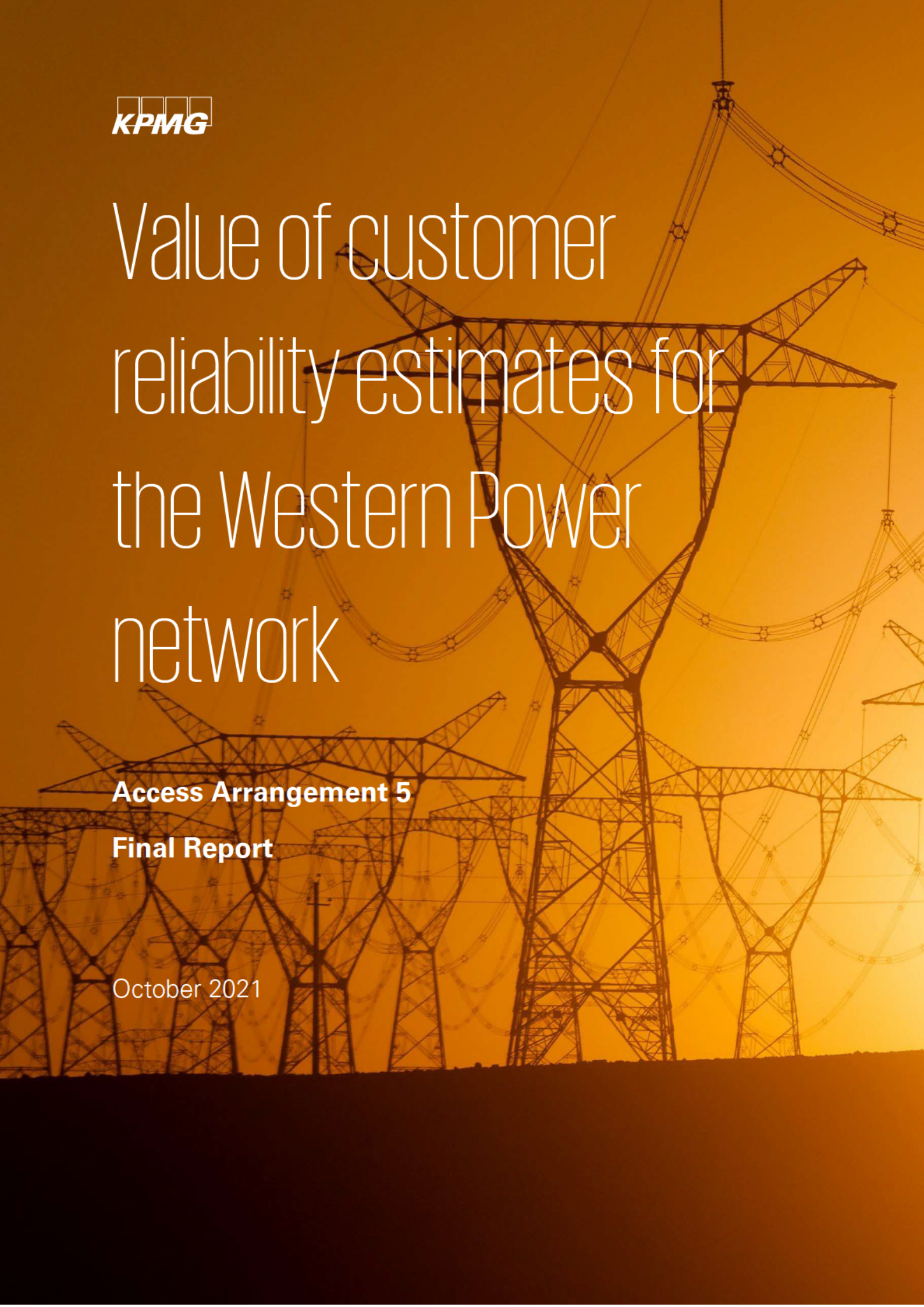

KPMG

Value of customer reliability estimates for the Western Power network

Access Arrangement 5

Final Report

October 2021

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Our reporting date corresponds with a period of significant volatility in global financial markets and widespread macro-economic uncertainty. In light of the emergence and spread of COVID-19, this volatility and uncertainty could persist for some time. The assumptions set out in our report will need to be reviewed and revised to reflect any changes which emerge as a result of COVID-19. As a result of the continued uncertainty in relation to the impact of COVID-19, our work may not have identified, or reliably quantified the impact of, all such uncertainties and implications. If the assumptions provided by Western Power on which this report is based are subsequently shown to be incorrect or incomplete, this could have the effect of changing the findings set out in this report and these changes could be material. We are under no obligation to amend our report for any subsequent new information.

Executive Summary

Values of customer reliability (VCR) represent the willingness of different customer types to pay for the reliable supply of electricity. VCR serves as an important input into regulatory and network investment contexts; informing the reliability incentive rates used in service standard incentive schemes, as well as informing decision making with respect to the trade-off between the benefit of reliability improvements and the cost of investment needed to achieve such improvements.

Western Power has engaged KPMG to develop robust estimates of the VCR values to apply during the Access Arrangement 5 (AA5) period between July 2022 and June 2027. These estimates are based on the methodology used in the National Electricity Market (NEM).

VCR was most recently reviewed in the NEM by the Australian Energy Regulator (AER) in 2018[1]. The AER released the final outcomes of its VCR review in December 2019, setting out VCR values for both distribution and transmission connected customers related to unplanned outages of up to 12 hours in duration for the NEM and Northern Territory. Prior to the AER's review, the VCR values used in the NEM were those from the 2014 AEMO review[2].

In both the 2019 AER and the 2014 AEMO reviews, VCR estimates were developed through a detailed customer survey process. This involved collecting responses from a representative sample of residential and business customers relating to their willingness to pay to avoid a baseline outage scenario, and the contingent value they place on additional outage characteristics.

The 2019 AER review segmented residential customers with greater granularity as compared to AEMO in its 2014 review. The AER segmented residential customers by climate zone and remoteness classification, capturing differences in reliability preferences driven by climate conditions and location, including differences across different regions of the same state. AEMO segmented residential customers at a state level and estimated residential VCR for each state in the NEM.

The 2019 AER review also applied a different definition to 'Very Large Business' customers, as compared to AEMO's definition of 'Direct Connect' customers. The AER considered that high voltage distribution connected customers with peak demand greater than 10 MVA were representative of a similar reliability experience to transmission-connected customers and therefore grouped these customers in a segment 'Very Large Business'. The AER's review also differed from AEMO's with respect to the pool of customers surveyed, the contingent valuation and choice modelling survey designs, and the outage scenarios for which VCRs were estimated.

For Access Arrangement 4 (AA4), Western Power proposed VCR values based on the 2014 AEMO estimates for the NEM, with adjustments to reflect the frequency and nature of outages experienced by different customer types on Western Power's network. This avoided the need to undertake a detailed customer survey process and associated analysis on a standalone basis for Western Power's customers.

For AA5, the Economic Regulation Authority (ERA) has proposed that VCR values be estimated using broadly the same approach as in AA4. That is, "the most recent AER results available should be used to estimate suitable values for Western Power. There are some differences in the method and format of data compared with the previous study undertaken by AEMO that will need to be accounted for to obtain suitable values for Western Power's customers."[3]

Consistent with this, Western Power has engaged KPMG to develop robust VCR estimates for AA5 that are adapted from the outcomes of the AER's 2019 VCR review.

[1] Australian Energy Regulator – Values of Customer Reliability, Final report on VCR values – December 2019, p. 56
[2] Australian Energy Market Operator – Value of Customer Reliability Review – Final Report, September 2014
[3] ERA, Framework and approach for Western Power's fifth access arrangement review – Issues Paper, April 2021, p.34.

VCR estimation methodology

In adapting the AER's VCR estimates to Western Power's context, the methodology we have used is designed to:

- align as much as possible (subject to data availability) with that used in the 2019 AER review; and
- produce a complete set of VCR estimates with adjustments to reflect the frequency and nature of outages experienced by different customer types on Western Power's network, and that can be appropriately applied to all customer types on the Western Power network.

Estimation process

We have employed the following steps in adapting the AER's VCR estimates to Western Power's context.

Step 1 – Customer segmentation

Identify appropriate customer segments to align with the segments used by the AER and segment Western Power's data accordingly.

Step 2 – Assess the robustness of the translation exercise

For each customer segment, determine that the context within which the NEM customer sample was taken is sufficiently representative of Western Power's network, and therefore that translating the AER's estimates to Western Power's context is reasonable.

Step 3 – Adapting the AER VCR to Western Power VCR for each customer segment

Actual outage data of interruptions on Western Power's network is used to adapt the AER's estimates to reflect the frequency and nature of outages observed on the Western Power network.

Step 4 – Weight customer segment VCRs together

Using detailed data on energy consumption (kWh) over the last 5 years, VCRs have been weighted together to produce aggregated estimates for various customer segments and feeder types on the Western Power network.

Step 5 – Develop final VCR recommendations

Determine the appropriate averaging periods to be applied to Western Power's outage and consumption data, and escalate VCR values in line with CPI, to provide final recommended VCR estimates.

Step 1 – Customer segmentation

The AER estimated VCR values for three broad customer segments: Residential, Business, and Very Large Business. These were further divided into:

- **Residential** – 12 sub-segments based on climate zone and remoteness combinations (only some of which are relevant for Western Power);
- **Business** – 6 sub-segments based on size (Small & Medium, and Large) and industry type (Agricultural, Industrial, and Commercial) combinations; and
- **Very Large Business** – 4 sub-segments based only on industry type (Services, Industrial, Metals and Mines). These businesses are either connected to the distribution network or the transmission network.

In line with the segmentation used by the AER, we have segmented Western Power's customers into three broad segments:

- **Residential** – 6 sub-segments based on the climate zone and remoteness combinations observed on the Western Power network.
- **Commercial** – 2 sub-segments based on size (Small Commercial, and Large Commercial < 10 MVA)[4]
- **Very Large Business** – 8 sub-segments based on the 4 industry types used by the AER (Services, Industrial, Metals and Mines), split by distribution and transmission connections.

The tables below outline the customer segments applied to Western Power's customer base, and for each segment – the comparator selected from the available sets of VCR estimates published by the AER.

Residential customer segments

Western Power AA5 VCR: customer segments	AER 2019 VCR review: selected comparator
Climate Zone 4 CBD & Suburban	Climate Zone 3 & 4 Regional[5]
Climate Zone 5 CBD & Suburban	Climate Zone 5 CBD & Suburban, SA[6]
Climate Zone 3 Regional	Climate Zone 3 & 4 Regional
Climate Zone 4 Regional	Climate Zone 3 & 4 Regional
Climate Zone 5 Regional	Climate Zone 5 Regional
Climate Zone 6 Regional	Climate Zone 6 Regional

Business/Commercial customer segments

Western Power AA5 VCR: customer segments	AER 2019 VCR review: selected comparator
Small Commercial	Small & Medium Business, weighted average of three industry sectors (Agriculture, Industrial, Commercial)
Large Commercial < 10 MVA	Large Business, weighted average of three industry sectors (Agriculture, Industrial, Commercial)

[4] Western Power does not collect information on the industry sector in which Commercial customers operate, therefore segmentation by industry sector was not feasible.
[5] Climate Zone 3 & 4 Regional was selected because a corresponding Climate Zone 4 CBD & Suburban region is not observed in the NEM, as such the AER did not publish VCR estimates for this customer segment.
[6] In the case of Climate Zone 5 CBD & Suburban the AER determined that customers in South Australia displayed materially different preferences than those in New South Wales, and published independent sets of VCR estimates for each state. We have selected South Australia as the most appropriate comparator to Western Power's network.

Very Large Business customer segments

Western Power AA5 VCR: customer segments		AER 2019 VCR review: selected comparator	
Distribution-connected Large Commercial > 10 MVA	Services	Very Large Business (distribution and transmission connected customers > 10 MVA)	Services
	Industrial		Industrial
	Metals		Metals
	Mines		Mines
Transmission-connected	Services		
	Industrial		
	Metals		
	Mines		

The Very Large Business category is defined by the AER to capture customers with a peak demand greater than 10 MVA, and includes both transmission-connected and distribution-connected customers. To best align with this definition, we have split Western Power's distribution-connected Large Commercial customer segment into two customer segments: Large Commercial (excluding > 10 MVA) and Large Commercial > 10 MVA. The Large Commercial > 10 MVA segment captures distribution-connected customers with a contract maximum demand greater than 10 MVA, which have been mapped to the AER's Very Large Business VCR values.

Step 2 – Assessing the robustness of the translation exercise

With respect to Western Power's residential customers, we have conducted a contextual analysis of the factors likely to drive reliability preferences in the NEM as compared to Western Power's context, as a means of verifying that those customers in the survey sample of the 2019 AER review are sufficiently representative of Western Power's residential customer base.

Our analysis of a number of factors related to residential customers' willingness to pay for reliability of electricity supply over the AA5 period indicated broad comparability between Western Power and the corresponding climate zones in the NEM. This supports the robustness of the translation exercise for the AA5 period.

We were not able to conduct a similar analysis for non-residential customers because the AER has not published VCR estimates segmented by region for Business or Very Large Business customers. The AER noted that for business customers the willingness to pay for reliability is most closely aligned with the industry sector in which each business customer operates, and we have proceeded on the basis that the region in which a business operates is not a material driver of its reliability preferences.

Step 3 – Adapting the AER VCR to Western Power VCR for each customer segment

Developing customer segment VCRs for Residential, Small Commercial and Large Commercial (excluding > 10 MVA) customers

VCR estimates for Residential (segmented by 6 climate zone and remoteness segments as in the table above), Small Commercial and Large Commercial (excluding > 10 MVA) customers have been developed by combining:

- the AER's VCR estimates for the relevant customer segment as published for each of 32 different outage scenarios comprising 4 duration categories and 8 combinations of peak/off-peak, weekday/weekend and season (Winter or Summer). These capture the average willingness to pay of surveyed customers to avoid different outage durations or characteristics; and

- Western Power's outage probabilities for each of the 32 scenarios (calculated based on five years of outage data between April 2016 and March 2021).

Developing customer segment VCRs for Large Commercial > 10 MVA and Transmission-connected customers

VCR estimates for Large Commercial > 10 MVA and Transmission-connected customers are developed (consistent with the AER's approach) by:

- unweighting the AER's published Very Large Business estimates (for each of 4 industry types) using the published frequency of various outage durations observed in the NEM (the same frequency distribution was used across all 4 industry types) to produce a set of raw VCR estimates; and
- reweighting these values using Western Power's frequency of various outage durations impacting Large Commercial > 10 MVA and Transmission-connected customers respectively.

Step 4 – Weighting customer segment VCRs together to produce VCRs for Western Power's network segments

Using detailed data on energy consumption (kWh) over the last 5 years, VCRs have been weighted together to produce aggregated estimates for various customer segments and feeder types on the Western Power network.

Step 5 – Final VCR recommendations

KPMG has developed the following aggregated VCR estimates for customers on the Western Power network, segmented by customer type and feeder type, in June $2021.

The VCR estimates below have been derived using a 5-year averaging period between April 2016 and March 2021 applied to both Western Power's outage data and annual consumption data. We tested the sensitivity of VCR results to the use of 1-year and 5-year averaging periods, observing minor differences for certain customer segments. However, results were broadly stable across both averaging periods. Ultimately, we applied a 5-year period as this aligns with the length of period used in setting service standard benchmarks and incentive rates, as well as smoothing some annual variation observed in the data over shorter time periods.

The only exception to this is in the case of Large Commercial > 10 MVA and Transmission-connected customers in respect of which, we have applied a 10-year averaging period to Western Power's outage data. This is because the number of interruptions impacting customers in these segments was small relative to other customer segments, and therefore a longer averaging period provided more stable VCR estimates and captured a greater proportion of the available data.

In line with the AER's methodology, the VCR estimates presented below apply to standard outages only, referring to unplanned outages of up to 12 hours in duration. The VCR estimates in this report therefore do not cover all reliability events. Western Power may need to consider additional analysis with respect to extreme outage events on the network that fall outside the 12 hour standard duration, particularly in assessing projects which aim to improve resilience against extreme events.

Table 1 – Recommended VCR estimates by customer segment (June $2021/kWh)

Customer segment	VCR estimate
Residential	$30.59
Small Commercial	$62.38
Large Commercial	$42.55
Transmission-connected	$70.43

Table 2 – Recommended VCR estimates by network segment (June $2021/kWh)

Customer segment	VCR estimate
CBD	$42.54
Urban	$41.52
Rural Short	$40.14
Rural Long	$39.71

Table 3 – Recommended VCR estimates – whole of network (June $2021/kWh)

Customer segment	VCR estimate
Aggregate (distribution network)	$41.08
Aggregate (including transmission-connected)	$48.10

The methodology used by AEMO in its 2014 review is different to that used in the 2019 AER review, and some customer segments used by Western Power have since been discontinued, therefore the methodologies do not lend themselves to a direct comparison between the AA4 and AA5 VCR estimates.

However, the VCR estimates derived for AA5 using the methodology aligned with the 2019 AER review are similar in most cases to those used for similar customer segments in AA4, escalated for movements in CPI to June 2021

Differences between the AA5 VCR estimates for Western Power and those developed by the AER for the NEM are driven largely by differences in the nature and frequency of outages observed on Western Power's network as compared to those recorded in the NEM.

Table 4 – Difference in outage distribution (NEM vs. Western Power) - residential customers in Climate Zone 5 CBD & Suburban

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	-1.04%	1.09%	-0.19%	0.26%	-1.06%	0.54%	0.32%	0.39%
1 - 3	-4.60%	-4.04%	-5.00%	0.13%	-5.86%	0.62%	-3.00%	0.56%
3 - 6	-2.67%	-1.10%	0.01%	-1.75%	3.95%	3.22%	2.61%	1.14%
6 - 12	1.27%	0.21%	0.18%	-0.02%	7.56%	3.24%	2.20%	0.85%

As displayed in the example above, Western Power's outage distribution includes a higher percentage of outages of 6-12 hours in duration and a higher percentage of outages in the Summer. For all customer segments in the AER's survey sample, 6-12 hour duration outages carry the lowest willingness to pay to avoid the outage and Summer outages carry higher willingness to pay than Winter outages to avoid the outage all else the same. Overall, in Western Power's outage distribution the former effect dominates the latter effect, which contributes to lower VCR estimates for Western Power's distribution-connected customer segments.

The Large Commercial > 10 MVA and Transmission-connected customer VCR estimates for Western Power are broadly higher than those estimated by the AER for Very Large Business customers in the NEM in 2019. This is primarily due to a higher frequency of short duration (10 minute) outages in Western Power's outage data, which the surveyed Very Large Business customers typically place a very high value on due to the high fixed cost of restoring operations following an outage of any duration.

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1 Introduction

1.1 Background and context

Value of customer reliability (VCR) represents the value different classes of customers place on reliability of electricity supply under different conditions. VCR plays an important role as an input in network investment decision making, balancing competing customer outcomes of affordability and reliability. VCR is comprised of a set of values expressed in dollars per kilowatt hour ($/kWh), representing different residential and business customer types, which can be used selectively as relevant to the context in which they are being applied.

VCR estimates are typically derived by conducting customer surveys, involving collating responses across a representative sample of consumers of their willingness to pay for the reliable supply of electricity in different scenarios.

Between October 2018 and December 2019, the Australian Energy Regulator (AER) derived VCR estimates for customers served by networks operating in the National Energy Market (NEM) and the Northern Territory through an extensive consumer survey process, collecting responses from approximately 7,400 residential customers and 1,800 business customers. This is the largest review of VCR undertaken in Australia to date. The Australian Energy Market Operator (AEMO) conducted a similar exercise in 2014, surveying approximately 3,000 residential and businesses customers across the NEM. The survey was the first of its type conducted across the whole of the NEM.

To date, no equivalent choice modelling and contingent valuation survey process has been undertaken with a sufficiently large and representative sample of WA customers.

For Access Arrangement 4 (AA4), Western Power proposed VCR values based on the 2014 AEMO estimates for the NEM, with adjustments to reflect the frequency and nature of outages experienced by different customer types on Western Power's network. This avoided the need to undertake a detailed customer survey process and associated analysis on a standalone basis for Western Power's customers.

For AA5, the Economic Regulation Authority (ERA) has proposed that VCR values be estimated using broadly the same approach as in AA4. That is, "the most recent AER results available should be used to estimate suitable values for Western Power. There are some differences in the method and format of data compared with the previous study undertaken by AEMO that will need to be accounted for to obtain suitable values for Western Power's customers."[7]

Western Power has engaged KPMG to develop estimates of VCR for customers on its network to apply over the Access Arrangement 5 (AA5) period: July 2022 to June 2027. KPMG's task is to adapt the AER's VCR estimates from the 2019 review to apply to Western Power's customers.

[7] ERA, Framework and approach for Western Power's fifth access arrangement review – Issues Paper, April 2021, p.34.

1.2 Role of VCRs

VCR values will have multiple applications for Western Power over the AA5 period, in both a regulatory and network investment decision making context:

- For the setting of incentive rates in the AA5 submission for network reliability service standard benchmarks under the financial incentive scheme and Service Standard Adjustment Mechanism.
- To inform network investment decisions, including assessing the trade-off between reliability and affordability when investing to deliver a reliable electricity network.

1.3 Scope of VCRs in this report

The VCR estimates presented in this report apply to standard outages only, referring to unplanned outages of up to 12 hours in duration. The VCR estimates in this report therefore do not cover all reliability events. In March 2020, the AER published a draft model and consultation paper relating to Widespread and Long Duration Outages (WALDO). Stakeholder feedback on the AER's proposed approach to model WALDO events raised questions regarding the quantification of social costs, and the shape of the WALDO VCR curve. As a result, the AER discontinued the WALDO model and methodology in September 2020[8]. No further information has since been published, however the AER has noted it will continue to consider the issue and carry out further research on the costs of WALDO.

Western Power will need to consider additional analysis with respect to extreme outage events on the network that fall outside the 12 hour standard duration covered by KPMG's review, particularly in assessing projects which aim to improve resilience against extreme events.

We also note the possibility that VCR measures may not fully capture all customers' preferences and values for reliability and resilience. Generally speaking, resilience is different to reliability as it includes the capacity of consumers, firms, and markets to temporarily adjust, adapt, or otherwise compensate for the loss of electricity in ways that mitigate economic impacts.

Following an external shock or extreme disruption such as a bushfire, consumers and firms (i.e. the community) will try to adapt and adjust their behaviour. Having a reliable source of supply during this period will greatly assist in their success, and impact on how the outcomes of their actions will help their response and recovery. While the AER VCR measures are targeted at the individual customer value, this can ignore the wider community benefit from access to reliable supply (i.e. access to shops and cafes, local community centres, communications).

Certain segments of Western Power's customers may place a high value on reliability that is not captured in the preferences of customers in the survey sample used by the AER. With respect to specific projects Western Power is undertaking to reduce costs that will impact certain customer segments, for example the rollout of stand-alone power systems to very remote customers, Western Power may seek to diverge from the VCR estimates derived using the methodology in this report in order to more accurately reflect the unique preferences of its customers in making network investment decisions.

[8] Australian Energy Regulator – Widespread and Long Duration Outages – Values of Customer Reliability, Final Conclusions, September 2020

1.4 Structure of this report

This report is organised around the following sections.

- **Section 2: Comparative assessment of Western Power's regional context**

  This section assesses the context within which Western Power operates, and the factors that may impact the preferences of Western Power's customers as compared to customers in the AER's survey sample. The primary function of the contextual analysis component of our review is to consider the extent to which conditions in the NEM states may be considered sufficiently representative of the customer environment in Western Power's service area, and therefore that the outcomes of the adaptation exercise being applied are expected to be robust.

- **Section 3: Estimation methodology**

  This section provides a detailed description of the methodology we have applied in using outage and energy consumption data provided by Western Power to develop VCR estimates for each of the customer segments and feeder types on the Western Power network. It identifies issues that we encountered in applying our methodology, and how we resolved these issues to develop robust VCR estimates.

- **Section 4: Results and recommendations**

  This section details the VCR estimates we have derived for the Western Power network under a range of different scenarios for all customer segments, and provides our final recommended VCR estimates for Western Power.

2 Comparative assessment of Western Power's regional context

This section assesses the context within which Western Power operates, and the factors that may impact the preferences of Western Power's customers as compared to customers in the AER's survey sample.

The primary function of the contextual analysis component of our review is to consider the extent to which conditions in the NEM states may be considered sufficiently representative of the customer environment in Western Power's service area, and therefore that the outcomes of the adaptation exercise being applied are expected to be reasonably robust.

The 2019 AER review published residential VCR estimates segmented by region on the basis of climate zone and remoteness, and non-residential VCR estimates segmented by industry sector and size, with no geographic segmentation.

Reliability preferences for business customers were not considered to be materially different across states or regions. The AER also found that there were "few statistically significant differences between the ANZSIC sectors"[9] that were used to segment business customers, leading to only three broad sector groupings: Agriculture, Industrial, Commercial for business VCRs. VCRs for Very Large Business customers were similarly segmented by industry sector: Services, Industrial, Metals, Mines but not by region.

Given the AER's segmentation, it is necessary to translate the AER's VCR estimates for Business and Very Large Business customers across the whole of the NEM to Western Power's Commercial and Transmission-connected customers based on the implicit assumption that the region in which a business operates is not a material driver of its reliability preferences.

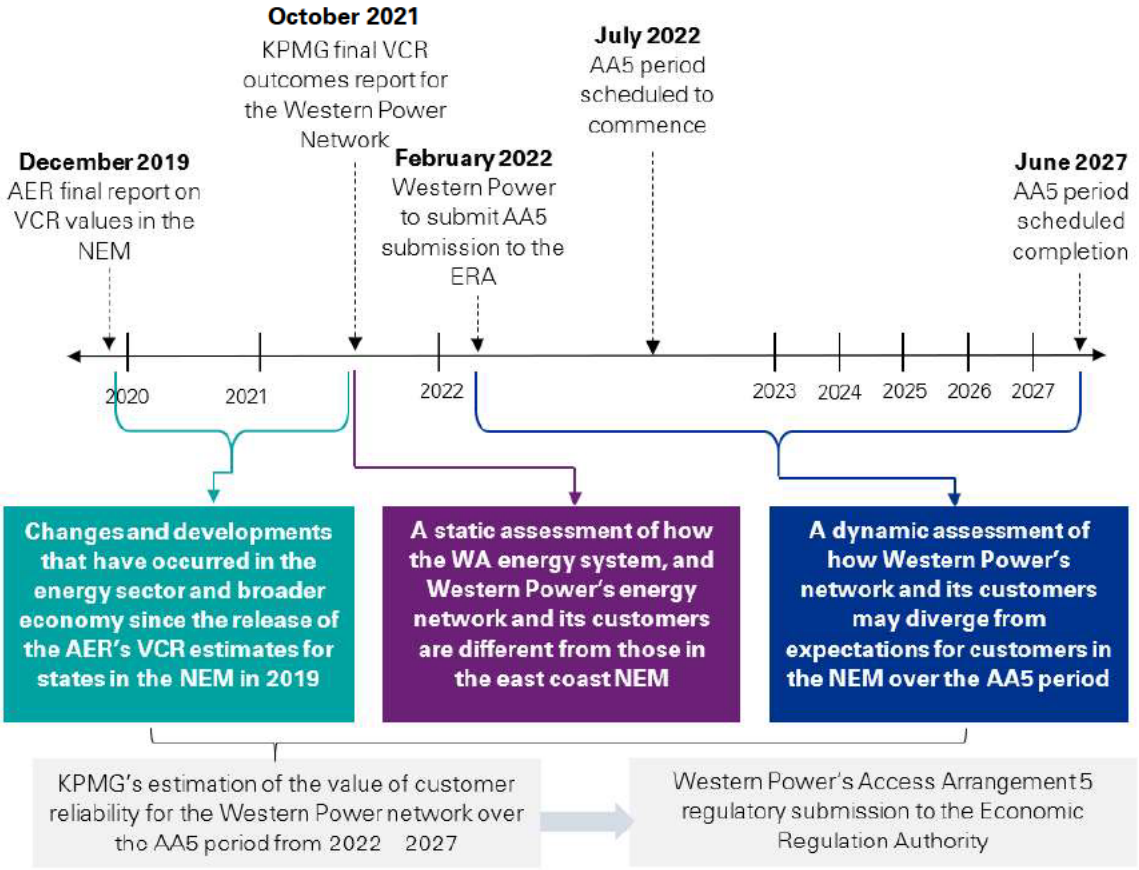
Our contextual analysis in this section therefore focuses on sources of difference in the factors driving VCR for residential customers on Western Power's network as compared to NEM customers who are located in the same climate zone.

2.1 The scope and timescale of contextual considerations for VCR in AA5

This report seeks to adapt estimates of VCR values as developed by the AER in 2019 for states in the NEM at that point in time to values applicable to Western Power's network throughout the duration of the AA5 period between 2022 and 2027. Given this, the consideration of contextual factors relevant to VCR involves both a static and dynamic assessment, as depicted in Figure 1 below.

[9] Australian Energy Regulator – Values of Customer Reliability, Final report on VCR values – December 2019, p. 56

Figure 1 – Scope and timescale of contextual considerations for VCR in AA5



2.2 Function of the contextual assessment in our Residential VCR methodology

Assessing the potential drivers of divergence in the VCRs of Western Power's residential customers relative to NEM customers has four functions in our methodology:

1. Verifying that states classified as similar to south west WA by climate zone are representative of the customer environment in Western Power's service area.
2. Informing the selection of appropriate jurisdictional proxies from the AER's 2019 study where a choice is necessary[10].
3. Identifying any areas of significant difference that may present a case for quantitative adjustments to our modelling approach, or that may be addressed by Western Power in a qualitative sense.
4. Highlighting areas where there may be an opportunity for Western Power to conduct further research (e.g. via conducting surveys of customers on the Western Power network).

Western Power and Synergies Economic Consulting conducted a similar contextual analysis in developing VCR estimates for AA4[11]. However, the residential VCR estimates derived in the 2014 AEMO review were segmented differently than those derived in the 2019 AER review that we have used to develop VCR estimates for AA5. Residential VCR values used in AA4 were segmented by jurisdiction, i.e. VCR values for each state represented the responses of all surveyed residential customers in that state. Therefore, in translating the NEM VCR estimates to Western Power's

[10] This only occurs in the case of Climate Zone 5 CBD & Suburban, where VCR estimates are presented separately for South Australia and New South Wales.
[11] Western Power and Synergies Economic Consulting, Access Arrangement Information – Attachment 6.4 – Estimation of value of customer of customer reliability for Western Power's Network, pp. 14-22

context, a choice was required as to which state in the survey sample best represented the drivers of VCR for Western Power's residential customers.

In its 2019 review, the AER found that when grouped together by climate zones, residential customers had very similar reliability preferences. Therefore, residential customers were segmented by climate zone and remoteness classification. In alignment with the AER methodology, we have segmented Western Power's residential customers by climate zone and remoteness classification and adapted the corresponding VCR estimates to each segment. In contrast to AA4, this method does not generally call for the selection of a particular state to be used as a proxy for Western Power's network.

In developing VCR estimates using the AER values segmented by climate zone and remoteness classification, it is important to consider whether the factors that may impact VCR are similar between Western Power's region and the states where the corresponding climate zone classifications are observed, noting that under the AER's method multiple states are captured under the same climate zone and remoteness segment (as displayed in Table 5 below).

Western Power's service region includes local government areas (LGAs) that are classified under climate zones 3, 4, 5 and 6. The table below indicates that South Australia and New South Wales are most closely aligned in terms of climate conditions to the south west region of WA that Western Power services.

Table 5 – AER 2019 Residential customer segments and applicable states

AER 2019 Residential customer segment	Applicable states in the NEM
Climate Zone 1 Regional	QLD
Climate Zone 2 CBD & Suburban	QLD, NSW
Climate Zone 2 Regional	QLD, NSW
Climate Zone 3 & 4 Regional*	QLD, **NSW**, VIC, **SA**
Climate Zone 5 CBD & Suburban*	**NSW**, **SA**
Climate Zone 5 Regional*	**NSW, SA,** QLD
Climate Zone 6 CBD & Suburban	VIC, NSW, SA, ACT
Climate Zone 6 Regional*	VIC, **NSW, SA**
Climate Zone 7 CBD & Suburban	ACT, VIC
Climate Zone 7 Regional	TAS, VIC, NSW

As set out above, the climate zones that map to the Western Power network (asterisked), are most closely aligned with residential customer segments in South Australia and New South Wales, meaning customers in South Australia and New South Wales represent a large proportion of the customer sample that informed the Residential VCR estimates that will be adapted to Western Power's customers.

The following analysis of a number of factors that may impact customers' willingness to pay for reliability compares outcomes on the Western Power Network (or the whole of WA in the absence of Western Power specific data) with outcomes in South Australia and New South Wales. The comparisons are approximate because the VCR estimates published by the AER are segmented by climate zone whilst the data that has informed our analysis in this section is presented on a whole of state basis.

The comparison aims to verify that the impactors of customer preference in the regions which represent a large portion of the customer survey sample which will be mapped Western Power are not materially different to the drivers of customer preference in Western Power's context.

2.3 Assessment of key contextual factors impacting residential VCR on Western Power's network

2.3.1 Variation in climate

Climate conditions are the most significant driver of variations in electricity use across regions. Temperature drives demand for electricity to serve heating and cooling needs in residential homes, and therefore the value customers place on reliable electricity to heat and cool their homes is likely to vary due to differences in climate conditions across states.

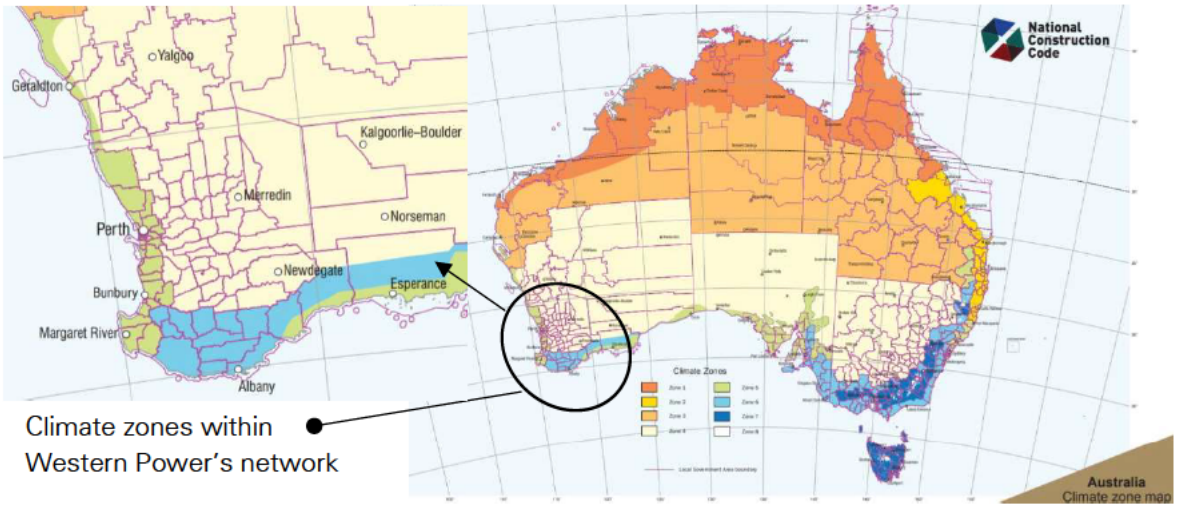
Climate is a particularly strong impactor of reliability outcomes in the context of hot summer and cold winter conditions that increase residential air conditioning and heating loads, driving peak demand events and placing a strain on the ability of energy networks to maintain a reliable supply of energy.

For AA4, climate conditions were not able to be captured with much granularity in adapting VCR estimates because AEMO's 2014 study published VCR estimates segmented only by state jurisdiction. South Australia and New South Wales were selected as appropriate state level proxies for Western Power on the basis of comparable temperature data; however, this approach did not account for variation in climate within different regions of the proxy states or across different regions of Western Power's network, nor did it account for other climatic factors such as humidity and rainfall.

The AER recognised the role of climate as a driver of customers' expectations of reliability in estimating VCRs in 2019, segmenting VCR values for residential customers by climate zone and remoteness, rather than state jurisdiction as adopted by AEMO the 2014 VCR review.

The AER found that customer preferences related to reliability and the avoidance of outages were broadly aligned with climate zone characteristics. We do not see any reasons not to accept this for developing VCR estimates for the Western Power network.

Figure 2 - Climate zone map of Australia



Source: Australian Building Codes Board – Climate Zone Map Australia

Table 6 - Australian climate zone classifications

Climate zone		Description	Applicable states
	Climate Zone 1	high humidity summer, warm winter	QLD, NT, WA
	Climate Zone 2	warm humid summer, mild winter	NSW, QLD
	Climate Zone 3*	hot dry summer, warm winter	NT, QLD, **WA**
	Climate Zone 4*	hot dry summer, cool winter	**NSW**, **SA**, VIC, **WA**
	Climate Zone 5*	warm temperate	**NSW**, QLD, **SA**, **WA**
	Climate Zone 6*	mild temperate	**NSW**, **SA**, VIC, **WA**
	Climate Zone 7	cool temperate	ACT, TAS, VIC
	Climate Zone 8	alpine	NSW

Source: Australian Building Codes Board – Climate Zone Map Australia

As depicted in the map above – in the south west portion of Western Australia that Western Power services – climate zones 3, 4, 5 and 6 apply. This aligns closest with the climate zones in South Australia and New South Wales.

Climate zone classifications are developed by the Australian Building Codes Board using climate data from the Australian Bureau of Meteorology on humidity, temperature and rainfall characteristics. Climate zone classifications are the most consistent and holistic representation of climate factors that drive heating and cooling requirements across different regions.

Our estimation methodology (as described in more detail in section 3) adapts Residential VCR estimates for each of the climate zone and remoteness categories observed on Western Power's network from VCR values published by the AER for the corresponding climate zone in the NEM. Residential VCRs for each climate zone and remoteness segment have been weighted together using the proportion of total residential consumption in each climate zone and remoteness region of Western Power's network. On this basis, our methodology captures difference in VCR due to differences in climate within different regions of Western Power's network.

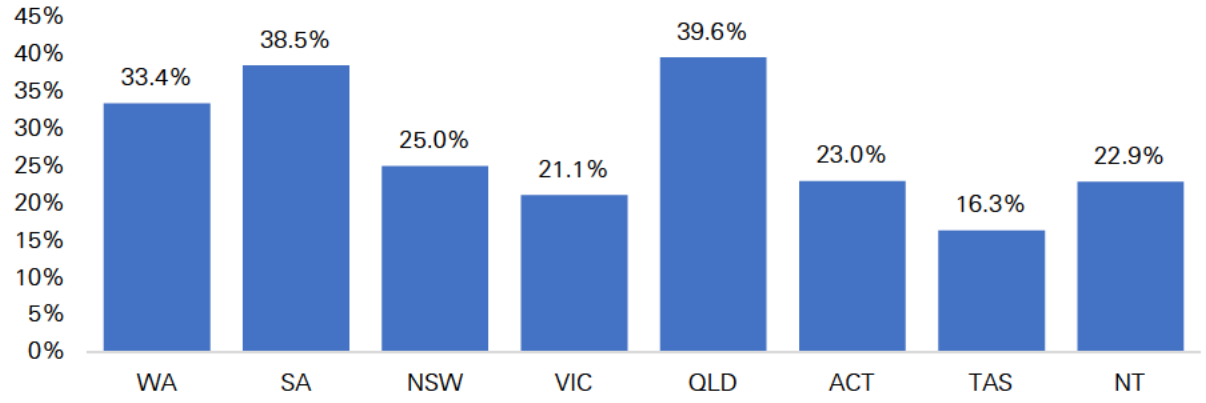
2.3.2 Penetration of distributed energy resources as an alternative energy source

The increasing ownership of distributed energy resources (DER) such as rooftop solar PV, battery storage and electric vehicles is a trend present across all states, with Western Australia being a leading jurisdiction in DER uptake in Australia.

As displayed in Figure 3 and Tables 7 – 9 below, various forms of DER technology are at different levels of progression. Rooftop solar PV is the most well progressed technology in terms of consumer uptake and integration with energy networks. Battery storage, electric vehicles and other forms of DER technology are at a much earlier stage in their progression, with lower levels of uptake and greater uncertainty regarding the models under which they will be integrated with energy networks.

Given this positioning, the impact of DER on VCR is likely to increase over the AA5 period and beyond as uptake increases and the technology becomes more integrated with networks.

Figure 3 - Percentage of dwellings with a solar PV system installed



Source: Australian PV Institute – Solar PV Status, March 2021

Table 7 - Rooftop solar PV penetration in Australia

Jurisdiction	Total number of small-solar solar generation units installed (up to May 2021)	Growth in total number of small-scale solar installations since December 2019
New South Wales	691,159	28.7%
Victoria	547,347	22.7%
Queensland	793,546	18.0%
Western Australia	388,325	20.8%
South Australia	317,773	17.3%
Tasmania	41,396	12.8%
Australian Capital Territory	34,055	28.5%
Northern Territory	18,439	24.6%
Australia	2,832,040	21.8%

Source: Clean Energy Regulator – Postcode data for small-scale installations, Australian PV Institute – Solar PV Status

Table 8 – Battery storage penetration in Australia

Jurisdiction	Number of solar PV systems with concurrent battery storage capacity (up to May 2021)	Proportion of installed small-scale solar PV systems with concurrent battery capacity (up to May 2021)
New South Wales	8,950	1.29%
Victoria	6,073	1.11%
Queensland	6,600	0.83%
Western Australia	2,171	0.56%
South Australia	7,963	2.51%
Tasmania	516	1.25%
Australian Capital Territory	1,448	4.25%
Northern Territory	312	1.69%

Source: Clean Energy Regulator – Postcode data for small-scale installations

Table 9 – Electric vehicle penetration in Australia

Jurisdiction	Electric vehicle registrations	Electric vehicle registrations as a percentage of total light vehicle fleet
New South Wales	6,823	0.13%
Victoria	6,086	0.13%
Queensland	3,825	0.10%
Western Australia	1,528	0.07%
South Australia	2,129	0.16%
Tasmania	313	0.07%
Australian Capital Territory	899	0.31%
Northern Territory	42	0.03%

Source: National Transport Commission, August 2021.

2.3.2.1 Rooftop solar PV and batteries

As displayed in Figure 3 (and reflected also in Table 7), uptake of small-scale rooftop solar PV in Western Australia is high and is most comparable to the level of penetration present in South Australia and Queensland. This is aligned with the hypothesis that customer preferences in South Australia are representative of Western Power's customers, given customers in Western Australia and South Australia are closely aligned in terms of behind the meter generation capability.

The relationship between rooftop solar PV ownership and VCR is not clear in any one direction in existing data collected in the NEM.

Solar PV owners provided differing reasoning in respect of their willingness to pay to avoid outages. Some solar PV owners presented a higher willingness to pay because their energy bills were low, while some presented a lower willingness to pay because they perceived they were immune from outages due to their rooftop solar PV capability (this perception is often incorrect as many rooftop solar PV systems rely on mains electricity).

Battery uptake is less well progressed among WA customers; only 0.56% of solar PV systems installed in Western Australia have concurrent battery capacity relative to 2.51% in South Australia, and an average of 1.87% in the NEM.

Currently, battery owners may be likely to have a higher willingness to pay for reliability, perhaps reflecting that customers who are early adopters of battery technology generally place a high value on reliability, and hence invested in battery storage to provide improved reliability and protection from outages. The direction of this relationship may shift as a larger and more representative sample of customers install batteries, with some customers potentially displaying a lower willingness to pay given the protection from outages that a battery provides. As uptake increases, additional data could be collected to provide a more robust indication of the direction of the relationship between VCR and battery ownership, and whether this relationship implies material differences between the VCRs of battery owners and non-battery owners.

2.3.2.2 Electric vehicles

Electric vehicle uptake in Australia to date has been low relative to international standards, and historical data is not sufficient to identify a reliable trend in uptake in each state. Given the very low proportion of customers who own an electric vehicle, it is unlikely that electric vehicle ownership had a material impact on VCR estimates derived by the AER in 2019, or will have a material impact on residential VCR for Western Power in AA5.

Intuitively, it may be expected that electric vehicle drivers place a higher value on reliability of electricity supply given their reliance on the electricity network to facilitate one of their primary modes of transport, which may point towards material upward shifts in VCR as electric vehicle uptake increases.

Alternatively, the AER also noted that electric vehicles may be used in the future to back up household electricity supply but may be charged at public high voltage charging stations. In this case, electric vehicle uptake may have a less significant impact on household VCR.

AEMO forecasts the total number of electric vehicles in the NEM to increase by approximately 70% between 2020-21 and 2026-27. Although uncertain, if electric vehicle uptake among Western Power's customer throughout the AA5 period is aligned with expectations in the NEM, it is likely to pose increasingly material implications for VCR estimates in AA6. Furthermore, if uptake of electric vehicles among Western Power's customers is not aligned with outcomes in the NEM, this may similarly have material implications for the validity of adapting VCRs from a survey sample of customers in the NEM to Western Power's customers.

Current data does not indicate that the difference between electric vehicle uptake among Western Power's customers and customers in the AER's VCR survey sample poses any material implications for VCR in AA5. However, it is likely that over the course of the AA5 period, in AA6 and beyond, the implications of electric vehicle charging on the residential energy consumption profile will be material and a necessary consideration that may be best captured through a survey of Western Power's customers.

2.3.3 Gas in the residential energy consumption profile

Table 10 – Breakdown of household expenditure on electricity and gas

Jurisdiction	Average weekly expenditure on gas	Proportion of total energy expenditure on mains gas consumption
New South Wales	$6.81	18.23%
Victoria	$16.44	37.55%
Queensland	$1.28	3.90%
Western Australia	$10.57	27.67%
South Australia	$10.52	25.23%
Tasmania	$0.95	2.52%
Australian Capital Territory	$20.97	45.42%
Northern Territory	$0.55	1.21%

Source: Australian Bureau of Statistics – Household Expenditure Survey 2015-16

The jurisdictions most comparable to Western Australia in terms of both weekly household expenditure on gas and the proportion of household energy use represented by gas are South Australia and, to a lesser degree, New South Wales (see Table 10 above). This indicates that the values customers in these regions place on reliable electricity are likely to be comparable in the context of the balance between electricity use and gas as an alternative energy source.

In contrast, states such as Victoria and the Australian Capital Territory display a much higher reliance on gas as an alternative or complementary energy source to electricity. Hence, values of customer reliability in these states will likely differ from those in Western Australia. This is aligned with the hypothesis that the drivers of residential customer preference in South Australia and New South Wales are comparable to those observed in Western Power's customer base, with households in these states being closely aligned with Western Power's customers in terms of the composition of the residential consumption profile.

2.3.4 Demographic factors

Table 11 – Household income, expenditure and size in Australia

Jurisdiction	Median income per week	Proportion of total goods and services expenditure on electricity	Average number of people per household	Average number of employed persons per household
New South Wales	$2,445	9.78%	2.6	1.3
Victoria	$2,193	10.65%	2.6	1.3
Queensland	$2,044	11.48%	2.6	1.3
Western Australia	$2,409	9.42%	2.7	1.4
South Australia	$1,923	14.21%	2.4	1.2
Tasmania	$1,770	18.88%	2.4	1.1
Australian Capital Territory	$2,687	8.53%	2.6	1.4
Northern Territory	$2,979	11.80%	2.8	1.7

Source: Australian Bureau of Statistics – Survey of Income and Housing 2017-18, Household Expenditure Survey 2015-16

As shown in Table 11, median weekly income in Western Australia was equal to $2,409 in 2017-18, higher than that observed in South Australia ($1,923) and approximately equivalent to that in New South Wales ($2,445). These income figures were reflected in the proportion of total expenditure spent on electricity, with this proportion being higher in South Australia and approximately equivalent in New South Wales and Western Australia.

Demographic factors such as the average number of people per household and average household income may drive the nature of energy consumption, and the willingness or ability of households to pay for improved reliability of electricity service. For example, intuitively it may be expected that higher income households would have higher VCRs, both because they consume more electricity and possess a greater capacity to pay for improvements in reliability. However, historical VCR outcomes do not support this intuitive relationship.

VCR estimates developed by AEMO in 2014 that were adapted by Synergies for AA4 were presented on a state basis, and show no clear correlation between household income and willingness to pay for reliability of electricity supply. For example, Tasmania had the highest VCR estimate in the NEM ($28.58/kWh) despite having the lowest median weekly income in 2015-16 ($1,770). Similarly, the VCR values for South Australia and New South Wales were very similar ($26.88/kWh and $26.53/kWh respectively) despite median weekly income in New South Wales in 2015-16 ($2,445) being materially higher than in South Australia ($1,923).

VCR outcomes from the AER's review in 2019 similarly do not support the hypothesis that income or other demographic characteristics are significant drivers of VCR. For example, although displaying significantly lower incomes, CBD residents in South Australia were estimated to have materially higher VCRs ($33.23/kWh) than CBD residents in New South Wales ($29.27/kWh).

It should also be noted that a range of additional factors are likely to impact the relationship between income in a given state and corresponding VCR estimates. Factors including variations in the cost of living across states, and the extent of variation in incomes in different regions within a state (e.g. urban customers relative to rural customers) are likely to introduce variability in the relationship between income and VCR. As such, it is unlikely that a robust methodology exists to accurately reflect the variability in income level and distribution across states in adapting VCR estimates to the Western Power network. Conducting a comprehensive survey of a representative sample of Western Power's customers across different regions of the network with different income levels may inform

the consideration as to what the key drivers of VCR are among Western Power's customers, and how these factors vary with income.

We note there are material differences in incomes between Western Australia and South Australia, and to a lesser extent New South Wales. However, the available evidence suggests that other factors included in our analysis such as climate conditions play a much more significant role in driving VCR outcomes.

2.3.5 COVID-19 and changing electricity consumption habits

The COVID-19 pandemic is the most significant development in the broader economy since the AER completed their VCR review in December 2019. The impact of COVID-19 has extended to shifting the nature of electricity consumption. As stay-at-home restrictions were introduced for periods in 2020 and 2021 and businesses adopted flexible working arrangements, changing work habits created material shifts in demand patterns. Although the pandemic itself is expected to be temporary, it is likely that shifts to flexible working arrangements and the associated increased reliance on reliable electricity supply to residential customers may persist, including throughout the AA5 period.

Specifically, many customers are now spending more time at home and are consuming more electricity during off-peak times to heat or cool their home office spaces, power their work appliances, and rely more significantly on stable home internet connections to connect with others working remotely. Prior to the COVID-19 pandemic, this electricity consumption load would be attributed to business customers in the commercial category, but an increasing share can be attributed to residential customers using their home as a workspace during the day.

Data collected by the Australian Competition and Consumer Commission indicates that residential customers in Victoria, New South Wales, South Australia and South East Queensland used 10% more grid electricity in 2020 relative to 2019, while small business customers used 17% less over the same period. Although residential consumption increased in all states and small business consumption decreased in all states, the percentage changes were highly variable across states reflecting the differing length and severity of lockdown restrictions introduced by state governments. Furthermore, the increase in residential grid consumption of 10% does not reflect the increase in underlying residential demand in totality due to rooftop solar PV playing an increasing role in offsetting residential daytime demand in 2020.

Given the significant impact of the COVID-19 pandemic in Australia since the early part of 2020, and the fact the AER's estimates for the NEM were developed prior to the start of the pandemic, it should be considered whether an adjustment must be made to accurately reflect shifts in the size and nature of electricity consumption among Western Power's customers, and the potentially higher value customers may place on reliability given the changing nature of their electricity consumption.

It is likely that the extent to which changes in working habits have penetrated and will persist in the behaviour of consumers is highly variable across different regions in Australia, and different classes of customers.

Certain states in Australia were more significantly impacted by higher levels of COVID-19 transmission in their communities, and therefore experienced longer periods of stay-at-home restrictions, whereas other states were less significantly impacted and workers have continued to work from offices for large parts of the past 18 months. It may be true that customers who have worked from home for larger parts of 2020 and 2021 will be more likely to continue working from home in the future, whereas those in other states will largely return to pre-COVID-19 work conditions.

The impact of the pandemic on electricity consumption is variable across different classes of customers and is unlikely to be persistent for all types of customers. For example, industrial or large

commercial customers are unlikely to be permanently impacted by the pandemic in the size or nature of their electricity consumption. Similarly, customers in Rural Long regions are less likely to be permanently impacted by the pandemic in their electricity consumption than those in CBD or Urban regions. As such, the impact of COVID-19 is unlikely to be material or persistent in the VCRs of all customer segments.

However, in certain customer groups it may be more likely that a material change in the values they place on reliability has occurred since the start of the pandemic, for example, residential customers in urban areas or commercial customers in CBD areas are likely to be most clearly impacted as consumption shifts from CBD offices to urban home offices. Therefore, the VCRs of customers in certain segments and regions of Western Power's network should be considered as potentially likely to shift from those derived for AA4 in 2017, and to differ from those derived for states in the NEM in 2019.

The key limitations in recognising the impact of the pandemic in modelling VCRs are a lack of data on the impact of COVID-19 on electricity consumption behaviour and consumers' willingness to pay for improved reliability, and uncertainty as to the extent to which changing work habits will persist and how demand patterns will settle into the future. Therefore, it is not feasible to include this impact in a robust manner in modelling VCRs for Western Power in AA5, but there is certainly scope for both the AER and Western Power to collect further data and conduct customer surveys on how COVID-19 has changed the way customers use and value reliable electricity and potentially reflect this in future VCR estimates.

2.3.6 Emerging changes to the composition of Western Power's network

Western Power is seeking to transform the composition of its grid, investigating the merits of multiple emerging technologies and power system models that can provide an alternative to, or complement large scale generators. These technologies include microgrids and stand-alone power systems, both of which Western Power is already implementing through trials and early-stage rollouts. The primary aim of this transformation is for Western Power to service its customers at least cost, which for Rural Long customers in remote areas may be best achieved through a stand-alone power system rather than grid connection. Western Power's Rural Long customers may have unique reliability preferences that differ from those of customers in other segments of the Western Power network or those of customers in the NEM. As such, it is important to consider the implications of these emerging network transformations on the VCRs of Western Power's Rural Long customers in AA5 and beyond.

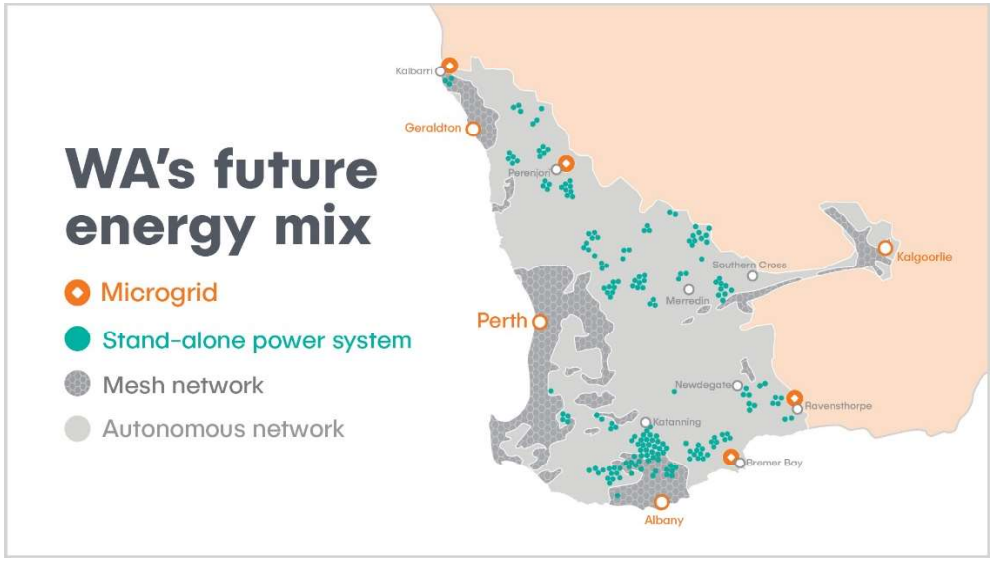
Microgrids

A microgrid is a small-scale power grid that can power a local community via a range of energy sources including solar, wind and battery storage. Microgrids are often located in isolated areas at the end of long feeder lines, improving reliability by placing the source of energy generation closer to where it will be used. Microgrids operate by supplying power via an islanded network that is disconnected from the grid, but unlike stand-alone power systems, microgrids typically have a back-up connection to the main power grid.

Stand-alone power systems

A stand-alone power system is a self-sufficient power system that generates power through a renewable energy supply such as solar panels, and contains a battery, inverter and backup generator. A stand-alone power system supplies electricity to a single property, with the system sized to match the power use of the property. Western Power are rolling out stand-alone power systems in order to shift customers relying on the main electricity grid to a more reliable and safer power supply.

Figure 4 – Future shifts in the composition of Western Power's network



Source: Western Power – The future of the grid: What is it made up of? (October 2019)

As part of the AA5 Customer and Community Engagement Program, Western Power engaged with stakeholders through forums, focussed research groups and surveys of 1,500 residents and 300 business customers. The customer engagement process found that:

- Rural Long customers currently experience an outage every 3 months.
- Rural Long customers were the most sensitive to maintaining the current standard of reliability, and demonstrated support for improvements to reliability, specifically reduced outage duration.
- Rural Long customers were less sensitive to bill changes relative to their Urban and Rural Short counterparts, demonstrating a higher willingness to pay to secure improved service.
- Rural Long customers are more supportive of and have a higher willingness to pay for renewables and new technologies where they will improve reliability outcomes.

The above findings point towards a higher VCR for Rural Long customers and highlight that the VCRs of customers in remote areas may be more responsive to changes in the reliability of service.

In addition to expected savings in the cost to service remote customers, the transition to microgrids and stand-alone power systems may impact the frequency of outages, speed up restoration time and provide more reliable supply to customers at the end of long powerlines on the edge of the grid. As this transition progresses, it is likely to have several implications for the VCRs of customers on Western Power's network by impacting preferences related to willingness to pay for reliability, and potentially shifting the probability distribution of outages for certain network segments.

In the absence of comparative survey data on the reliability preferences of customers both before and after being transitioned from a grid-connection to a stand-alone power system, it is difficult to quantify the impact of the transition on VCR. As the rollout progresses further, Western Power could seek to consult with customers who are served by stand-alone power systems and obtain data on the extent to which there have been shifts in the value they place on reliability. Depending on how material this impact is, Western Power may seek to reflect this in VCR estimates for Rural Short and Rural Long customers in subsequent access arrangements.

Although similar alternative network solutions are being explored by network service providers in the NEM, the extent of this network transition is more material in Western Power's context. Therefore, in the future VCR estimates developed with respect to regional and remote customers surveyed in the NEM may be less representative of the reliability preferences of Western Power's rural

customers. In this context, survey data capturing a representative sample of customers across Western Power's network may more accurately reflect the preferences of Rural Short and Rural Long customers in VCR estimates for AA6 and subsequent periods.

Western Power's plans to implement this significant system level shift also highlight the important role that accurate and robust VCR estimates play. Western Power's plan for the future composition of its network is centred around dedicating capital expenditure to construct off-grid solutions to ensure that customers are serviced at least cost, whilst maintaining reliability of supply. In this context, VCRs play a key role in evaluating the trade-offs between capital expenditure, operational savings in network maintenance expenditure, and customer reliability outcomes to ensure that Western Power makes efficient decisions in the best interests of all customers with respect to providing reliable and affordable electricity.

2.4 Conclusion on the impact of contextual factors on our approach to residential VCR

Our analysis of the contextual factors that are likely to drive customers willingness to pay for reliability of electricity indicates that:

- In relation to the factors that are likely to be material impactors of VCR over the AA5 period, outcomes in Western Power's context are broadly comparable to those observed in the corresponding climate zone regions in the NEM.
- Therefore, the exercise of adapting the AER's VCR estimates to Western Power's context on the basis of a climate zone segmentation appears reasonably robust for the AA5 period.
- However, although a number of the factors assessed appear unlikely to drive any material variation in the value that Western Power's customers place on reliability relative to the surveyed customers in the NEM over the course of AA5, these factors are likely to have more material implications for customer preferences in future access arrangement periods.

2.4.1 Scope for change in Western Power's residential VCR estimation process

Western Power may in future identify unique customer preferences among its customers that are driven by a number of factors, including the following:

- Distributed energy resources uptake: as the DER Roadmap is rolled out in WA and uptake increases, the role of assets behind the meter appears likely to be significant and may have a material impact on the value customers place on reliability.
- Stand-alone power systems and alternative network solutions: as customers are transitioned onto stand-alone power systems, it will be timely to consider the change in outage frequency and duration, and whether this has a material impact on the reliability preferences of Rural Long customers.
- COVID-19 and work from home trends: as the situation relating to the pandemic stabilises and demand patterns settle, the impact of COVID-19 on electricity consumption in Western Australia may be very different from what is observed in the NEM.

A comprehensive survey of a representative sample of customers in Western Australia would most effectively capture the impact of unique drivers of their willingness to pay for reliability. Western Power could use the results of this survey to develop VCR estimates specific to its customer base rather than adapting VCR estimates derived using a sample of customers in other states.

To the extent that the composition of Western Australia's energy system and the preferences of customers in Western Australia diverge further from what is observed in the NEM, meaning VCR estimates derived using a survey sample of customers in the NEM are no longer representative of customers in Western Australia – survey results specific to customers in Western Australia may be valuable to enable Western Power to develop VCR estimates that most accurately represent the preferences of its customers.

2.5 Conclusion on the impact of contextual factors on our approach to non-residential VCR

As noted at the start of this section, the 2019 AER review did not segment VCR estimates by geography for non-residential customer segments (Small/Medium Business, Large Business, Very Large Business). VCR estimates for these customers were further segmented using industry sectors: Agricultural, Industrial, Commercial for Business customers and Services, Industrial, Metals, Mines for Very Large Business customers. The AER considered that surveyed business customers in each of the sector groupings had broadly similar reliability preferences, and few statistically significant sources of difference were present within these segments to warrant further granularity in the segmentation of Business and Very Large Business customers.

Given the AER's segmentation, it is necessary to translate the AER's VCR estimates for Business and Very Large Business customers across the whole of the NEM to Western Power's Commercial and Transmission-connected customers based on the implicit assumption that the region in which a business operates is not a material driver of its reliability preferences. This is the approach we have taken in the methodologies set out in sections 3.2.3 and 3.2.4.

2.5.1 Scope for change in Western Power's non-residential VCR estimation process

The preferences of Western Power's Commercial and Transmission-connected customers may be different to those of the business customers in the survey sample used in the 2019 AER review, however it is difficult to verify the similarity or difference of Western Power's customers and those in the NEM with the available data published by the AER and collected by Western Power.

A survey of a representative sample of business customers in Western Australia is the most effective means of identifying the unique reliability preferences of these customers, including customers within Western Power's Commercial and Transmission-connected segments. A detailed survey of customers in Western Australia of a similar nature to that conducted by the AER would facilitate the development of VCR estimates on a bottom-up basis, which may be valuable in most accurately reflecting the reliability preferences of Western Power's Commercial and Transmission-connected customers in AA6 and subsequent periods.

3 Estimation methodology

This section details the process we have followed to adapt the estimates from the 2019 AER review to Western Power's context, including the way in which Western Power's customers have been segmented to align with the segments used by the AER, the various estimation methodologies we have applied for different customer segments, and the process used to weight customer segment VCRs into aggregated estimates for Western Power's network segments.

Throughout the section, we outline the key issues faced in implementing the estimation methodology, options considered, the decisions made to resolve these issues and the rationale for these decisions.

The VCR values published by the AER in 2019 were developed using survey responses from approximately 7,400 residential customers and 1,800 business customers. The AER used a combination of contingent valuation and choice modelling to determine consumers' willingness to pay to avoid a baseline outage scenario, and the incremental value they placed on specific outage attributes, such as time of day, day of week and duration. Contingent valuation and choice modelling survey responses were then used to calculate the dollar values which different customer types place on different outage scenarios. For each customer segment, VCR estimates derived for each outage scenario using survey responses were weighted together using the probability of each outage scenario, based on the frequency of each outage scenario affecting the relevant customer segment. This produces a standard outage VCR for each customer segment in dollars per kilowatt hour terms.

Business customers with a peak demand of more than 10 MVA per annum were classified as Very Large Business customers and surveyed separately using a direct cost survey approach.

To adapt the AER's VCR estimates to Western Power's context, we have used a three-step methodology.

1. Segment Western Power's customers to align with the AER's VCR method as closely as the available data allows.

2. Calculate VCR values for each Western Power customer segment based on the 2019 AER values (adjusted for inflation to June quarter 2021) and Western Power's own outage data.

3. Weight these VCR values together using energy consumption (kWh) weights to calculate estimates for each network segment.

Each of these steps is discussed in more detail in the following sections.

The VCR values presented in this report have been adjusted for actual inflation of 2.24% (over three quarters) between September quarter 2020 and June quarter 2021 (based on the Australian Bureau of Statistics Consumer Price Index, All Groups, Weighted Average of Eight Capital Cities). This builds on the inflation update made by the AER in December 2020, when the September quarter 2020 CPI was used to add four quarters of inflation to the 2019 VCR values.

Consistent with the AER's approach, VCR values should continue to be adjusted for inflation over time to maintain the VCR values in real terms. In making these adjustments, to maintain consistency, Western Power should apply the CPI forecasts and assumptions used throughout the AA5 proposal.

3.1 Segmenting Western Power's customers to align with the AER's VCR method

The methodology implemented by the AER in the 2019 VCR study estimates VCR under three broad customer segments: 'Residential', 'Business' and 'Very Large Business'. These were further divided into:

- **Residential** – 12 sub-segments based on climate zone and remoteness combinations (only some of which are relevant for Western Power);
- **Business** – 6 sub-segments based on size (Small/Medium, and Large) and industry type (Agricultural, Industrial, and Commercial) combinations; and
- **Very Large Business** – 4 sub-segments based only on industry type (Services, Industrial, Metals and Mines).

In line with the segmentation used by the AER, we have segmented Western Power's customers into three broad segments:

- **Residential** – 6 sub-segments based on the climate zone and remoteness combinations observed on the Western Power network.
- **Commercial** – 2 sub-segments based on size (Small Commercial, and Large Commercial < 10 MVA)
- **Very Large Business** – 8 sub-segments based on the 4 industry types used by the AER (Services, Industrial, Metals and Mines), split by distribution and transmission connections.

For the Business/Commercial translation, a simplified mapping was used because Western Power's systems record the size of a business customer but not its industry type.

The AER defined the Very Large Business segment to refer to business customers with a peak demand of 10 MVA or more, including both distribution and transmission connected customers. Western Power's Large Commercial customer segment includes a small number of customers with contract maximum demand of 10 MVA or more. To align with the AER's method, we have split Western Power's Large Commercial customer segment into 2 segments: Large Commercial (ex. > 10 MVA), and Large Commercial > 10 MVA. Western Power's Large Commercial > 10 MVA customers have been mapped to the AER's Very Large Business VCR estimates, whilst the remaining Large Commercial customers have been mapped to the AER's Large Business VCR estimates.

Table 12 – Residential customer segments

AER 2019 VCR review: customer segments	Western Power AA5 VCR: customer segments
Northern Territory	–
Climate Zone 1 Regional	–
Climate Zone 2 CBD & Suburban	–
Climate Zone 2 Regional	–
Climate Zone 3 & 4 Regional →	Climate Zone 3 Regional
Climate Zone 3 & 4 Regional →	Climate Zone 4 Regional
Climate Zone 3 & 4 Regional →	Climate Zone 4 CBD & Suburban
Climate Zone 5 CBD & Suburban NSW	Climate Zone 5 CBD & Suburban
Climate Zone 5 CBD & Suburban SA →	Climate Zone 5 CBD & Suburban
Climate Zone 5 Regional →	Climate Zone 5 Regional
Climate Zone 6 CBD & Suburban	–
Climate Zone 6 Regional →	Climate Zone 6 Regional
Climate Zone 7 CBD & Suburban	–
Climate Zone 7 Regional	–

Table 13 – Business/Commercial customer segments

AER 2019 VCR review: customer segments		Western Power AA5 VCR: customer segments
Small & Medium Business	Agricultural	→ Small Commercial
	Industrial	
	Commercial	
Large Business	Agricultural	→ Large Commercial < 10 MVA
	Industrial	
	Commercial	

Table 14 – Very Large Business customer segments

AER 2019 VCR review: customer segments	Western Power AA5 VCR: customer segments	
Services	Distribution-connected Large Commercial > 10 MVA	Services
Industrial		Industrial
		Metals
		Mines
Metals	Transmission-connected	Services
Mines		Industrial
		Metals
		Mines

3.2 Calculating VCR values for each Western Power customer segment based on the 2019 AER values

At a high level, we have applied two different methodologies to adapt the AER's VCR estimates to Western Power's context:

- The first method is applicable with respect to customers with peak demand less than 10 MVA, suitable for adapting VCR estimates for Western Power's Residential, Small Commercial and Large Commercial (ex. > 10 MVA) customer segments.
- The second method is applicable to Very Large Business customers, suitable for adapting VCR estimates for Western Power's Large Commercial > 10 MVA and Transmission-connected customer segments.

3.2.1 Determining VCR for Residential, Small Commercial and Large Commercial (ex. > 10 MVA) customers

3.2.1.1 Data published by the AER

Using the responses of surveyed customers, the AER published VCR estimates associated with 32 outage scenarios for the following customer segments:

- Residential: segmented by each climate zone and remoteness combination observed in the NEM.
- Business: segmented by sector (Agriculture, Commercial, Industrial) and size (Small/Medium, Large).

The outage scenarios used are organised by outage duration, and outage attributes (time of day[12], day of week, season). The 32 outage scenarios are derived using the 4 durations and 8 sets of outage attributes set out in the template below:

[12] Peak times are defined by the AER as: 7am-10am, 5pm-8pm. Off-peak captures all other times.

		Outage attributes							
		Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
Duration	0 – 1 hours								
	1 – 3 hours								
	3 – 6 hours								
	6 – 12 hours								

3.2.1.2 *The AER's approach to outage probability*

The AER used historical data on the distribution of the frequency of outages across the 32 scenarios to determine the appropriate outage probability to be applied to the VCR estimates derived for each scenario. The distribution network outage data was filtered according to the following outage criteria:

- outages must be unplanned;
- outages must be 3 minutes or more in duration and not longer than 12 hours in duration;
- outages must affect a minimum of one customer; and
- outages must take place in summer and winter.

To determine the frequency of each outage scenario, the AER used the number of 'customer minutes affected' for each outage scenario. Customer minutes affected for each outage record is calculated as the product of the duration of the outage (in minutes) and the number of customers affected.
A number of outages in the AER's data set fell across multiple outage scenarios. For example, an interruption that spans both peak and off-peak times, or commences on a weekday and is restored on the weekend. In these cases, customer minutes affected were allocated across the multiple relevant outage scenarios (being the same outage duration but differing outage attributes).

3.2.1.3 *Data provided by Western Power to KPMG*

Western Power provided KPMG the following data relating to customers connected to the distribution network:

- Outage data: records of all interruptions that have impacted customers connected to the distribution network between April 2011 and March 2021.
- Monthly consumption data: records of the total consumption (MWh) of each customer segment by feeder type and postcode between April 2011 and March 2021.

Outage data was used to determine the probability to be applied to each outage scenario, allowing for the VCR estimates published by the AER for each outage scenario to be adapted to Western Power's context.

Consumption data was used to weight Residential VCR estimates for different climate zone and remoteness categories into an aggregate Residential VCR value, and to weight Residential, Small Commercial and Large Commercial VCRs into aggregate VCR values for each feeder type (CBD, Urban, Short Rural, Long Rural).

3.2.1.4 *Determining outage probabilities using Western Power's distribution network outage data*

In calculating the appropriate outage scenario probabilities for each of Western Power's Residential and Commercial customer segments, we have filtered the outage data in line with the method used by the AER:

- planned outages have been excluded – only unplanned outages are included;
- non-standard outages have been excluded – only outages 3 minutes or more in duration and not longer than 12 hours in duration are included;
- all outages in the provided data affect a minimum of one customer; and
- outages occurring in autumn or spring have been excluded – only outages that take place in summer or winter have been included.

Additionally, the outage records provided by Western Power identify the network level at which an interruption originates or is caused. Interruptions at the following network levels have been excluded:

- Generation;
- Transmission; and
- Third-party.

Only distribution network level outages have been included in calculating outage probabilities for Western Power's Residential and Commercial customers. Note that the exclusion of the above network level interruptions is in line with the 2018 distribution network Category Analysis Regulatory Information Notice data collected by the AER and used in the 2019 review[13], which excludes interruptions:

- due to a generation shortfall;
- caused by a failure of the shared transmission network or transmission connection assets; and
- at the direction of AEMO, a System Operator or state or federal emergency services.

Consistent with the AER's approach, we have used 'customer minutes interrupted', calculated as the product of the duration of the outage and the number of customers affected, to calculate the frequency of each outage scenario for a given customer segment. Where an outage falls across the boundary of multiple scenarios, we have allocated the customer minutes interrupted across the multiple applicable scenarios but maintained the same overall outage duration.

3.2.2 VCR methodology - Residential

3.2.2.1 *Residential VCR segments in the AER's 2019 study*

The AER estimated residential VCR segmented by:

- Climate zone (sourced from the Australian Building Codes Board)
- Remoteness (sourced from the Accessibility/Remoteness Index of Australia (ARIA))

For each of the climate zone and remoteness combinations observed in the NEM, the AER published VCR estimates for each of the 32 outage scenarios based on the responses of residential customers surveyed in the relevant region.

[13] Australian Energy Regulator - Values of Customer Reliability, Final report on VCR values - December 2019, p. 51; Australian Energy Regulator - Reviewing the STPIS and Establishing a new Distribution Reliability Measures Guidelines - January 2017, Issues Paper, pp. 59-60

3.2.2.2 Mapping Western Power's postcode identified data to climate zone and remoteness

Location in Western Power's outage and consumption data is identified using postcode. As such, it was necessary to map the relevant climate zone and remoteness classification to each postcode, such that Western Power's outage data could be aligned with the AER's VCR values, segmented by climate zone and remoteness.

This process involves the following steps:

1. Mapping each postcode to the relevant remoteness category

- Using data sourced from the Accessibility/Remoteness Index of Australia (ARIA), the AER published an index of postcodes and remoteness classifications, assigning one of 6 remoteness classifications (CBD, Suburban, Inner Regional, Outer Regional, Remote, Very Remote) to each postcode.
- Using this data, we have collated the remoteness categories for each of the postcodes on the Western Power network.
    - Where a postcode spans across multiple remoteness categories (e.g. Suburban and Inner Regional), the AER assigned the least remote category to the postcode (e.g. Suburban). We have adopted this same approach in mapping postcodes to remoteness categories.
- Note that the AER found that the survey responses of residential customers in CBD areas were not significantly different from those in urban areas. Similarly, few significant differences were found between inner regional and outer regional customers, and the sample size of remote customers was very small. Therefore, the AER merged CBD and suburban customers into one remoteness category (CBD & Suburban), and regional and remote customers into one remoteness category (Regional) to calculate VCR estimates.

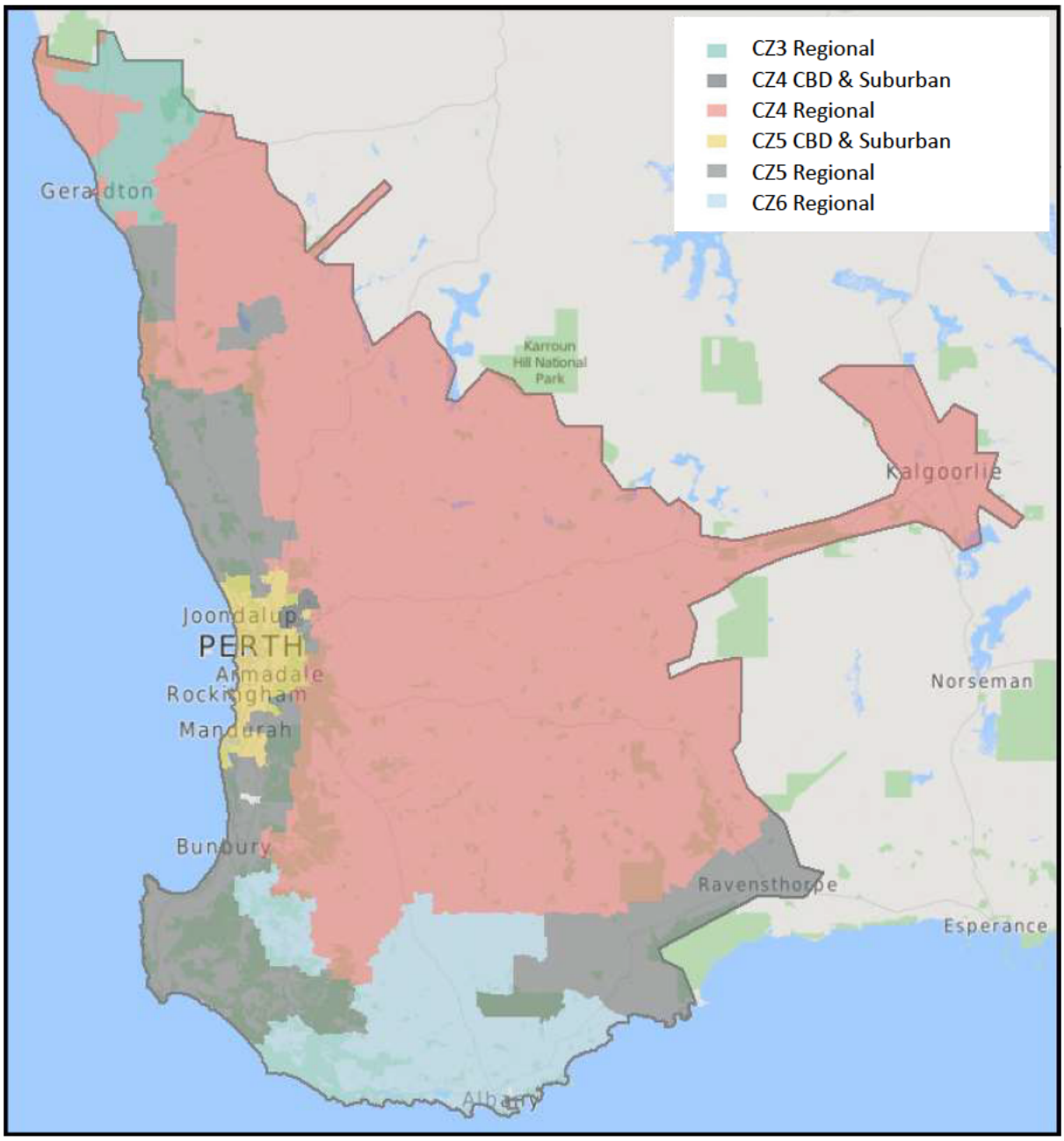
2. Mapping each postcode to the relevant climate zone

- The Australian Building Codes Board has published a climate zone map[14] that sets out the relevant climate zone assigned to each LGA in Australia under the National Construction Code.
- Using the AER's published index of postcodes to LGAs, we have mapped each postcode on the Western Power network to the relevant LGA, and each LGA to the relevant climate zone, thereby assigning a climate zone to each postcode.
    - Where a postcode falls across the boundary of multiple LGAs that are assigned different climate zones, the postcode is assigned the climate zone of highest heat stress (lowest numerical climate zone code). This is consistent with the AER's approach.

Applying the above mapping process to the postcodes on Western Power's network results in 6 climate zone and remoteness combinations, which have been used to segment Western Power's residential customers. The geographic distribution of these customer segments across the Western Power network is displayed in Figure 5 below.

[14] Australian Building Codes Board - Climate Zone Map Australia

Figure 5 – Map of VCR by climate zone and remoteness on the Western Power Network



Source: Western Power analysis using data provided by KPMG

3.2.2.3 *Weighting the AER's scenario-based VCR estimates by the probability of outage scenarios on Western Power's network*

An example of the probability distribution of outages across the 32 outage scenarios is provided below for Climate Zone 6, Regional. The example below reflects the frequency of outages over the past 5 years.

Table 15 – Western Power outage probabilities - Residential customers in Climate Zone 6 Regional, (2016 - 2021)

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	3.15%	3.30%	1.54%	1.25%	2.87%	2.69%	1.19%	0.41%
1 - 3	10.44%	3.72%	1.46%	0.34%	8.39%	2.87%	3.55%	1.43%
3 - 6	8.51%	3.41%	3.89%	1.01%	6.42%	3.11%	0.96%	0.33%
6 - 12	3.87%	1.68%	1.88%	0.63%	10.62%	3.05%	1.46%	0.58%

The Western Power outage probabilities for each of the outage scenarios can be mapped to the VCR estimates developed by the AER for the corresponding climate zone and remoteness customer segment, for example those set out in Table 16 below.

Table 16 – Residential VCR estimates, Climate Zone 6 Regional (NEM) (June $2021/kWh)

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	20.98	33.15	19.58	32.88	30.51	51.83	28.33	49.29
1 - 3	19.72	20.64	18.40	20.48	28.69	32.28	26.64	30.69
3 - 6	14.71	13.97	13.73	13.85	21.40	21.85	19.87	20.77
6 - 12	10.62	9.45	9.91	9.36	15.45	14.77	14.34	14.05

Multiplying and summing across the 32 outage scenarios produces a probability weighted Residential VCR estimate for the relevant climate zone and remoteness combination on the Western Power Network, e.g. for residential customers in Climate Zone 6 Regional, VCR = $21.07/kWh.

The application of this method is presented for all climate zone and remoteness segments in Appendix B.

3.2.2.4 *Absence of a comparator in the NEM for residential customers in Climate Zone 4 CBD & Suburban on Western Power's network*

Our residential VCR methodology relies on there being an AER VCR value that corresponds with each of the climate zone and remoteness combinations observed on Western Power's network.

However, a small number of residential customers on Western Power's network are located in the postcode 6083, mapping to the LGAs of Swan and Toodyay, captured under Climate Zone 4 CBD & Suburban. There is no direct equivalent to this combination of climate zone and remoteness in the NEM states, and therefore no corresponding VCR values are available in the AER's 2019 review.

In this case, an appropriate proxy set of VCR values must be selected from the AER's published VCR values. The available proxies for Climate Zone 4, CBD & Suburban are:

a) Climate Zone 3 & 4, Regional
b) Climate Zone 5, CBD & Suburban, SA
c) Climate Zone 5, CBD & Suburban, NSW

In choosing between these, the key consideration is if climate or location (remoteness) is a more significant driver of the willingness of residential customers to pay for reliability of electricity.

The AER's study in 2019 stated that "analysis of the residential responses found that climate zone was a strong driver of differences in reliability preferences…by comparison, remoteness was a weaker driver of differences in reliability preferences"[15]. On the assumption that the same pattern is true with Western Power's customers, we have used option (a): Climate Zone 3 & 4, Regional, as the most appropriate proxy for Climate Zone 4, CBD & Suburban on Western Power's network because it maintains the same climate zone.

3.2.2.5 Selection of state VCR values for Climate Zone 5 CBD & Suburban: Residential VCR

The AER's review found that residential survey participants in Climate Zone 5 CBD & Suburban, South Australia responded with materially different preferences to avoid certain types of outages, as compared to residential survey participants in Climate Zone 5 CBD & Suburban, New South Wales. As such, the AER divided Climate Zone 5 CBD & Suburban into two separate cohorts and estimated separate VCR values for South Australia and New South Wales.

The AER considered subdividing other climate zone and remoteness combinations to reflect any statistically significant differences in the preferences of surveyed customers, however ultimately determined the differences were minor and did not warrant the subdivision. Therefore, only for Climate Zone 5 CBD & Suburban do we need to make a choice between multiple applicable sets of VCR values that can be adapted to Western Power's network.

On the basis of our contextual analysis presented in section 2, we consider that the drivers of customer preferences observed in South Australia are most representative of those driving the preferences of Western Power's residential customers.

Therefore, we recommend that Western Power use VCR values for South Australia in estimating VCR for Climate Zone 5 CBD & Suburban residential customers.

We note that although this decision only applies to one of six residential climate zone and remoteness combinations observed on Western Power's network, it's impact on aggregate VCR estimates is significant. This is because the Climate Zone 5 CBD & Suburban region captures the Perth CBD and surrounding suburbs and represents approximately 81% of total residential consumption on Western Power's network.

3.2.3 VCR methodology – Small Commercial & Large Commercial (ex. > 10 MVA)

3.2.3.1 Business VCR segments in the AER's 2019 study

The AER segmented business VCR values by:

- Industry segment – based on Australia and New Zealand Standard Industrial Classification (ANZSIC) classification
    - Agricultural
    - Industrial
    - Commercial
- Size – based on total annual consumption
    - Small & Medium (annual consumption < 100 MWh per annum)

[15] Australian Energy Regulator - Values of Customer Reliability, Final report on VCR values - December 2019, p. 40

- Large (annual consumption > 100 MWh per annum)

For Small & Medium, and Large customers in each industry segment, the AER published VCR estimates for each of the 32 outage scenarios based on the responses of the relevant business customers surveyed.

3.2.3.2 Segmentation in the commercial outage data provided by Western Power

For distribution-connected business customers with peak demand less than 10 MVA, the AER segmented VCR values by three industry segment categories and two size categories.

Western Power identify all distribution-connected business customers as 'Commercial', segmented by two size categories: Small Commercial and Large Commercial. The 'Commercial' customer segments include agricultural, commercial and industrial customers; however, these cannot be split out to match the AER segments because Western Power does not collect data that identifies the nature of each business customer's operations.

Figure 6 – Business customer segments used by the AER and commercial customer segments used by Western Power

<table>
<tr><th colspan="2">AER segmentation: distribution-connected business customers with peak demand <10MVA</th><th colspan="2">Western Power segmentation: distribution-connected business customers</th></tr>
<tr><td rowspan="2">Agricultural</td><td>Small & Medium</td><td rowspan="2">Small Commercial</td><td rowspan="6">Note that these two categories will also capture agricultural and industrial customer types.</td></tr>
<tr><td>Large</td></tr>
<tr><td rowspan="2">Commercial</td><td>Small & Medium</td></tr>
<tr><td>Large</td><td rowspan="2">Large Commercial</td></tr>
<tr><td rowspan="2">Industrial</td><td>Small & Medium</td></tr>
<tr><td>Large</td></tr>
</table>

Two options were considered for mapping the AER's VCR estimates for the 6 business customer segments to Western Power's 2 commercial customer segments (and associated outage data).

1. Map the AER's 'Commercial' category to Western Power's 'Commercial' category

   - This approach directly applies VCR values estimated by the AER for 'Commercial' customers (i.e. a subset of all business customers) to outage data for Western Power's 'Commercial' customers (i.e. all business customers including agricultural and industrial customers).
   - This approach is simple and requires no manipulation of the VCR estimates published by the AER.

     However, the mapping lacks definitional and numerical integrity. The AER's Commercial customer segment is not definitionally aligned to Western Power's Commercial customer segment and as a consequence this approach would only use a subset of the VCR estimates published by the AER for business customers. VCR estimates for surveyed agricultural and industrial customers would be disregarded, which is significant given that these customers represent 83.3% of total business consumption in the NEM (excluding Very Large Business customers).

2. Weight the AER's agricultural, commercial and industrial VCR estimates together into a 'blended business' category and then map this to Western Power's 'Commercial' category – there are two sub-options for the weights:

   a. NEM consumption data

- Using annual consumption data published by the AER for each customer type in the NEM, the three industry segments can be weighted together to produce one set of Small & Medium Business VCR values, and one set of Large Business VCR values that can be mapped to Western Power's Small Commercial and Large Commercial (ex. > 10 MVA) outage data.
- This approach would use weights that may not be a perfect representation of the relative proportions of agricultural, commercial and industrial customer types on Western Power's network.

b. An estimate from Western Power

- Western Power does not collect data to provide a precise indication of the relative weightings of agricultural, commercial and industrial customer types within their Small Commercial and Large Commercial customer segments.
- In the absence of available data, Western Power could provide an estimate of the relative proportions of Small Commercial and Large Commercial customers that operate agricultural and industrial businesses, with the remaining proportion dedicated to the commercial segment.
- However, this approach is less likely to be robust given it would be based only on Western Power's qualitative understanding of their customer base without quantitative data to support it.

Based on the pros and cons of each option we have adapted VCR estimates under option 2(a): a set of VCR values weighted by the annual consumption of agricultural, commercial and industrial customer types in the NEM as a proxy for Western Power's Commercial customer segments. This allows for all of the AER's VCR values for business customers to be factored into Western Power's context, albeit based on the proportion of agricultural, commercial and industrial customers in the NEM.

3.2.3.3 Approach to adapting the AER's business VCR estimates to Western Power's context

As for Residential VCR, we have multiplied the AER's 2019 VCR estimates (weighted by annual consumption of business customer type as per option 2(a) above, and escalated to June $2021), by the probability of each of the 32 outage scenarios in Western Power's outage data to produce VCR estimates for Small Commercial customers and Large Commercial (ex. > 10 MVA) customers.

An example of the probability distribution of outages across the 32 outage scenarios is provided below for Western Power's Small Commercial customers. The example reflects the frequency of outages over the past 5 years.

Table 17 – Western Power outage probabilities - Small Commercial segment, (2017 - 2021)

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	2.23%	1.48%	0.63%	0.57%	3.06%	1.91%	1.19%	0.94%
1 - 3	6.50%	3.42%	1.81%	0.78%	8.91%	4.53%	3.06%	1.67%
3 - 6	4.86%	1.73%	1.39%	0.65%	9.86%	3.61%	3.56%	1.55%
6 - 12	4.04%	1.30%	1.16%	0.44%	13.34%	4.73%	3.88%	1.20%

The Western Power outage probabilities for each of the outage scenarios can then be mapped to the VCR estimates developed by the AER, where the agricultural, commercial and industrial values have

been weighted together by annual consumption for each group in the NEM – see the example set out in Table 18 below.

Table 18 – VCR estimates – Small & Medium agricultural, industrial and commercial business customers (weighted by annual consumption) (June $2021/kWh)

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	195.76	186.97	205.00	200.88	199.03	195.01	207.55	211.05
1 - 3	70.88	67.67	74.37	72.82	72.04	70.39	75.29	76.46
3 - 6	38.11	36.32	40.09	39.20	38.74	37.84	40.59	41.17
6 - 12	19.38	18.48	20.38	19.93	19.70	19.24	20.63	20.92

Multiplying and summing the 32 outage scenarios produces a probability weighted VCR estimate for the relevant commercial customer segment, e.g. Small Commercial VCR = $62.38/kWh.

The same process was repeated using the AER's Large Business VCR estimates and outage probabilities for Western Power's Large Commercial (ex. > 10MVA) segment.

The application of this method is presented in Appendix C

3.2.4 VCR methodology – Large Commercial > 10 MVA and Transmission-connected customers

3.2.4.1 AER approach and outcomes

The AER's Very Large Business customer category captures business sites that have reached a peak demand level of 10 MVA or greater at some point in the previous 12 months. Around 300 business sites across the NEM met this criterion, connected either to the transmission network or to a high voltage distribution network.

The AER used a direct cost survey approach to quantify the costs incurred by Very Large Business customers as a result of an outage and, of the 300 eligible business sites in the NEM, received 40 completed surveys suitable for use in calculating VCR values.

Due to the difference in survey approach for Very Large Business customers, as compared to Residential and Commercial customers, i.e. direct cost survey as compared to choice modelling and contingent valuation, VCR values are not estimated for the same 32 outage scenarios used for residential and business customers with peak demand less than 10 MVA.

The AER published Very Large Business VCR values by industry sector and outage duration. This segments VCR estimates for Very Large Business customers into 20 outage scenarios using the 4 industry sectors and 5 outage durations set out in the template below:

		Outage duration				
		10 minutes	1 hour	3 hours	6 hours	12 hours
Industry	Services					
	Industrial					
	Metals					
	Mines					

3.2.4.2 Defining Very Large Business customers on Western Power's network

As outlined above, the AER defined Very Large Business customers on the basis of the level of peak demand reached by a business site in the previous 12 months.

Western Power does not collect data on the recorded peak demand of individual customers; however, Western Power does assign a contract maximum demand to large customers on a high voltage distribution connection tariff or on a transmission connection tariff. We have therefore used contract maximum demand as a proxy for recorded peak demand.

3.2.4.3 Large Commercial > 10MVA customers

Customers on a high voltage distribution connection tariff, with a contract maximum demand greater than or equal to 10 MVA have been defined as Very Large Business customers, as per the definition applied by the AER. There are 30 NMI connections on Western Power's network that meet this definition and we have included an additional customer segment to capture these customers – Large Commercial > 10 MVA.

This customer segment will be mapped to the AER's Very Large Business VCR estimates, to produce a VCR estimate for Large Commercial > 10 MVA customers. Similarly, the customer minutes and consumption for these 30 NMIs has been filtered out of the data used to determine VCR for the Large Commercial (ex. > 10 MVA) customer segment.

3.2.4.4 Transmission connected customers

Customers connected to Western Power's transmission network have been defined as Very Large Business customers for the purposes of mapping to the AER's VCR values. There are 39 such customers connected to Western Power's transmission network.

We have not applied a peak demand or contract maximum demand condition in defining transmission connected customers as Very Large Business.

We have taken this approach for the following reasons:

- All transmission-connected customers in similar industries are likely to have broadly similar characteristics and reliability preferences, even where below 10MVA.
- Transmission connections are typically very reliable, and are materially different in reliability to most distribution connections. Therefore, all transmission-connected customers are likely to have observed a similar reliability experience in the past, and will continue to face a similar reliability experience in the future.

The alternative approach would have been to map Western Power's transmission-connected customers with contract maximum demand less than 10 MVA to the AER's Large Business VCR estimates. However, the AER's Large Business VCR estimates are derived using a survey sample of distribution-connected customers only. As noted above, we consider that the reliability experience and preferences of transmission-connected customers < 10 MVA are likely to be more closely aligned with those of the Very Large Business customers in the AER's direct cost survey, as compared to those distribution connected customers in the large business survey sample.

3.2.4.5 Segmentation of Very Large Business VCR and Western Power outage data

The AER segments Very Large Business VCR estimates by four industry sectors: services, industrial, metals and mines, whereas Western Power's outage and consumption data for very large distribution-connected and transmission-connected customers is not segmented in a similar manner.

To address this, for the Large Commercial > 10 MVA and Transmission-connected customer segments we have:

- Assigned one of the four industry sector categories to each of Western Power's customers on a case by case basis (using NMI level data).
- Calculated the proportion of annual consumption by Western Power's customers in each of the four industry sectors.
- Weighted together the AER's VCR estimates for each of the four industry sectors proportionate to the annual consumption of Western Power's customers in each of the four industry sectors.

The approach above produces two sets of VCR values that can be mapped to Western Power's Large Commercial > 10 MVA customers and Transmission-connected customers respectively.

3.2.4.6 Limitations in the available data for Very Large Business customers

We have observed limitations in the size of the pool of available data for Very Large Business customers, both in the AER's study of Very Large Business customers and in relation to Western Power's Large Commercial > 10 MVA and Transmission-connected customers.

Approximately 300 business sites in total met the AER's 'Very Large Business' threshold of peak demand of 10 MVA, of which 40 provided survey responses suitable for inclusion in the calculation of VCR estimates. We note that the AER's 2019 review surveyed a larger sample of customers with greater diversity than the corresponding sample surveyed by AEMO in 2014, however a total survey pool of 40 customers is much smaller than the pool of residential and commercial customers surveyed to calculate VCRs for other customer segments.

Furthermore, transmission and high voltage distribution connections are very reliable[16] and therefore interruptions are much less frequent, which limits the number of outage records available to the AER to determine the appropriate weightings that should be applied to VCR estimates for each outage duration. This is similarly the case in the outage data provided by Western Power, which records a total of 56 interruptions to transmission connections over the 10-year period between 2012 and 2021, as compared to over 600,000 total interruption records on the distribution network in the same period.

As a result of the sample size limitations discussed above, users of the AER's Very Large Business VCR estimates and Western Power's VCR estimates for transmission-connected customers should be aware that the VCR outcomes in both of these contexts are highly sensitive to the direct cost survey responses on which they are based and to the relative weightings applied in calculating aggregated VCR values (noting that there are very significant differences in the VCR values between industry segments).

[16] Australian Energy Regulator - Values of Customer Reliability, Final report on VCR values - December 2019, p. 64

3.2.4.7 *Approach to adapting the AER's Very Large Business VCR estimates to Western Power's context*

The AER published VCR estimates for Very Large Business customers weighted by the frequency of each outage duration, such that the sum of VCRs for all outage durations represented the total VCR for each industry segment, as shown in Table 19 below.

Table 19 – Very Large Business VCR estimates (NEM) (June $2021/kWh) – duration weighted

Industry sector	10 minutes	1 hour	3 hour	6 hour	12 hour	Total of all durations
Services	1.34	2.33	1.32	1.79	4.09	10.85
Industrial	37.83	64.34	14.68	3.14	1.46	121.47
Metals	4.07	12.51	2.89	0.63	0.33	20.45
Mines	10.30	18.63	4.79	1.48	0.99	36.19

Source: Australian Energy Regulator – Value of Customer Reliability, Final report on VCR values, December 2019 – Table 5.19, p. 65

The AER also published the frequency of each outage duration, based on outages occurring in the transmission system in the NEM between 2010 and 2019. Note that although survey data was collected from distribution and transmission connected customers, the outage probabilities below were derived using data related only to interruptions in the transmission system.

Table 20 – Outage duration probabilities, NEM transmission networks (2010-2019)

	10 minutes	1 hour	3 hour	6 hour	12 hour
Weighted frequency	4.4%	44.3%	29.5%	11.8%	10.0%

Source: Australian Energy Regulator – Value of Customer Reliability, Final report on VCR values, December 2019 – Table 5.18, p. 64

Dividing the AER's weighted VCR estimates presented in Table 19 by the frequency presented in Table 20 produces a table of unweighted VCR values that can be adapted to Western Power's context, these values are set out in Table 21 below.

Table 21 – Very Large Business VCR estimates (NEM) (June $2021/kWh) – unweighted

Industry sector	10 minutes	1 hour	3 hours	6 hours	12 hours
Services	30.44	5.26	4.47	15.16	40.90
Industrial	859.72	145.23	49.77	26.60	14.62
Metals	92.48	28.25	9.81	5.37	3.27
Mines	233.98	42.05	16.25	12.56	9.92

3.2.4.8 *Estimating VCR for Western Power's transmission-connected customers*

Using the Western Power outage data for transmission-connected customers we have calculated the following table of outage duration probabilities based on 10 years of data.

Table 22 – Outage duration probabilities – Western Power transmission-connected (2012-2021)

	10 minutes	1 hour	3 hour	6 hour	12 hour
Frequency	26.67%	33.33%	11.11%	17.78%	11.11%

Combining the unweighted AER VCR estimates in Table 21 with the Western Power outage duration probabilities in Table 22 above, we have calculated a table of weighted VCR values adapted to Western Power's context.

Table 23 – Very Large Business VCR estimates (June $2021/kWh) – Western Power weighted, transmission-connected

Industry sector	10 minutes	1 hour	3 hours	6 hours	12 hours	Total of all durations
Services	8.12	1.75	0.50	2.70	4.54	17.61
Industrial	229.26	48.41	5.53	4.73	1.62	289.55
Metals	24.66	9.42	1.09	0.95	0.36	36.49
Mines	62.40	14.02	1.81	2.23	1.10	81.55

Using data on the annual consumption of each of Western Power's transmission-connected customers, we have calculated the proportion of annual consumption represented by each of the four industry sectors over the previous 5 years and the previous 12 months.

Table 24 – Proportion of total transmission-connected consumption on Western Power's network by industry sector

Industry sector	Proportion of total consumption 2016/17 – 2020/21	Proportion of total consumption 2020/21
Services	21.40%	21.91%
Industrial	3.38%	3.31%
Metals	9.91%	8.75%
Mines	65.32%	66.03%

Weighting the total VCR estimates for each industry sector by the proportion of total consumption of each of the industry sectors produces an overall VCR estimates for Western Power's transmission-connected customers, weighted by either 5 years or 1 year of annual consumption data.

Table 25 – Final VCR estimates for Western Power's transmission-connected customers (June $2021/kWh)

	5 year weighted	1 year weighted
Transmission-connected VCR	$ 70.43	$ 70.47

3.2.4.9 *Estimating VCR for Western Power's Large Commercial > 10 MVA customers*

Using the Western Power outage data for Large Commercial >10MVA (distribution-connected) customers we have calculated the following table of outage duration probabilities based on 10 years of data.

Table 26 – Outage duration probabilities – Western Power Large Commercial > 10 MVA (2011-2021)

	10 minutes	1 hour	3 hour	6 hour	12 hour
Frequency	8.21%	33.58%	36.94%	15.30%	5.97%

Combining the unweighted AER VCR estimates in Table 21 with the Western Power outage frequencies in Table 26 above, we have calculated a table of weighted VCR values adapted to Western Power's context.

Table 27 – Very Large Business VCR estimates (June $2021/kWh) – Western Power weighted, Large Commercial > 10 MVA

Industry sector	10 minutes	1 hour	3 hours	6 hours	12 hours	Total of all durations
Services	2.50	1.77	1.65	2.32	2.44	10.68
Industrial	70.57	48.77	18.38	4.07	0.87	142.67
Metals	7.59	9.49	3.62	0.82	0.20	21.72
Mines	19.21	14.12	6.00	1.92	0.59	41.85

Using data on the annual consumption of each of Western Power's Large Commercial > 10 MVA customers, we have calculated the proportion of annual consumption represented by each of the four industry sectors over the previous 5 years and the previous 12 months.

Table 28 – Proportion of total Large Commercial > 10 MVA consumption on Western Power's network by industry sector

Industry sector	Proportion of total consumption 2016/17 – 2020/21	Proportion of total consumption 2020/21
Services	27.54%	24.98%
Industrial	26.86%	25.44%
Metals	0.00%	0.00%
Mines	45.59%	49.58%

Weighting the total VCR estimates for each industry sector by the proportion of total consumption of each of the industry sectors produces an overall VCR estimates for Western Power's Large Commercial > 10 MVA customers, weighted by either 5 years or 1 year of annual consumption data.

Table 29 – Final VCR estimates for Western Power's Large Commercial > 10 MVA customers (June $2021/kWh)

	5 year weighted	1 year weighted
Large Commercial > 10 MVA VCR	60.35	59.71

3.3 Conversion of customer segment VCRs into aggregate VCRs for Western Power's network segments

The Residential, Commercial and Very Large Business methodologies outlined in section 3.2 produce the following set of customer segment VCRs.

Table 30 – Customer segment VCR estimates (June $2021/kWh)

<table>
<tr><th colspan="2">Residential</th><th colspan="2">Commercial</th><th colspan="2">Transmission connected</th></tr>
<tr><td>CZ 4 CBD & Suburban</td><td>$24.55</td><td rowspan="2">Small Commercial</td><td rowspan="2">$62.38</td><td rowspan="4">Transmission connected</td><td rowspan="4">$70.43</td></tr>
<tr><td>CZ 5 CBD & Suburban</td><td>$32.15</td></tr>
<tr><td>CZ 3 Regional</td><td>$23.23</td><td rowspan="2">Large Commercial (ex. > 10 MVA)</td><td rowspan="2">$39.65</td></tr>
<tr><td>CZ 4 Regional</td><td>$24.81</td></tr>
<tr><td>CZ 5 Regional</td><td>$24.17</td><td rowspan="2">Large Commercial > 10 MVA</td><td rowspan="2">$60.35</td></tr>
<tr><td>CZ 6 Regional</td><td>$21.07</td></tr>
</table>

These values must be weighted together into aggregate VCRs representative of the network and customer segments used by Western Power. The following aggregate VCRs are required for Western Power in AA5:

- Customer segment
  - Residential
  - Small Commercial
  - Large Commercial
- Connection type
  - Distribution-connected
  - Transmission-connected
- Feeder type
  - CBD
  - Urban
  - Rural Short
  - Rural Long

3.3.1 Determining energy consumption weights

The appropriate weightings to be applied to each customer segment are determined based on the volume of energy consumed by each customer segment. Western Power has provided the following consumption data to KPMG:

- Monthly consumption of distribution-connected customers between April 2011 and March 2021, identified by:
  - Postcode
  - Feeder type (CBD, Urban, Short Rural, Long Rural)
  - Customer segment (Residential, Small Commercial, Large Commercial (ex. > 10 MVA), Large Commercial > 10 MVA)
- Annual consumption of transmission-connected customers between 2016-17 and 2020-21, identified by:
  - National Metering Identifier

Load weightings have been determined based on annual consumption over a 5-year averaging period and 1-year averaging period. The weights reflect the proportion of consumption that a specific customer segment represents within the broader network segment over the averaging period, for example the proportion of total residential consumption represented by customers in Climate Zone 4

Regional, or the proportion of total urban feeder consumption represented by Small Commercial customers. Appendix F provides a summary of the energy load weightings determined for each customer segment using a 5-year averaging period and 1-year averaging period.

3.3.2 Converting customer segment VCRs into network segment VCRs

The VCR estimates in Table 30 have been weighted together using the weights in Appendix F.

For each customer segment within a network segment, the relevant VCR value has been multiplied by the corresponding energy consumption weighting.

For example, Table 31 below sets out the approach for determining the urban feeder VCR estimate.

Table 31 – Calculation of aggregate urban feeder VCR (June $2021/kWh)

Customer segment	Customer segment VCR	Energy consumption weight (proportion of urban feeder consumption, 2016-21)	Weighted customer segment VCR
Residential – CZ4 CBD & Suburban	$24.55	0.00%	$0
Residential - CZ5 CBD & Suburban	$32.15	36.79%	$11.83
Residential - CZ3 Regional Australia	$23.23	0.00%	$0.00
Residential - CZ4 Regional Australia	$24.81	0.95%	$0.23
Residential - CZ5 Regional Australia	$24.17	0.77%	$0.19
Residential - CZ6 Regional Australia	$21.07	0.06%	$0.01
Small Commercial	$62.38	15.87%	$9.90
Large Commercial (ex. > 10 MVA)	$39.71	39.31%	$15.59
Large Commercial > 10 MVA	$60.35	6.25%	$3.77
		Aggregate urban feeder VCR	**$41.52**

This process has been repeated for all network segments.

4 Results and recommendations

This section presents the VCR estimates derived for the Western Power network for AA5.

In the first instance, VCR estimates are presented for each customer segment using both a 5-year and 1-year averaging period. These estimates are compared to those of the 2019 AER review, as well as those used by Western Power over the AA4 period, and an assessment is made as to the extent and materiality of any areas of difference, and the potential reasons for this difference.

Final VCR recommendations are provided for each customer segment (Residential, Small Commercial, Large Commercial, Transmission-connected), feeder-type (CBD, Urban, Rural Short, Rural Long), and connection-type (distribution connected, transmission-connected).

4.1 Results

The results from applying the estimation methodology as described in section 3 are set out in the following tables in respect of VCR values for residential, commercial, transmission-connected customers and by feeder-type.

Table 32 – Residential VCR estimates (June $2021/kWh)

		VCR based on 5-year average data	VCR based on 1-year average data
CZ 4 CBD & Suburban		$24.55	$21.70
CZ 5 CBD & Suburban	SA proxy	$32.15	$31.85
	NSW proxy	$27.01	$26.30
CZ 3 Regional		$23.23	$21.10
CZ 4 Regional		$24.81	$23.04
CZ 5 Regional		$24.17	$24.24
CZ 6 Regional		$21.07	$21.91
Aggregate Residential VCR		**$30.59**	**$30.35**

Table 33 – Small Commercial and Large Commercial (ex. > 10 MVA) VCR estimates (June $2021/kWh)

	VCR based on 5-year average data	VCR based on 1-year average data
Small Commercial	$62.38	$59.08
Large Commercial (ex. > 10 MVA)	$39.65	$38.77

Table 34 – Large Commercial > 10 MVA VCR estimates (June $2021/kWh)

VCR by industry sector (using outage data over 10-year period, 2011-2021)		
Services		$10.68
Industrial		$142.67
Metals		$21.72
Mines		$41.85
Large Commercial > 10 MVA VCR	**5 year weighted: $60.35**	**1 year weighted: $59.71**

Table 35 – Transmission-connected VCR estimates (June $2021/kWh)

VCR by industry sector (using outage data over 10-year period, 2011-2021)		
Services		$17.61
Industrial		$289.55
Metals		$36.49
Mines		$81.55
Transmission-connected VCR	**5 year weighted: $70.43**	**1 year weighted: $70.47**

Table 36 – VCR estimates by feeder type (June $2021/kWh)

	VCR based on 5-year average data	VCR based on 1-year average data
CBD	$42.54	$39.97
Urban	$41.52	$39.40
Rural Short	$40.14	$38.64
Rural Long	$39.71	$38.20
Aggregate distribution-connected VCR	**$41.08**	**$39.12**

4.1.1 Comparative assessment of VCR estimates for AA5

Tables 37 – 39 below provide a comparison of the VCR estimates we have developed for AA5, as compared to those used in AA4, and those estimated by the AER in 2019 which we have used as inputs.

Table 37 – Comparison of Residential VCR estimates

Western Power (KPMG) AA5 estimate (June $2021/kWh)		AER 2019 VCR estimate (June $2021/kWh)		Western Power (Synergies) AA4 estimate (June $2021/kWh)	
CZ 4 CBD & Suburban	$24.55	CZ 3&4 Regional	$27.25	Aggregate residential (SA)	$30.71
CZ 5 CBD & Suburban	$32.15	CZ 5 CBD & Suburban (SA)	$34.21		
CZ 3 Regional	$23.23	CZ 3&4 Regional	$27.25		
CZ 4 Regional	$24.81	CZ 3&4 Regional	$27.25	Aggregate residential (NSW)	$31.99
CZ 5 Regional	$24.17	CZ 5 Regional	$25.29		
CZ 6 Regional	$21.07	CZ 6 Regional	$21.87		
Aggregate residential	$30.59				

Table 38 – Comparison of Commercial VCR estimates

Western Power (KPMG) AA5 estimate (June $2021/kWh)		AER 2019 VCR estimate (June $2021/kWh)		Western Power (Synergies) AA4 estimate (June $2021/kWh)	
Small Commercial	$62.38	Agricultural (S/M)	$59.34	Commercial	$53.85
		Industrial (S/M)	$81.71		
		Commercial (S/M)	$70.31		
Large Commercial	$42.55	Agricultural (L)	$34.69	Industrial (no longer used)	$58.97
		Industrial (L)	$64.27		
		Commercial (L)	$41.10		

Table 39 – Comparison of Very Large Business VCR estimates

Western Power (KPMG) AA5 estimate (June $2021/kWh)		AER 2019 VCR estimate (June $2021/kWh)		Western Power (Synergies) AA4 estimate (June $2021/kWh)	
Distribution-connected, Large Commercial > 10 MVA	$60.35	Distribution Very Large Business	$27.03	Direct Connect Customers	$10.34
Transmission-connected	$70.43	Transmission Very Large Business	$57.96		

4.1.1.1 Comparing the AER's 2019 VCR estimates to our AA5 estimates

We have adapted VCR estimates for Western Power from the values estimated in the 2019 AER review, weighting the VCR values estimated by the AER for various outage scenarios by the probability distribution of the corresponding outage scenario. No other adjustment has been made to the values published by the AER following the 2019 review. Therefore, any difference in our VCR estimates for Western Power as compared to those developed by the AER is driven largely by differences in the nature and frequency of outages observed on Western Power's network as compared to those recorded in the NEM. There may also be some differences related to the mapping between the AER's segments and those available in the Western Power data.

Comparing Residential, Small Commercial and Large Commercial (ex. > 10 MVA) results

Residential and Commercial VCR estimates for Western Power are broadly lower than those estimated by the AER for the NEM in 2019 and adjusted for inflation to June quarter 2021. This is primarily due to differences in the distribution of outage probabilities across the 32 outage scenarios:

- Western Power's outage data displays a higher percentage of longer duration outages (6-12 hours) relative to data collected in the NEM.
    - VCR estimates developed through customer surveys (both by AEMO in 2014, and the AER in 2019) typically show that customers place a higher value on shorter duration outages on a per hour basis.
    - Therefore, a higher frequency of longer outages on Western Power's network contributes to lower VCR estimates.

For example, Tables 40 – 42 below display the outage distribution for Climate Zone 5 CBD & Suburban in the NEM, the outage distribution in the corresponding residential segment on Western Power's network, and the difference between the two distributions (i.e. the second minus the first).

Table 40 – National Electricity Market outage probabilities - residential customers in Climate Zone 5 CBD & Suburban, SA

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	3.69%	0.71%	0.89%	0.41%	4.94%	1.02%	0.88%	0.41%
1 - 3	12.95%	8.08%	7.77%	1.20%	17.21%	4.94%	6.96%	1.56%
3 - 6	6.76%	2.61%	1.49%	2.37%	4.50%	0.46%	0.94%	0.13%
6 - 12	2.13%	0.89%	1.07%	0.45%	1.75%	0.46%	0.29%	0.06%

Table 41 – Western Power outage probabilities - residential customers in Climate Zone 5 CBD & Suburban

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	2.65%	1.80%	0.70%	0.67%	3.87%	1.56%	1.19%	0.80%
1 - 3	8.35%	4.04%	2.76%	1.33%	11.36%	5.55%	3.96%	2.12%
3 - 6	4.09%	1.51%	1.50%	0.61%	8.45%	3.68%	3.55%	1.28%
6 - 12	3.40%	1.10%	1.25%	0.43%	9.31%	3.70%	2.49%	0.92%

Table 42 – Difference in outage distribution (NEM vs. Western Power) - residential customers in Climate Zone 5 CBD & Suburban

Outage duration (hours)	Offpeak Weekday Winter	Peak Weekday Winter	Offpeak Weekend Winter	Peak Weekend Winter	Offpeak Weekday Summer	Peak Weekday Summer	Offpeak Weekend Summer	Peak Weekend Summer
0 - 1	-1.04%	1.09%	-0.19%	0.26%	-1.06%	0.54%	0.32%	0.39%
1 - 3	-4.60%	-4.04%	-5.00%	0.13%	-5.86%	0.62%	-3.00%	0.56%
3 - 6	-2.67%	-1.10%	0.01%	-1.75%	3.95%	3.22%	2.61%	1.14%
6 - 12	1.27%	0.21%	0.18%	-0.02%	7.56%	3.24%	2.20%	0.85%

As displayed above, Western Power's outage distribution includes a higher percentage of outages of 6-12 hours in duration and a higher percentage of outages in the Summer. For all customer segments in the AER's survey sample, 6-12 hour duration outages carry the lowest willingness to pay to avoid the outage and Summer outages carry higher willingness to pay than Winter outages to avoid the outage all else the same. Overall, in Western Power's outage distribution the former effect dominates the latter effect, which contributes to lower VCR estimates for Western Power's distribution-connected customer segments.

A similar pattern is observed in the difference tables for each residential climate zone and remoteness customer segment, and for the Small Commercial and Large Commercial (ex. > 10 MVA) customer segments.

Comparing Large Commercial > 10 MVA and Transmission-connected results

The Large Commercial > 10 MVA and Transmission-connected customer VCR estimates for Western Power are broadly higher than those estimated by the AER for the NEM in 2019. This is primarily due to a higher frequency of short duration (10 minute) outages in Western Power's outage data.

- Very Large Business customers place the highest value on short duration outages, and as such a higher frequency of short duration outages contributes to a higher VCR estimate.
- The AER's 2019 review notes that this is in part due to the high fixed cost of restoring operations following an outage of any duration, particularly in the industrial and mining sectors.

Annual consumption of transmission-connected customers on Western Power's network is dominated by mining customers. As such, the weighted transmission-connected VCR is closely aligned with the mining segment specific VCR estimate.

Tables 43 and 44 below demonstrate the difference in outage distribution for Western Power's Large Commercial > 10 MVA and Transmission-connected customers relative to the surveyed Very Large Business customers in the NEM.

Table 43 – Outage duration distribution – Very Large Business customers (NEM) vs. Western Power Large Commercial > 10 MVA

	10 minutes	1 hour	3 hour	6 hour	12 hour
NEM frequency	4.40%	44.30%	29.50%	11.80%	10%
Western Power frequency	8.21%	33.58%	36.94%	15.30%	5.97%
Difference	3.81%	-10.72%	7.44%	3.50%	-4.03%

Table 44 – Outage duration distribution – Very Large Business customers (NEM) vs. Western Power Transmission-connected

	10 minutes	1 hour	3 hour	6 hour	12 hour
NEM frequency	4.40%	44.30%	29.50%	11.80%	10%
Western Power frequency	26.67%	33.33%	11.11%	17.78%	11.11%
Difference	22.27%	-10.97%	-18.39%	5.98%	1.11%

4.1.1.2 Comparing Western Power's AA4 VCR estimates to our AA5 estimates

The VCR estimates used during AA4 were adapted from the 2014 AEMO review, which used a different methodology to the 2019 AER review from which we have adapted VCR estimates for AA5. Furthermore, Western Power's Commercial customer segmentation has changed since the start of the AA4 period such that the Industrial customer segment is no longer used. Therefore, it is not appropriate to draw a direct comparison between the AA4 and AA5 VCR estimates.

The VCR estimates we have developed for AA5 have been adapted from the most recent AER results available, in line with the ERA's proposed approach for AA5. Fundamentally, the methodology outlined in section 3 provides a means of converting a series of inputs developed using survey data from customers in the NEM, to a series of outputs that are reflective of Western Power's context. Any sources of difference in VCR outputs under this approach are ultimately a reflection of the distribution of outages on Western Power's network. There may be additional sources of difference attributable to the unique reliability preferences of Western Power's customers, that are also likely to be correlated with the probability distribution of outages they experience. However, the nature and extent of this difference can only be revealed through survey responses of a representative sample of Western Power's customers.

4.2 Recommendations

4.2.1 Choice of averaging period for outage and energy load data

The results presented in section 4.1 indicate that VCR estimates are relatively stable across both 5-year and 1-year averaging periods for outage and energy load data. In some cases, for certain residential and commercial customer segment, the length of averaging period applied to outage data can contribute to material differences in VCR outcomes. Overall, a five-year averaging period (for both outage and energy load data) results in slightly higher VCR estimates for all customer segments relative to a one-year averaging period.

The length of averaging period applied to energy consumption data does not have a material impact on VCR estimates, as energy load weights are reasonably consistent over time across all customer segments.

Table 45 below outlines the sensitivity of VCR outcomes under different averaging periods for both outage data and energy load data.

Table 45 – Sensitivity of aggregate VCRs to different averaging periods (June $2021/kWh)

Outage data avg. period	5 years	5 years	1 year	1 year
Energy load data avg. period	5 years	1 year	1 year	5 year
Residential	30.59	30.70	30.35	30.23
Large Commercial	42.55	42.33	41.49	41.71
CBD feeder	42.54	40.99	39.97	41.35
Urban feeder	41.52	40.29	39.40	40.49
Short rural feeder	40.14	39.49	38.64	39.19
Long rural feeder	39.71	39.45	38.20	38.34

The AER used an averaging period of one-year in 2019, and Synergies Economic Consulting recommended an averaging period of five-years for Western Power in AA4.

We have considered the following factors in determining an appropriate averaging period:

- The ERA's approach to set service standard benchmarks and incentive rates in service performance incentive schemes is to use a five-year average of historical performance outcomes. The AER similarly uses average service performance data over a five-year period to set performance targets. VCR values will serve as a key input in these calculations for AA5, as such it is appropriate to align the length of period used to set VCR with the length of period used in determining incentive rates.
- The AER's study captured a larger pool of outage data with a greater number of outage records spanning a broad range of networks in the NEM. In adapting the AER's VCR estimates to Western Power's context, we have used a smaller set of outage records relating only to one network. For some customer segments, the use of a one-year averaging period produces more variable results with respect to the distribution of outage probabilities across the 32 outage scenarios. A longer averaging period, such as five-years, is likely to smooth any large annual variations in VCR outputs for Western Power's context.

Therefore, we recommend that Residential, Small Commercial and Large Commercial (ex. > 10 MVA) VCR estimates be derived and weighted using outage data and energy consumption data collected over a five-year period. This approach is consistent with the averaging period used in service performance incentive schemes and is likely to smooth any large sources of variation that may be present in data collected over shorter periods.

For Very Large Business customers both Large Commercial > 10 MVA and Transmission-connected, the available number of outage records is much smaller, and is therefore more sensitive to changes in the selected data and length of averaging period. Therefore, in determining the frequency of each outage duration scenario for these customer segments, we recommend that Western Power use the full set of available outage data for each customer segment: capturing interruptions occurring between 2011 and 2021 for Large Commercial > 10 MVA customers, and interruptions occurring between 2012 and 2021 for Transmission-connected customers. As for other customer segments, we recommend that 5 years of energy load data should be used in determining aggregate network segment VCRs.

4.2.2 Final VCR recommendations to Western Power

Table 46 – Recommended VCR estimates by customer segment (June $2021/kWh)

Customer segment	VCR estimate
Residential[a]	$30.59
Small Commercial	$62.38
Large Commercial	$42.55
Transmission-connected	$70.43

[a] Distribution of Residential VCR values across the Western Power Network is depicted in Figure 7.

Table 47 – Recommended VCR estimates by network segment (June $2021/kWh)

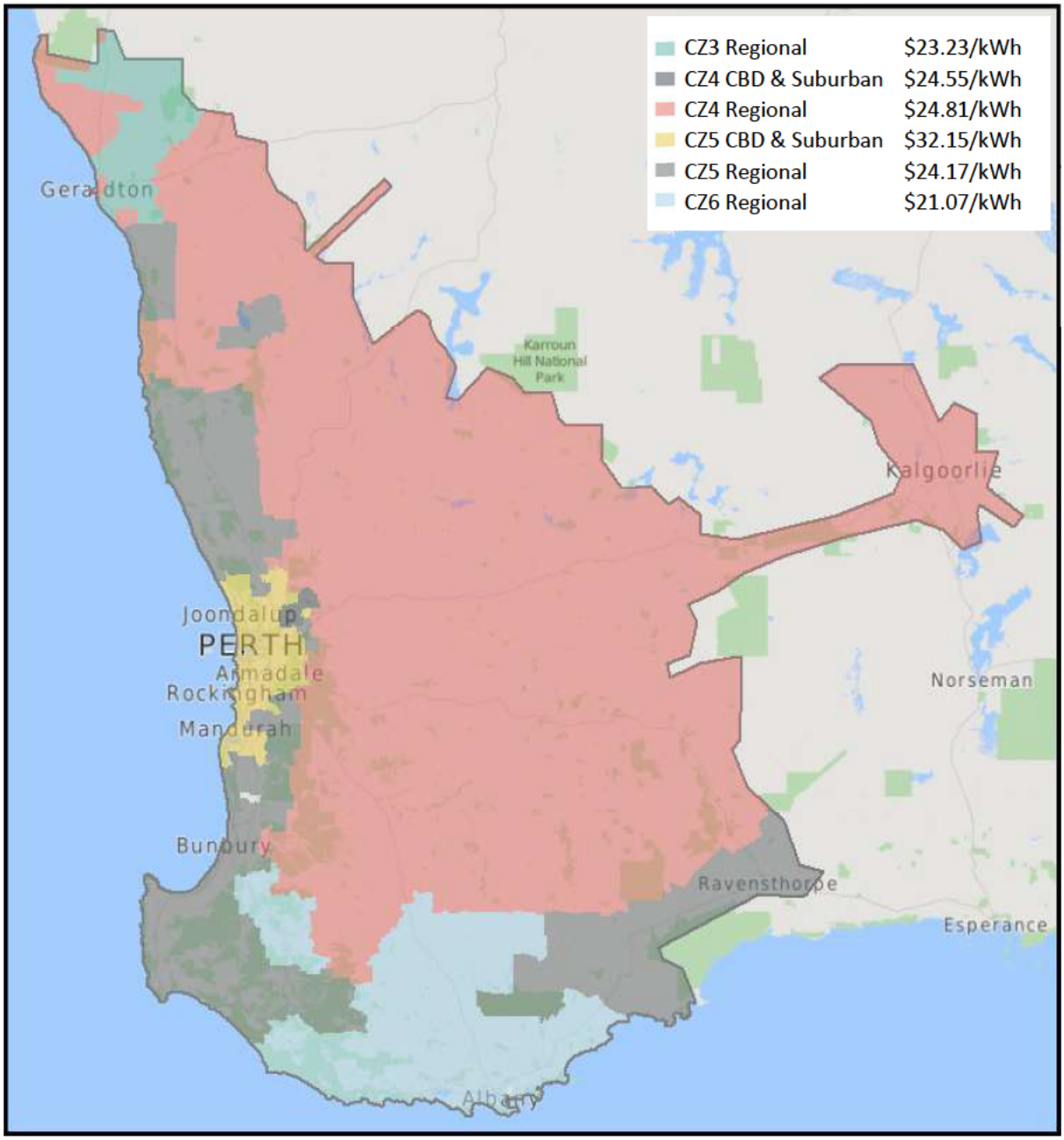
Customer segment[b]	VCR estimate
CBD	$42.54
Urban	$41.52
Rural Short	$40.14
Rural Long	$39.71

[b] Distribution of VCR values by feeder type across the Western Power Network is depicted in Figure 8.

Table 48 – Recommended VCR estimates – whole of network (June $2021/kWh)

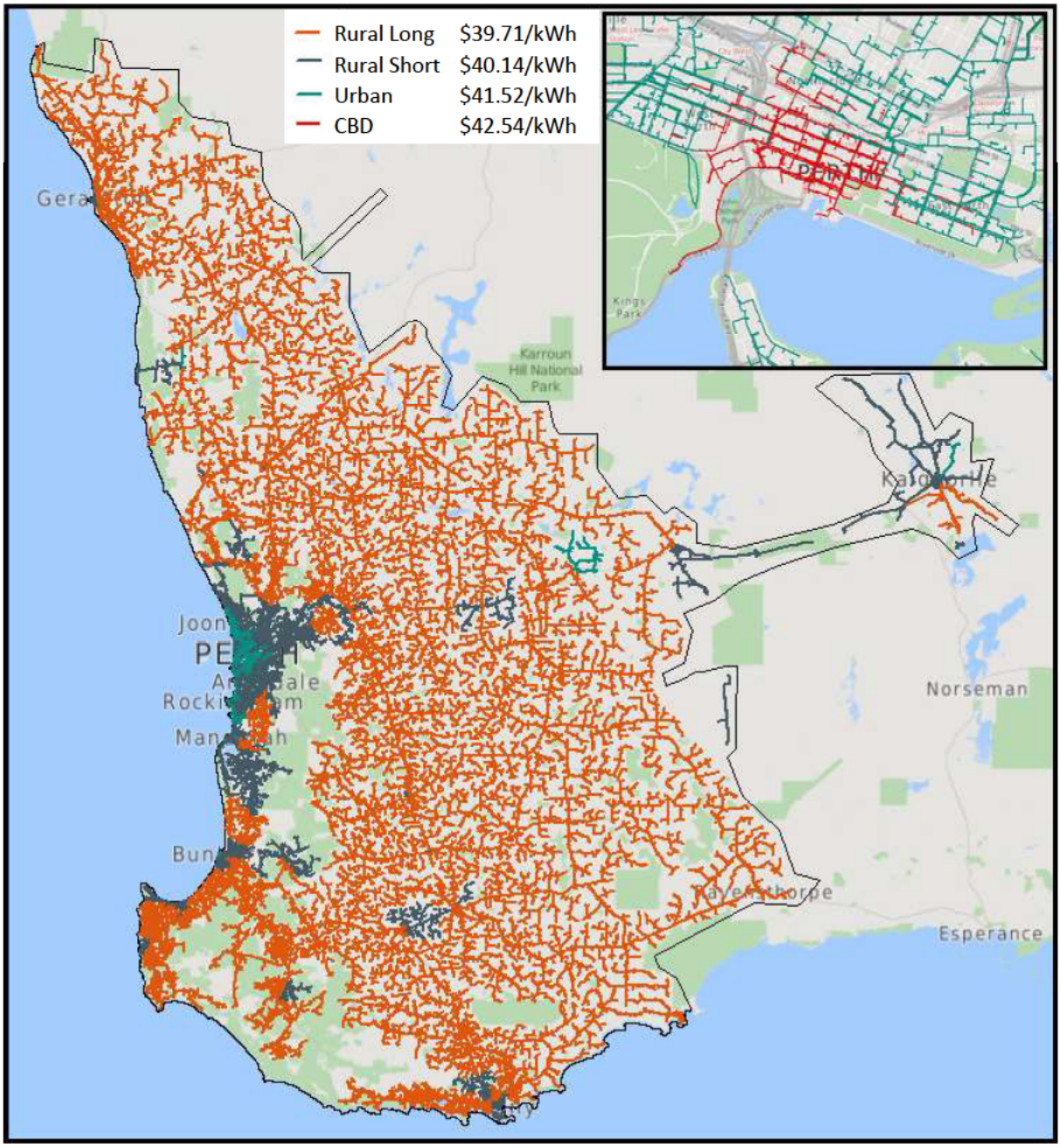
Customer segment	VCR estimate
Aggregate (distribution network)	$41.08
Aggregate (including transmission-connected)	$70.43

Figure 7 - Map of VCR by climate zone and remoteness on the Western Power Network (June $2021/kWh)



Source: Western Power analysis using data provided by KPMG

Figure 8 - Map of VCR by feeder type on the Western Power Network (June $2021/kWh)



Source: Western Power analysis using data provided by KPMG

Appendix

An appendix spreadsheet document has been prepared and published alongside this report.

Appendices A – H contained in the document provide additional detail on how the methodology outlined in section 3 of this report has been implemented.

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