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NSW Value of Customer Reliability

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1. Executive summary

1.1. Study background and purpose

This study is being undertaken by the Australian Energy Market Commission (AEMC) in response to a direction from the Ministerial Council on Energy (MCE)[1]. The MCE's direction was motivated by the significant increases in the price of electricity that have been observed over recent years and the corresponding impact on customers' bills. Several studies[2] have identified distribution reliability standards as one factor contributing to these price increases. The overall objective of the investigation is to ensure that there is "an effective balance between maintaining reliability of supply and efficient pricing outcomes for customers"[3].

The investigation is being undertaken in two streams, as follows:

- A national stream, which will analyse the approaches and underpinning methodologies used in each of the NEM jurisdictions for setting and achieving a standard of electricity supply reliability for electricity distribution companies.
- A NSW stream, which is being undertaken in response to a request from the NSW Government, and will provide a framework and information that will help it ensure that the distribution companies within the state "deliver a level of reliability that most effectively balances the costs of incremental investment and on-going maintenance with the benefits of reliability"[4].

The NSW stream is comprised of two parts:

- An assessment of the potential costs of achieving alternative distribution reliability outcomes.
- An assessment of the value of electricity supply reliability to customers.

This study being reported on here was undertaken to address the latter of those topics. Its purpose is to provide specific values of customer reliability for:

- three customer sectors (residential, small business, and medium to large business);
- each of the four feeder types maintained by the state's electricity distribution companies;

1 The remit of the MCE was transferred to the Standing Councilon Energy and Resources (SCER) by the Council of Australian Governments (COAG) as of July 2011.

2 Comments regarding the impact of distribution reliability standards on consumers' electricity prices have been made by Australian Energy Regulator and several jurisdictional regulators.

3 AEMC, *Request for Proposal in relation to NSW value of customer reliability*, p 1.

4 AEMC, *Request for Proposal in relation to NSW value of customer reliability*, p 1.

- the three DNSPs – Ausgrid, Endeavour Energy, and Essential Energy – themselves; and
- the state as a whole.

The AEMC plans to combine the outputs of this study with information developed regarding the costs of achieving alternative distribution reliability outcomes to provide the NSW Government with a cost-benefit analysis of different distribution reliability standards. The NSW Government will then use that information in considering whether the electricity reliability standards specified in the state's DNSP license conditions should be amended and if so, in what direction.

1.2. Study approach

The study was conducted, as specified in the AEMC's Request for Proposal, using the Australian Energy Market Operator's (AEMO's) methodology for estimating the value of customer reliability. That methodology, which is often referred to as the VCR method, was originally developed by Monash University for VENCorp, and was subsequently implemented to assess the value of customer reliability in Victoria in 1997, 2002 and 2007[5].

The VCR approach seeks to determine the costs that electricity supply interruptions impose on end-use customers. It is essentially seeking to quantify the opportunity cost of unserved energy (USE); that is, the electricity that the customer does not receive due to a supply interruption, and is measured in dollars per kWh ($/kWh) of electricity not supplied. This is a somewhat different question to what the customer would be willing to pay for a different level of reliability, but the assumption can be made that a rational customer would be willing to pay a price for increased reliability that is no more (and presumably somewhat less than) the cost they would incur in the event of an interruption to their electricity supply.

The VCR approach uses interview techniques to determine the costs that different groups of consumers experience when their electricity supply is interrupted. Interviews with business customers generally seek to elicit quantified estimates of the costs imposed by electricity supply interruptions. The assumption here is that businesses will be able to quantify the direct and indirect costs they incur when their electricity supply is interrupted.

The costs incurred by residential customers due to electricity supply interruptions are more likely to be dominated by inconvenience rather than direct costs. For example, while an extended supply failure may impose costs on residential customers in the form of spoiled food, supply interruptions of even relatively short duration can cause material inconvenience such as preventing the family from preparing meals or using household appliances and equipment for entertainment or study purposes. The VCR approach seeks to include these 'costs' in its assessment of the damages imposed by electricity supply interruptions.

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5 The 1997 study was conducted by Monash University. The 2002 and 2007 studies were conducted by CRA International Pty Ltd. All three studies were commissioned by VENCorp, whose responsibilities were transferred to AEMO in 2009. Copies of the 2002 and 2007 studies are available on the AEMO website.

Because residential customers are much less likely to incur direct costs as a result of electricity supply interruptions than are business customers, a different interview approach is needed. Rather than asking residential customers how much financial damage they would incur due to a power failure, the VCR approach offers the residential respondent choices of actions that they might take in the event of frequent supply interruptions. The costs of the various options are also mentioned in the interview. The cost of the options selected by the respondent essentially represent the amount of money the respondent would be willing to spend to mitigate the effects of electricity supply interruptions.

1.3. Results

1.3.1. Number of interviews completed

In order to be used in calculating the VCR each interview had to provide two key types of information:

- information on the costs that would be incurred due to power failures of different durations; and
- information about the customer's annual electricity consumption.

Table 1 displays the sample sizes on which the VCRs reported in this study were calculated.

Table 1: VCR sample size* by DNSP and feeder type

Customer sector	Total	DNSP			Feeder Type		
		Ausgrid	Endeavour Energy	Essential Energy	CBD feeders	Urban feeders	Rural feeders
Residential	718	251	232	236	30	383	306
Business <160 MWhpa	497	164	194	139	6	306	185
Business ≥ 160 MWhpa	74	35	24	15	5	47	22
Total	**1288**	**449**	**450**	**389**	**41**	**735**	**512**

* Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration. Column and row totals may not add exactly due to rounding.

1.3.2. State-wide, DNSP, feeder and customer sector VCRs

Table 2 below presents the VCR results by customer sector for each of the state's distribution companies. Table 3 presents the results by customer sector and feeder type at the state level.

Table 2: VCRs by DNSP and sector ($/kWh)

Customer sector	State-wide	Ausgrid	Endeavour Energy	Essential Energy
Residential	$20.71	$22.77	$19.75	$17.82
Business <160 MWhpa	$413.12	$408.48	$563.46	$202.82
Business ≥ 160 MWhpa	$53.30	$34.83	$33.99*	$130.57*
Total	**$94.99**	**$86.79**	**$110.71**	**$90.71**

Table 3: State-wide VCRs by sector and feeder type ($/kWh)

Customer sector	All feeders	CBD feeders	Urban feeders	Rural feeders
Residential	$20.71	$32.27	$23.05	$15.11
Business <160 MWhpa	$413.12	$295.87*	$452.12	$302.49
Business ≥ 160 MWhpa	$53.30	$80.54*	$29.96	$128.50*
Total	**$94.99**	**$120.52**	**$93.88**	**$93.86**

* The VCR quoted here is based on a sample size of 30 observations or less, so will have less statistical validity. Therefore, values have been provided for illustrative purposes and should be used with caution.

As can be seen, the VCR of small business customers is significantly higher than the corresponding values for residential or larger business customers. The overall state-wide VCR of $94.99/kWh is significantly higher than the $57.88 state-wide VCR in Victoria[6], but virtually all of this difference is due to the very high VCR in the NSW small business sector.

6 The Victorian VCR is based on interviews conducted in 2007. The value reported above has been indexed to FY 2011-12 dollars.

Although the VCR studies undertaken in Victoria and NSW segmented non-residential customers differently, the 2012 NSW VCRs for the residential sector and for medium and large businesses are not very different from the corresponding indexed Victorian values. In fact, the NSW VCR for residential customers is a bit lower than the Victorian VCR ($20.71/kWh vs $23.80/kWh), and the NSW VCR for medium and large businesses is only somewhat higher than the VCR of Victorian industrial customers $53.30/kWh vs $41.24/kWh)[7]. The really significant difference between the 2012 NSW results and the indexed 2007 Victorian results occurs with regard to small business customers. The VCR of NSW businesses with annual electricity consumption less than 160 MWh is about four times higher than the VCRs of the agricultural and commercial customers surveyed in Victoria in 2007. This is a very significant difference and it also drives the increase in the overall NSW VCR as compared to the 2007 Victorian result.

1.3.3. Willingness to pay

The MCE's terms of reference to the AEMC requested that customers' "willingness to pay for a range of reliability outcomes" be estimated. This is a somewhat different question to the question posed in the calculation of the VCR, and there is a well-developed body of literature regarding methodological approaches for addressing customers' willingness to pay (WTP) for different attributes and features of products and services. Application of a full battery of questions that would address customers' willingness to pay (WTP) for increased reliability and/or their willingness to accept (WTA) a lower level of reliability could not be feasibly developed and tested in the time available for the AEMC's review. In addition, a questionnaire that combined a robust battery of WTP/WTA questions with the question required by the VCR methodology would have been excessively long.

Therefore, a simplified battery of questions was developed to address these issues. Customers were asked whether they would be willing to pay 1% more on an annual basis to reduce the total time their power would be out by 60 minutes over the course of the year. Additional questions were used to more closely determine the amount each customer would be willing to pay. Table 4 on the following page shows the responses obtained to these questions, which were asked of approximately half of the residential customers contacted in the survey.

A parallel set of question was developed to determine how much of a discount customers would require in order to accept an additional 60 minutes of power outages over the course of the year. The other half of the residential respondents were asked these questions. Table 5, also on the following page, shows respondents' answers to these questions.

7 Direct comparison of the results for non-residential customers is difficult, however, due to the fact that different segmentation schemes were used in the two studies.

Table 4: Customers' willingness to pay for supply interruption to be reduced by 60 minutes over the course of a year

Per cent of customers who reported they would be willing to pay:	% of customers (base = 541)
At least 1% more to reduce the total time their power would be out due to power failures by 60 minutes per year	60.8%
Of those, per cent that reported they would be willing to pay:	
1% more	29.0%
between 1% and 2% extra	7.4%
2% more	7.4%
more than 2% extra	15.0%
could not quantify	2.0%

Table 5: Customers' willingness to accept an additional 60 minutes of supply interruption over the course of a year

Per cent of customers who reported they would be willing to accept an increase of 60 minutes per year of interruptions to their electricity supply if their bill was decreased by:	% of customers (base = 528)
1%	27.3%
1.5%	0.9%
2%	3.8%
more than 2%	34.1%
could not quantify or would not accept	33.9%

The willingness to pay to avoid 60 minutes of power supply interruptions that is implied by the state-wide residential VCR was also calculated. This was done by calculating the average number of kWh used by NSW residential customers and multiplying that number by the VCR (in $/kWh). Table 6 below compare the three results.

Table 6: Comparison of customers' stated willingness to pay with the willingness to pay implied by the VCR

Measure of customers' willingness to pay or accept 60 minutes less or more interruption to their electricity supply over the course of a year	Amount ($)	Base (no of customers responding)
WTP – Amount willing to pay for 60 minutes less power interruption over the course of a year	$12.34	541
VCR – Implied willingness to pay	$14.56	718
WTA – Amount of discount required to accept 60 minutes more power interruption over the course of a year	$28.54*	528

* Respondents were NOT asked whether they would accept less than a 1% reduction in the annual bill in order to accept 60 minutes of additional outages per annum. We assume that those who would accept a bill reduction of less than 1% would also accept a bill reduction of 1% or greater.

As can be seen, while the VCR value is higher than the estimate of customers' willingness to pay for increased reliability of their electricity supply, it is only marginally so.

Results also show that customers are reluctant to have the level of reliability they currently enjoy reduced. The discount that customers would require to accept an additional 60 minutes of power outages over the course of the year was essentially twice as much as the amount they would be willing to pay to reduce power outages by 60 minutes. Asymmetries of this type between WTP and WTA are often found to exist in studies of this kind.

1.3.4. Customer preferences for distribution investments related to reliability

Residential customers were also asked to identify their preference from three choices for reliability investment by distribution companies. Results indicated that 59.0% preferred investments that would reduce the number of interruptions as compared to investments that would reduce the duration of interruptions (16.8%) or that would provide better information to customers about how long outages would last (24.2%).

1.3.5. Low income VCR

The AEMC was interested to investigate whether low income groups expressed a different value for reliability as compared to other customers. 'Low income' was defined for the purpose of calculating a VCR as those respondents whose annual household income was $50,000 or less and who paid the Energy Concession Rate on their bill In total, 181 (25.2%) of the 718 residential respondents for whom information was available to calculate a VCR met this definition of low income.

The VCR for these low income customers was $15.62/kWh, which is almost 25 per cent lower than the VCR of $20.71 for all residential households in NSW. In fact, given that the VCR for all residential households includes low income households, the difference between low income and non-low income is actually greater than 25 per cent.

However, the fact that low income customers have a lower VCR than other customers should not necessarily be interpreted to mean that low income households place a lower value on reliability than do other customers. It may also mean that, due to their lower incomes and reduced ability to make discretionary purchases, they have selected fewer or lower-cost actions in the questionnaire as those they would take to mitigate the impact of interruptions to their electricity supply.

The questionnaire also provided residential respondents with the option of doing nothing in response to an outage[8]. Results showed that while the proportion of customers who indicated they would do nothing for short outages of one hour or less is similar for low income households and all other households, low income households are significantly more likely to do nothing than other households in response to outages of four hours or more.

This suggests that the lower income of these households may make them less likely to spend money to mitigate the cost of outages. That fact (if true) might mean that the VCR for these customers underestimates the inconvenience caused by outages, as they simply endure the inconvenience while the higher income of other customers makes them more likely to say they would take actions in response to an outage, which results in them having a higher apparent VCR. So, while lower income customers may be less willing to take actions, it does not mean that they do not experience the same level of inconvenience. In fact, to the extent that they take fewer mitigation actions due to their income constraints they may in fact experience more inconvenience than non-low income households that do take mitigation actions.

1.3.6. Caveats

There are several important caveats that should be kept in mind when using the NSW (and in some cases, any) VCR results. These include:

- The VCR is likely to over-state the damages or inconvenience associated with most power failures. This is the case for several reasons, including the fact that respondents are asked to consider the inconvenience or monetary damages they would incur if the electricity supply were to be interrupted at the time that is worst (i.e., most inconvenient or most costly) to them. Clearly, not all supply failures occur at the worst time for the customer.

- The VCR is calculated based on the average number of kWh used per hour by the customer. It is likely that the customer will be using a higher than average amount of electricity at the time he or she defines as being the 'worst time' for a power failure. The use of a higher number of kWh in the calculation of the VCR would reduce the dollar amount of the VCR. This is not done because it is not possible to know the consumption of the customer at that 'worst' time.

- The VCRs presented for CBD feeders are based on a very small number of responses and should be treated with extreme caution. The VCR for large business customers is also based on a relatively small number of responses (though not as small as the number of responses for CBD feeders) and should also be treated with caution.

8 Such a response results in the customer have a zero VCR for the supply interruption duration for which no action would be taken

- The VCR values presented here should not be taken as point estimates. There is a material error band around several of the VCRs reported here. These error bands should be kept in mind when comparing VCRs across sectors, feeders, or DNSPs.

Having said that, we believe that the results by feeder type represent a significant advance in the application and usefulness of the VCR approach. VCR by feeder type is likely to be of significantly more value in helping DNSPs assess the value of reliability improvements to their networks, and should provide a much better tool for government departments and the AER in setting reliability standards and incentive mechanisms.

2. Study background and purpose

2.1. Background

This study is part of a larger investigation of distribution reliability and outcomes that is being undertaken by the Australian Energy Market Commission in response to a direction from the Ministerial Council on Energy (MCE)[9]. The overall objective of the larger investigation is to ensure that there is "an effective balance between maintaining reliability of supply and efficient pricing outcomes for customers"[10].

The MCE's direction was motivated by the significant increases in the price of electricity that have been observed over recent years and the corresponding impact on customers' bills. Several studies[11] have identified distribution reliability standards as one factor contributing to these price increases. In its final report on the changes to be made to regulated electricity prices for the period 1 July 2011 through 30 June 2012, IPART recommended that the "NSW Government satisfy itself that the network licence conditions for network reliability and security align with customers' willingness to pay, and take steps to ensure that future changes in standards are subject to thorough analysis"[12]. IPART also noted as a positive step the announcement by the NSW Premier that a review would be undertaken of the state's electricity network licence conditions "to halt any over-spending which may be forcing up power prices"[13].

The larger investigation undertaken in response to the MCE's direction includes the following components:

- a national review of distribution reliability approaches and the methodologies behind these approaches; and
- a review of NSW distribution reliability standards

This present study is part of the NSW work-stream. Its purpose is to "provide advice and develop estimates of the value of customer reliability for a number of sectors of the NSW community, in relation to various parts of the NSW distribution system"[14].

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9 The remit of the MCE was transferred to the Standing Committee on Energy and Resources (SCER) by the Council of Australian Governments (COAG) as of July 2011.

10 AEMC, *Request for Proposal in relation to NSW value of customer reliability*, p 1.

11 Comments regarding the impact of distribution reliability standards on consumers' electricity prices have been made by Australian Energy Regulator and several jurisdictional regulators.

12 IPART, *Change in regulated electricity retail prices from 1 July 2011, Final Report*, June 2011, p 93.

13 Cited in the IPART Final Report as Premier of NSW, Media Release, *Premier announces three point plan to ease power price increase*, 14 April 2011, http://www.premier.nsw.gov.au/sites/default/files/110414-ThreePointPlan.pdf

14 AEMC, *Request for Proposal in relation to NSW value of customer reliability*, p 2.

2.2. Scope

The AEMC's Request for Proposals specified that the study to assess customers' willingness to pay for different reliability outcomes use the Australian Energy Market Operator's (AEMO's) methodology for estimating the value of customer reliability. That methodology, which is often referred to as the VCR method, was originally developed by Monash University, and was subsequently implemented to assess the value of customer reliability in Victoria in 1997, 2002 and 2007[15]. Further detail on the VCR methodology as implemented for this study is presented in Section 3.

The AEMC Request for Proposals stated that the study's outputs were to include:

- a specific value of customer reliability for each of the customer categories used in the Victorian studies (that is, residential, commercial, industrial and agricultural); and
- appropriately weighting of those customer categories in order to provide a specific value of customer reliability for each feeder type by DNSP, an average VCR for each DNSP and a NSW state-wide average VCR.

The AEMC plans to combine the outputs of this study with information developed in another part of the investigation about the costs of achieving alternative distribution reliability outcomes to provide the NSW Government with a cost-benefit analysis of different distribution reliability standards. The NSW Government will then use that information in considering whether the electricity reliability standards specified in the state's DNSP license conditions should be amended and if so, in what direction. Any such changes would commence in July 2014.

2.3. Report organisation

This report is organised as follows:

- Section 3 summarises the VCR approach and methodology, including how the VCR values are calculated from customers' responses to the questionnaires;
- Section 4 discusses how the questionnaires were designed and implemented, how questionnaire completions compare to the original completion targets, and the adjustments that were made to the customer sectors and feeder types for which VCRs were calculated;
- Section 5 presents the results of the VCR and related analyses of the questionnaire data;
- Appendix A contains copies of the questionnaires that were administered to the residential and business customers that were surveyed; and
- Appendices B through E provide detailed information on how the VCR values presented in the report were calculated and the statistical error bands associated with those results.

15 The 1997 study was conducted by Monash University. The 2002 and 2007 studies were conducted by CRA International Pty Ltd. All three studies were commissioned by VENCorp, whose responsibilities were transferred to AEMO in 2009. Copies of the 2002 and 2007 studies are available on the AEMO website.

3. The VCR approach and methodology

3.1. Overview of the VCR approach

The VCR approach seeks to determine the costs that electricity supply interruptions impose on end-use customers. This is a somewhat different question than what the customer would be willing to pay for a different level of reliability, but the assumption can be made that a rational customer would be willing to pay a price for increased reliability that is no more (and presumably somewhat less than) the cost s/he would incur in the event of an interruption to his or her electricity supply.

Electricity outages can impose costs on consumers – for example, the cost of lost business for a retail establishment – or inconvenience – for example, the inconvenience of not being able to watch television or use other household appliances. The VCR seeks to identify and quantify in dollar terms these costs and inconveniences for relevant customer sectors. More formally, the VCR seeks to identify and quantify the opportunity cost of unserved energy (USE); that is, the electricity that the customer does not receive due to a supply interruption, and is measured in dollars per kWh ($/kWh) of electricity not supplied to the customer due to a supply interruption.

The VCR approach assumes that businesses are able to quantify the direct and indirect costs they incur when their electricity supply is interrupted. This assumption is based on the fact that the availability of electricity is likely to have a direct and measureable impact on the business' ability to operate and earn revenue, and that these costs are the primary damages that the business would be likely to incur in the event of an interruption to its electricity supply. A business might incur other costs – for example, damage to its reputation for, say, its ability to deliver products in line with customers' expectations. Such costs are considerably more difficult to estimate, but ideally should be included, to the extent possible, in an assessment of the damages imposed by electricity supply interruptions.

The costs incurred by residential customers due to interruptions to their electricity supply are more likely to be dominated by inconvenience rather than direct costs. While an extended supply failure may impose costs on residential customers in the form of spoiled food or the decision to travel to a relative's house or stay in a hotel in order to have heating or air conditioning, supply interruptions of even relatively short duration are likely to be experienced as inconveniences rather than as imposing direct costs. For example, while a two-hour outage will not cause food to spoil it could interrupt a family's dinner or disrupt family members' use of household equipment for entertainment or study purposes. The VCR approach seeks to include these 'costs' in its assessment of the damages imposed by electricity supply interruptions.

Taking the above into account, the VCR essentially asks the following questions of residential and non-residential electricity users:

- For residential customers:

  What cost would your household incur to mitigate the effects of frequent outages of a specific duration?

- For business (agricultural, commercial and industrial) customers:

  What cost would your business incur as a result of an outage of a specific duration?

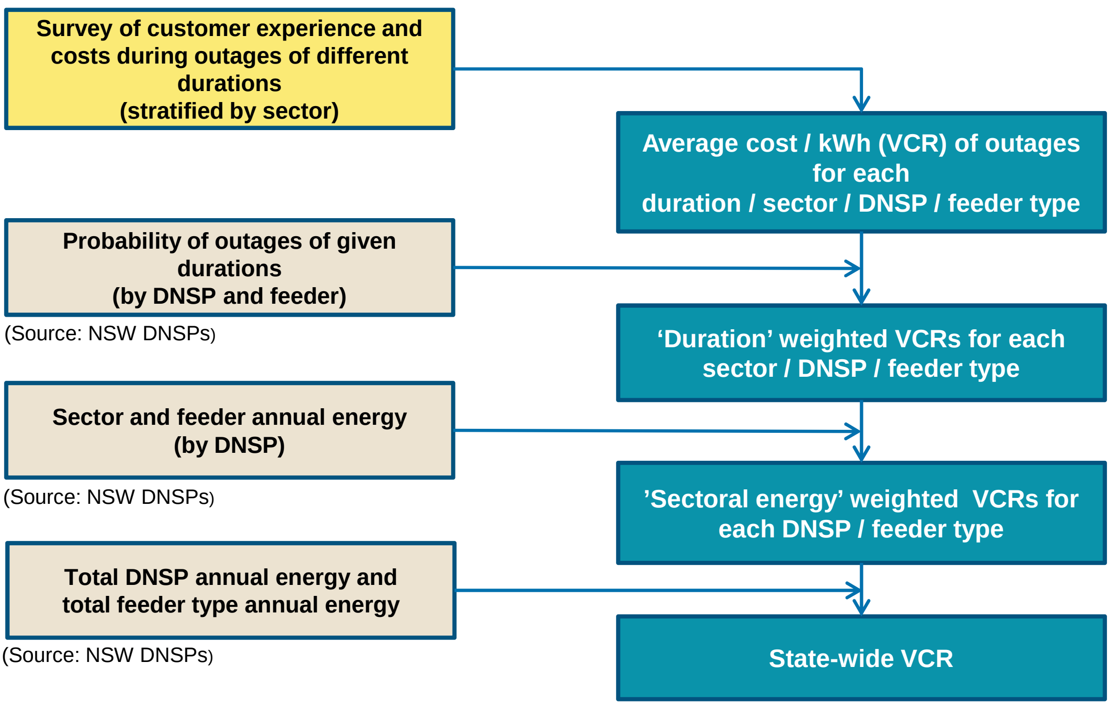
The VCR approach also takes into consideration the fact that:

- the level of damage imposed on the customer will differ depending on the length of time for which the electricity supply is interrupted; and
- the relationship between the length of the supply interruption and the damage imposed is not necessarily linear.

Accordingly, the VCR approach assesses the level of damage customers would incur due to supply interruptions of different durations in dollars per kWh of electricity not delivered. This is done by surveying residential and non-residential customers from different customer sectors. The results from those surveys then need to be adjusted to represent all customers within each sector and all customers within the geographic region of interest. This requires weighting the results of the survey responses by (a) the probability of supply interruptions of different durations occurring, and (b) the relative share of electricity consumed by the various customer sectors within the geographic region of interest, whether that be a feeder, a DNSP service territory, or the state.

Figure 1 below provides an overview of the inputs and calculation process of the VCR methodology as it was applied in this study.

Figure 1: Overview of the VCR calculation method for NSW



The remainder of this section of the report provides further detail on the VCR methodology as it was applied in this study.

3.2. VCR calculation methodology

The objective of this study is to produce estimates of the average value of customer reliability (VCR) across NSW, including aggregated VCRs across any combination of the following three dimensions:

- customer sector;
- feeder type; and
- DNSP territory.

The various combinations of those three dimensions are shown in Table 7 below.

Table 7: VCR estimate dimensions

Customer sector	DNSP territory 1			DNSP territory 2		DNSP territory 3	
	Feeder type A	Feeder type B	Feeder type C	Feeder type A	Feeder type B	Feeder type C	Feeder type A
Customer sector 1	✓	✓	✓	✓	✓	✓	✓
Customer sector 2	✓	✓	✓	✓	✓	✓	✓
Customer sector 3	✓	✓	✓	✓	✓	✓	✓

It should also be noted that the overall VCR for each of those dimensions is developed from the specific value that the customers in question place on supply interruptions of different durations. As a result, each of the VCR estimates depicted in Table 7 is, in fact, a set of weighted averages of the VCR across all interruption durations.

3.2.1. Data cleansing

Identifying usable survey records

For a survey record[16] to be usable for the purpose of calculating the VCR it had to include:

- Quantification of the opportunity cost of lost electricity supply, assuming <u>the outage were to occur at the worst possible time from the customer's perspective</u>:
  - for businesses, estimates of the economic cost of damages (≥ $0) incurred as a result of electricity supply interruptions lasting either: 20 minutes; 1 hour; 2 hours; 4 hours; 8 hours; or 24 hours;

16 A survey record is a completed set of responses to the questionnaire from one business or one household.

- for households, estimates of the cost of measures (≥ $0) taken to mitigate the effects of electricity supply interruptions lasting between: 5 minutes to 1 hour, 1 hour to 4 hours, 4 hours to 8 hours, and 8 hours to 24 hours;[17]

- The annual consumption of electricity (in kWhs) for the business or household – this information is used to both stratify businesses by size (in order create different business customer sectors) and to weight each respondent's interruption costs in combining it with that of other customers;[18]

- Information on the type of feeder to which the business or household is connected – that is: CBD, urban, short rural, or long rural; and

- Identification of the DNSP territory in which the business or household is located – that is: Ausgrid, Endeavour Energy or Essential Energy.

Where a survey record has each of these characteristics, we can calculate, for each respondent:

- their average kWh consumption per hour in a year;

- the economic cost of damages or the mitigation costs the customer is prepared to incur for each outage duration; and

- the average economic cost or mitigation cost per kWh of consumption each individual business or household experiences for each interruption duration assuming the interruption were to occur at the worst possible time for that business or household.

Other data cleansing / adjustment

Some adjustments were made to records to reflect the methodology used in the previous VENCorp funded studies of Victorian VCR[19]:

- Adjustment to annual energy consumption for on-site power generation:

  The annual electricity consumption of respondents who stated they routinely used on-site power generation was multiplied by a factor of 1.9;

- Compensation for central services electricity consumption:

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17 If a survey record did not provide quantification of the opportunity cost of lost electricity supply for every duration it was not excluded. For those durations for which quantification was provided, the information was included in the sample for that duration. The record was not included in the sample used to calculate the VCR for durations for which information on costs incurred was not provided. Explicit statements that no damage would be incurred or that no mitigation actions would be taken were included in the VCR calculations as $0.

18 Survey results are stratified by: a) business electricity consumption buckets; and b) residential customers, so we are able to assess the "average" damage incurred by each customer sector for each interruption duration.

19 The correction factors discussed here were adopted from the 2007 Victorian VCR study; they were not re-estimated.

The annual electricity consumption of respondents in multi-tenanted commercial buildings where central services are metered separately was multiplied by a factor of 2.7 to account for the electricity services they receive (such as air-conditioning) but are not reflected in their own metered electricity consumption.

3.2.1. Calculation of VCRs for "sector / feeder / DNSP"

Consider the following example:

- Business X consumes 40,000 kWh of electricity in a year, or an average of 4.566 kWh every hour of the year[20].
- If the customer's electricity supply were to be interrupted for 4 hours at the worst possible time, Business X, as reported in the questionnaire, would suffer economic costs of $5,000, or $1,250 per hour of supply interruption.
- Thus, by avoiding 4 hours of lost supply – during which time Business X would otherwise have consumed 18.265 kWh of energy (4hrs x 4.566 kWh) - Business X avoids $5000 of economic cost, which is equivalent to an average value of USE of $273.75 per kWh ($5,000 / 18.265 kWh).
- The weighted average value of USE with respect to a 4-hour electricity supply interruption for all businesses or households in a relevant cohort thus gives the average VCR per kWh for that cohort[21].

Rather than performing individual calculations for each survey record, an aggregated form of calculation is used to calculate the average VCR for all customers of interest with regard to a particular supply interruption duration.

In order to calculate a customer sector VCR, however, the interruption duration VCRs have to be weighted by the probability of an outage of each of the relevant durations occurring. The number of outages[22] that have occurred within each of the duration bands over the past three years were provided by each of the DNSPs with regard to each of the various feeder types (i.e., CBD, urban, short rural and long rural) within its service area. These numbers of occurrences are converted into probabilities for each of the following duration buckets:

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20 The use of average hourly consumption in calculating the value to the customer of electricity that is not received is a simplifying assumption. Very few customers use the same amount of electricity in every hour of the year, and it is probable that electricity consumption is higher than average at times when a supply interruption would be the worst possible time for the customer. The fact that the kWh (the denominator) of the VCR statistic is lower than it probably would be at the worst time for supply interruption to occur for the customer means that the VCR values calculated will represent high-end estimates of the value of customer reliability.

21 The weighting is supplied by annual consumption of energy. That is, each customer's value of USE contributes to the weighted average cohort VCR in proportion to the customer's average annual consumption as a proportion of the annual consumption of all customers that were surveyed from that cohort.

22 Supply interruptions relevant to this study were defined as all distribution outages, excluding major event days, plus all outages caused by transmission and generation.

a) up to 20 minutes;

b) 21 to 60 minutes;

c) 61 minutes to 2 hours;

d) over 2 hours and up to 4 hours;

e) over 4 hours and up to 8 hours; and

f) over 8 hours and up to 24 hours.

The customer sector VCR is then calculated as the probability weighted average of the individual interruption duration VCRs for that customer sector.

A similar process is then followed to calculate the average VCRs for each "customer sector" / "feeder type" / "DNSP territory". A total of 21 of these VCRs were calculated. Ausgrid VCRs were developed for 3 feeder types – CBD, urban and rural. Neither Endeavour Energy nor Essential Energy has any CBD feeders, so VCRs for those DNSPs were only calculated for urban and rural feeders. This results in 21 VCRs being calculated for "customer sector" / "feeder type" combinations across the 3 DNSPs: 9 for Ausgrid and 6 each for Endeavour Energy and Essential Energy.

Appendix B.1 provides the specific algorithms used in calculating these base level VCRs, along with several worked examples.

These base level VCRs are the building blocks for other locationally aggregated weighted average VCRs, as explained below.

3.2.2. Calculation of VCRs by "feeder type state-wide" or "DNSP territory"

Using the 21 base level VCRs described above, along with DNSP supplied information with respect to the annual consumption (in MWh) of each "customer sector" / "feeder type" / "DNSP territory" sector, weighted average VCRs were produced for each of three logical aggregation levels:

1. Aggregation level 1:

    a) all customer sectors plus any feeder type and any DNSP territory – 7 possible combinations;

    b) all feeder types plus any customer sectors and any DNSP territory – 9 possible combinations;

    c) all DNSP territories plus any customer sectors and any feeder type – 7 possible combinations;

2. Aggregation level 2:

    a) all customer sectors and all feeder types plus any DNSP territory – 3 possible combinations;

b) all customer sectors and all DNSP territories plus any feeder type – 3 possible combinations;

c) all feeder types and all DNSP territories plus any customer sector – 3 possible combinations;

3. Aggregation level 3: customer sectors, all feeder types and all DNSP territories – that is, an overall state-wide VCR.

Appendix B.2 provides the algorithms used to develop each of these aggregated VCRs along with worked examples.

4. Implementation of the NSW VCR survey

4.1. Questionnaire design

In order to provide as much continuity and consistency as possible in the application of the VCR approach, the questionnaires used in the VCR study that was undertaken in Victoria in 2007 were used as the starting point for the development of the questionnaires to be used in NSW. The following changes were made for the following reasons:

- The mitigation options presented to residential customers were reviewed – The list of measures presented to residential respondents was reviewed to ensure that the range of choices:
  - was realistic;
  - included options that were applicable to each interruption duration tested; and
  - would provide options at a number of price points in order to eliminate large gaps in the choices which would tend to make the calculated VCR overly lumpy.
- The costs of the mitigation options to be presented to residential customers were updated -- Once the list of mitigation options was finalised, we developed updated prices for each by reference to product catalogues and retailer websites.
- The questionnaires were re-formatted to better suit the manner in which they were to be implemented – Due to the limited time available to complete the customer surveys, the AEMC Request for Proposals specified that the questionnaires be undertaken by telephone for residential customers and by email for business customers. In the 2007 Victorian study, all questionnaires were mailed out to potential respondents. The mail formats had to be modified to accommodate telephone and electronic delivery.
- The wording of both versions of the questionnaires was reviewed via pilot testing with members of the target customer sectors. The pilot tests resulted in some fine-tuning of the wording of the questionnaires to improve clarity and flow.

Copies of the questionnaires that were used in the survey of NSW residential and business customers are contained in Appendix A.

4.2. Sample design

The AEMC's RFP specified that "the consultant will be required to provide a specific NSW value of customer reliability for each of the customer categories (that is residential, commercial, industrial and agricultural) used by AEMO in the Victorian value of customer reliability methodology. These values for each customer category will then need to be weighted appropriately to develop a specific value of customer reliability for each feeder type by DNSP, an average for each DNSP, and a NSW state wide average."

In response, the initial survey targets shown in Table 8 below were proposed.

Table 8: Original proposed survey completion targets

	State-wide	Ausgrid	Endeavour Energy	Essential Energy
Residential				
• CBD	100	100	n/a	n/a
• Urban	300	100	100	100
• Short rural	200	50	50	100
• Long rural	200	50	50	100
Total	800	300	200	300
Commercial				
• CBD	100	100	n/a	n/a
• Urban	300	100	100	100
• Short rural	200	50	50	100
• Long rural	200	50	50	100
Total	800	300	200	300
Industrial	300	100	100	100
Agricultural	200	50	50	100
Total = 2,100	2,100	750	550	800

As can be seen, the original sample design set quotas by customer sector, feeder type and DNSP. The sample design provided the following level of statistical validity at the 95% confidence level for the various groups of interest:

- $\pm$ 6 to 10% for each customer sector in which 100 completed surveys were targeted;
- $\pm$ 12 to 20% for each customer sector in which 50 completed surveys were targeted;
- $\pm$ 3 to 4% for the Ausgrid territory as a whole;
- $\pm$ 3 to 5% for the Endeavour Energy territory as a whole;
- $\pm$ 3 to 4% for the Essential Energy territory as a whole;
- $\pm$ 3 to 4% for the residential and commercial customer sectors at the state level;
- $\pm$ 4 to 6% for the industrial customer sector at the state level;
- $\pm$ 5 to 7% for the agricultural sector at the state level; and
- $\pm$ 2 to 3% for the state as a whole.

4.3. Sample frame and recruitment

The option of getting customer lists from the DNSPs was explored, but could not be used due to privacy considerations. It was also determined during this exploration that the NSW DNSPs do not keep information on the business activity type of their non-residential customers. This meant that even if the DNSPs could provide customer lists, there would be no way to segment those lists into the three non-residential sectors of interest, namely, commercial, industrial and agricultural.

As a result, the decision was made to use external sources of information to develop the sample frames from which residential and business customers would be recruited to complete the VCR questionnaires. The Wallis Consulting Group, who had been selected to undertake the survey field work, provided the lists that were used.

The sample source for the residential surveys was the AMSRO[23] approved Sample Pages listing, which is only available to AMSRO members. This is a high-quality sample source that can provide a degree of geographical tagging (i.e. postcode). Postcode was then used to append distributor and feeder type estimates as described below. These estimates were used to manage the sample to improve telephone dialling efficacy in the residential survey effort. They were also used to manage the distribution of the NMIs collected in the questionnaires to the relevant distributors in order to obtain respondent consumption information.

The sample for non-residential customers was sourced from the Australian Business Database. Because there is no comprehensive listing of business email addresses, initial recruitment was undertaken by telephone, using the telephone numbers that are included in the Database[24]. The sample itself was split into Agriculture, Manufacturing / Industrial, and Commercial / Services to aid sample management, however the final allocation of the response (where obtained) to the relevant non-residential sector was determined by the business' representative's response to the question in the survey regarding the facility's business activity type. The initial telephone recruitment call screened to identify the appropriate person within the organisation to complete the questionnaire (or to serve as the primary contact for doing so)[25].

As with the residential sample, records were also allocated estimated feeder types and distributors, based on postcodes.

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23 Association of Market and Social Research Organisations

24 Consideration was given to using letters as the initial approach in the recruitment process, but this was not possible given the study timeframe.

25 The initial recruitment call sought out the person within the business that would be in the best position to judge the effects that power failures would be likely to have on the business. In practice, that person often had to consult with others to develop monetary damage estimates, particularly in the case of medium to large businesses.

While this method provided a means for recruiting businesses by business type, the fact that the DNSPs do not categorise their non-residential customers by business type meant that it would be very difficult to develop the consumption weights that would be required to develop aggregated VCR values for these sectors. Doing so would require aggregate consumption by business sector by feeder type, DNSP and at the state level. Of those, only the state level figures were felt to be able to be developed within the study timeframe.

In addition, the fact that the DNSPs themselves do not classify their customers in these categories meant that VCR values for those groups – while intuitively interesting – would not be useful in planning or measuring changes in delivered supply reliability.

4.4. Survey delivery method and experience

4.4.1. Original approach and initial revisions

The original approach was to use computer-assisted telephone interviewing (CATI) to complete the questionnaires with residential customers, and email based surveys with business customers. However, in the initial planning stages of the survey it was determined that the available listings of business customers do not include email addresses. As a result, telephone recruitment of these respondents was undertaken, and the decision was made to implement the business questionnaire via a weblink, rather than individual distribution via email.

The following section of the report recounts several problems that were encountered. Following that, how those problems were addressed is discussed and the final samples achieved are presented.

4.4.2. Problems encountered

Implementation of the survey encountered several problems, as described below.

Difficulties in accurate identification of respondent feeder type

Accurate identification of the customer's feeder proved to be very challenging, as truly accurate feeder allocation requires address level targeting. The distributors were very helpful in providing maps of feeders by type, however, because sample lists suitable for survey recruitment can only be drawn geographically to postcode level accuracy[26], a more generalised approach was required.

Based on reviews of the maps provided by the DNSPs, it was ascertained that feeder type generally followed population density, and following this a remoteness classification system[27], as shown in Table 9, was used to determine probable feeder type.

26 Mapping to telephone exchanges was also explored, however this approach is difficult to map. In addition, the fact that phone numbers are now portable requires that the actual geographic location of each customer would need to be verified as part of the recruitment/interview process.

27 Accessibility and Remoteness Index of Australia++ (ARIA++) – Department of Health and Ageing.

Table 9: Remoteness classification system for feeder type identification

Feeder type	Classification
CBD	Postcode 2000
Urban	Remoteness groups 1 to 5
Short rural	Remoteness groups 6 to 11
Long rural	Remoteness groups 12 to 15

However, even this approach proved to be not effective enough for sampling purposes – in particular for long rural feeders. The difficulty is that long rural feeders tend to service the minority of properties in a postcode area and thus are statistically less likely to be sampled or respond to a survey than those on other feeder types. As the actual feeder can only be determined post-hoc, it was not possible to apply manageable quotas by feeder type. For example, more than 21 recruitment attempts were required to achieve each long rural feeder survey – as opposed to the 1 in 4 assumed in the original sample design and cost estimate. All long rural feeder interviews completed in the study were in Essential Energy's territory; it proved impossible to meet the original quotas for 50 long rural feeder surveys to also be undertaken in the Ausgrid and Endeavour Energy service territories.

Incomplete on-line questionnaires from businesses

The on-line business questionnaires suffered from a relatively slow response rate, which was particularly problematic in the present study due to its relatively tight timeframe.

However, even more problematic was the fact that many of the on-line questionnaires that were lodged as having been completed lacked either (or both) the customer's NMI(s) and/or estimation of the damages that the business would incur as a result of supply interruptions of differing lengths. Both of these data are required in order to calculate the customer's value of USE and to serve as an input to the customer's sector, feeder type, DNSP and state-wide VCR calculation.

As a result of the slow response rate to the on-line survey, and the number of incomplete surveys that were lodged, a decision was made to change over to a CATI approach with the business customers. Re-contact was made with customers who had lodged incomplete surveys to try to get them to complete them over the phone; additional business sample was also used to meet the overall response target.

Problems getting and matching NMIs

Significant problems were encountered in getting customers to provide their NMIs in their responses to the questionnaires. NMIs were needed in order to obtain the customer's consumption data which is required in the VCR calculation process.

Difficulties were anticipated in the residential CATI survey and sample bills were obtained and made available to the interviewers so that they could help customers locate the NMI on their bill. Of course, the first difficulty was that the customer did not necessarily have an electricity bill to hand when the interview call was made, which necessitated either the interviewer waiting while the respondent got a recent bill, or the scheduling of a call-back. In a number of cases, the need to have a bill resulted in the customer not proceeding with the interview, either because they simply did not have a bill or did not want to be bothered finding it and completing the questionnaire.

Once the bill was in hand, the interviewer could use the copies of the sample bills that had been obtained to guide the respondent to the NMI. Even with this help, however, some customers could not find their NMIs, and in some cases it appeared that there were some older bill formats being used in which the NMIs did not appear where they were shown as appearing on the sample bills.

Business customers in the on-line survey produced a lower but still material level of non-response to the NMI question, though this was reduced in the CATI approach.

Once the NMIs were received from the respondents they were forwarded to the DNSP assumed to serve the customer (based on postcode). The DNSPs provided the customer's annual consumption and the type of feeder that serves the customer. In this process a few additional problems and solutions were encountered. The two most common were as follow:

- Some numbers that looked like NMIs were not able to be identified as valid NMIs by the initial DNSP. These NMIs were then sent to the other two DNSPs. In some cases this allowed a match, but in some case, no match could be found by any of the DNSPs.

- Some numbers that did not look like NMIs (either customer or meter numbers) were able to be identified by the DNSPs and matched to the customer such that the needed consumption data could be provided.

4.5. Revised approach and final survey completions

Based on the problems described above:

- A second wave of CATI interviews was undertaken with residential customers to ensure that we obtained a sufficient number of NMIs from which to calculate the residential VCRs; and

- The on-line business survey was replaced by a CATI version, as mentioned above.

4.5.1. Residential sector

Table 10 provides information on the results of both waves of the residential survey effort and the final sample achieved for residential customers. As can be seen, the sample can be thought of as two components: all of the customers that completed the questionnaire, and the subset of customers for whom NMIs and annual consumption data could also be obtained. Only the responses from the subset for which consumption data was obtained could be used in the VCR calculation process, and this group is referred to in the remainder of this report as the VCR residential sample. The full set of completed questionnaires (which includes the VCR sample) provides a larger sample of customer responses on all other topics addressed in the questionnaire – such as:

- customers' perceptions of the reliability of their electricity supply;
- their willingness to pay for enhanced electricity supply reliability or willingness to accept a lower level of reliability; and
- their relative preference regarding investments related to the reliability of electricity supply.

Table 10: Details of the larger and VCR residential samples

Sample	State-wide	Ausgrid	Endeavour Energy	Essential Energy
Total larger sample	1,139	415	349	375
VCR sample				
CBD feeders	30	30		
Urban feeders	384	181	167	36
Short rural feeders	274	41	66	167
Long rural feeders	34			34
Total VCR sample	722	252	233	237

4.5.2. Business sector

As noted above, the problems encountered in the business survey – and particularly the large number of on-line surveys that had been lodged with missing damage information – provided a strong argument for a shift to CATI delivery so that the interviewer could (a) encourage the respondent to provide an answer for the damages in each interruption duration, and (b) provide assistance where needed.

Figure 2 indicates that this change in approach was quite successful.

Figure 2: Relative completion rates of on-line vs CATI surveys in the business sector

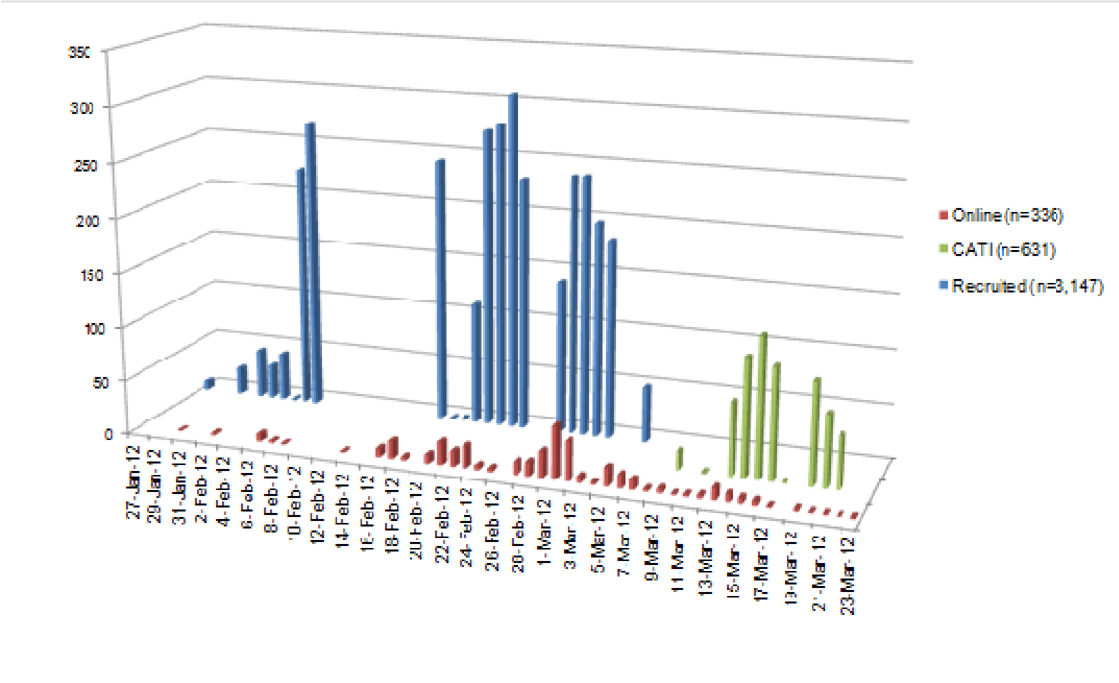


Table 11 presents an overview of the larger and VCR business samples.

Table 11: Details of the larger and VCR business samples

Sample	State-wide	Ausgrid	Endeavour Energy	Essential Energy
Total larger sample	967	277	349	341
Total with NMIs	840	235	306	299
Total with NMI and damage estimates (VCR sample)	589	203	229	157

4.6. Adjustments to the segmentation design

Our ability to produce *DNSP VCRs*, *State / feeder VCRs* and a *State VCR* is constrained by a lack of sufficient observations corresponding to the cells in Table 12 below which outlines the average number (across duration buckets) of usable observations provided by the survey data collected:

Table 12: Usable completed surveys by customer sector, DNSP and feeder type

	Ausgrid				Endeavour Energy			Essential Energy		
	CBD feeders	Urban feeders	Short rural feeders	Long rural feeders	Urban feeders	Short rural feeders	Long rural feeders	Urban feeders	Short rural feeders	Long rural feeders
Residential	30	181	41	0	166	66	0	36	166	34
Business <160 MWhpa	6	127	31	0	145	49	0	34	85	20
Business ≥ 160 MWhpa & < 750 MWhpa	4	14	5	0	13	5	0	5	7	0
Business ≥ 750 MWh	1	8	4	0	5	1	0	3	0	0
Total	41	330	81	0	329	121	0	78	258	54

The low number of observations for both large business (annual energy > 750 MWh) and long rural feeders prevents the production of a full set of VCRs in accordance with the original plan.

Several options for producing state-wide and DNSP-wide VCR estimates were considered, as follows:

- **Retain existing sectoral categories and produce weighted results using only a subset of the required *sector / DNSP VCRs*** – e.g. produce state-wide sectoral VCRs by using the relevant customers within each customer sector and weighting the state-wide VCR by the proportion of total sector consumption in each DNSP. Note that the large business sector would still be characterised by very small samples in every DNSP.

- **Retain existing sectoral and feeder categories and produce weighted results using only a subset of the required sector */ feeder / DNSP VCRs*** – e.g. produce a state-wide long rural VCR by aggregating the Essential Energy residential and small business VCRs weighted by the relevant Essential energy feeder / sector energy.

- **Combine the “short rural feeder” and “long rural feeder” categories to produce a “rural feeder” category** and use the combined energy weights of the short and long rural feeders in each DNSP – This would facilitate the production of a State rural VCR, along with the already available State urban VCR. State rural and State urban VCRs could then be combined with the Ausgrid CBD VCR to produce a State VCR (all feeders).

- **Combine the "short rural feeder" and "long rural feeder" categories to produce a "rural feeder" category plus combine the "medium business" and "large business" sectors** – This would overcome the inability otherwise to produce an Essential Energy "rural feeder" VCR as there are no usable survey responses for "large business" on either "short rural feeders" or "long rural feeders" in the Essential Energy DNSP territory. Such an approach would also boost the low number of usable survey responses for both the "medium business" and "large business" sectors across all DNSPs.

After consideration it was decided that the final option above (i.e., combining the two rural feeders and combining medium and large businesses) provided the best choice, as it would provide results with more statistical reliability than the other options. Table 13 below presents the sample sizes that result from this revision to the survey segmentation in terms of DNSP and feeder type by customer sector. Table 14 shows the same information aggregated at the state level by DNSP and feeder type.

Table 13: Revised segmentation scheme and sample sizes* for aggregating VCR results to DNSP and State levels

	Ausgrid			Endeavour Energy		Essential Energy	
	CBD feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders
Residential	30	181	41	166	66	36	200
Business <160 MWhpa	6	127	31	145	49	34	105
Business ≥ 160 MWhpa	5	22	9	18	6	8	7
Total	**41**	**330**	**81**	**329**	**121**	**78**	**312**

* Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration.

Table 14: VCR sample size* by DNSP and feeder type

Customer sector	Total	DNSP			Feeder Type		
		Ausgrid	Endeavour Energy	Essential Energy	CBD feeders	Urban feeders	Rural feeders
Residential	718	251	232	236	30	383	306
Business <160 MWhpa	497	164	194	139	6	306	185
Business ≥ 160 MWhpa	74	35	24	15	5	47	22
Total	1288	449	450	389	41	735	512

* Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration. Column and row totals may not add exactly due to rounding.

5. Results

This section presents the findings of the analysis of survey results. Section 5.1 describes the characteristics of the residential and business customers that responded to the VCR questionnaire. Section 5.2 provides an overview of customers' perceptions of the reliability of their electricity supply and the times at which interruptions are most inconvenient and/or impose the most monetary damage. This is material because the VCR questionnaire respondents were asked to estimate the level of inconvenience or monetary damage they would incur due to interruptions of different durations to their electricity supply at what they considered the worst time for their household or business.

Sections 5.3 and 5.4 present the results of the VCR calculations themselves for the various customer sectors, feeder types, DNSPs and the state as a whole, as well as the statistical reliability of those results.

Section 5.5 provides a separate analysis of the VCR of low-income households as compared to the remainder of the residential sample.

Section 5.6 provides residential customers' preferences regarding different aspects of electricity supply reliability that could be improved, including:

- a reduction in the number of supply interruptions that occur;
- a reduction in the duration of the supply interruptions that do occur; and
- improved information on how long supply interruptions will last once they occur.

Section 5.7 discusses residential respondents' willingness to pay for increased supply reliability and their willingness to accept lower levels of supply reliability when accompanied by a lower price. It should be noted that these topics were investigated in a very cursory manner and are meant to provide only an indicative check of the consistency of the VCR results with a similar question that also measures the value customers place on the reliability of their electricity supply.

Section 5.8 summarises the findings of the VCR analysis and their implications, and section 5.9 provides thoughts regarding how the VCR method and its implementation could be improved in future studies.

5.1. Characteristics of the sample

This section provides an overview of the characteristics of the sample from which the VCR values were calculated. Section 5.1.1 provides information on the demographics and appliance stock of the residential customers in the sample and section 5.1.2 presents parallel information for the business customers.

5.1.1. Residential sample

Demographics

Tables Table 15 through Table 17 present information on the demographic composition of the VCR sample. As can be seen in Table 15 and Table 16, the education and income levels tend to be highest in the Ausgrid sample and lowest in the Essential Energy service territory, but the sample for each of the DNSPs include a good cross section of both education and income levels.

Table 15: Highest education level achieved by VCR sample group members

DNSP	Respondents	Primary school	High school or equivalent	TAFE	University level	Other
Ausgrid	252	0.3%	25.4%	29.0%	45.2%	1.1%
Endeavour Energy	233	1.3%	30.0%	31.3%	36.5%	0.9%
Essential Energy	237	2.1%	40.5%	30.4%	25.7%	1.3%
Total	722	1.2%	31.4%	30.2%	36.0%	1.1%

Table 16: Household income of VCR sample group members

DNSP	<$25K	$25K - $50K	$51K to $75K	$76- to $100K	$101K to $125K	Over $125K	Would not say
Ausgrid	13.1%	19.0%	14.3%	15.5%	6.3%	21.0%	10.7%
Endeavour Energy	15.0%	20.6%	15.0%	13.7%	9.0%	17.6%	9.0%
Essential Energy	19.8%	30.0%	15.6%	15.2%	6.8%	5.1%	7.6%
Total	15.9%	23.1%	15.0%	14.8%	7.3%	14.7%	9.1%

Table 17 shows that the respondents to the questionnaire were more likely to be female in each of the DNSP sample groups, and the proportion of female respondents was highest in the Essential Energy sample and lowest in the Ausgrid sample. By contrast, household size tended to be lower in the Ausgrid sample and higher in the other samples representing both Essential Energy and Endeavour Energy. However, as with income and education, the samples in each DNSP territory exhibit a good representation across the range of household sizes.

Table 17: Gender and household size of VCR sample group members

DNSP	Gender		Number of people in the household					
	Male	Female	1	2	3	4	5	6+
Ausgrid	46.0%	54.0%	34.1%	32.1%	12.3%	14.3%	5.2%	2.0%
Endeavour Energy	42.5%	57.5%	18.5%	40.3%	16.7%	14.2%	6.0%	4.3%
Essential Energy	34.6%	65.4%	22.4%	47.3%	11.4%	10.1%	6.8%	2.1%
Total	41.1%	58.9%	25.2%	39.8%	13.4%	12.9%	6.0%	2.8%

Appliance stock

Table 18 provides information on the appliance stock of the households in the VCR samples, by DNSP. As can be seen, the penetration of all appliances surveyed was relatively high. None of the appliances was found to be present in less than half of the households represented in the VCR sample. Electric heating exhibited the lowest penetration of any of the appliances surveyed in each of the DNSP territories. Next lowest, reflecting at least in part the state policy prohibiting new installations of electric water heating (unless it is as a back-up to a solar water heating system) was electric water heating, the only exception being the Essential Energy territory where the penetration of air conditioning was just marginally lower than that of electric water heating.

Penetration of air conditioning ranged from just under two-thirds of the homes in the Essential Energy territory to just over 70% in the Ausgrid territory. The penetration of electric cooking was relatively constant across the DNSP samples at just a bit over 80%. The penetration of each of the other appliances surveyed – computers, radio/CDs, TVs and clothes washers – was very high, with all of them over 90% except computers in the Essential Energy territory, where it was just below at 88%.

These results would tend to suggest that residential customers in each of the DNSP territories are likely to face similar levels of inconvenience in terms of the appliances that would not be available for use in the event of a power failure.

Table 18: Appliance stock in households of VCR sample group members

DNSP	Electric cooking	Electric heating	Electric hot water	Air con	Clothes washer	TV	Radio or CD	Computer
Ausgrid	81.3%	63.5%	64.7%	71.4%	100.0%	95.2%	99.2%	94.0%
Endeavour Energy	80.3%	55.8%	61.4%	70.4%	100.0%	100.0%	99.1%	91.8%
Essential Energy	82.3%	50.2%	68.8%	65.8%	100.0%	100.0%	99.2%	88.6%
Total	81.3%	56.6%	65.0%	69.3%	100.0%	98.3%	99.2%	91.6%

By contrast, Table 19 suggests that sample members in the Endeavour Energy and Essential Energy territories are more likely than those in the Ausgrid territory to have alternatives to electricity for some of their household needs. The penetration of non-electric means for lighting, cooking and heating was significantly higher in those DNSP territories, as was the use of photovoltaic systems which can provide an alternative source of electricity during sunny daylight hours for use by any appliance. This distribution of back-up equipment could lead to the Ausgrid sample being more dependent on electricity and therefore potentially exhibiting a higher VCR.

Table 19: Use of back-up equipment in the VCR sample

DNSP	Gas or oil lantern	Portable gas stove or barbecue	Portable LPG or kerosene heater	Back-up power supply for computer	Solar PV panels	None of these
Ausgrid	11.9%	59.1%	9.9%	7.5%	7.9%	34.1%
Endeavour Energy	18.0%	75.1%	12.9%	5.2%	15.5%	18.9%
Essential Energy	18.1%	71.3%	11.4%	8.0%	13.9%	22.8%
Total	15.9%	68.3%	11.4%	6.9%	12.3%	25.5%

5.1.2. Business sample

Business activity type

Table 20 shows the distribution of business activity types in the VCR sample by DNSP territory. As can be seen, manufacturing and retail establishments account for over half of the sample in each of the DNSP territories and state-wide. The majority of the rest of the samples are other types of commercial establishments. Agricultural establishments represented only a very small part of the samples in the Endeavour Energy and Essential Energy territories; and there were no agricultural establishments in the Ausgrid sample.

Table 20: Business activity type of VCR sample, by DNSP

Business activity type	Total (n = 524)	Ausgrid (n = 190)	Endeavour Energy (n = 122)	Essential Energy (n=212)
Agriculture, forestry and fishing	2.1%	0.0%	4.9%	2.4%
Accommodation, cafes and restaurants	3.4%	5.8%	3.3%	1.4%
Communications	0.8%	1.1%	0.8%	0.5%
Construction	1.9%	1.1%	1.6%	2.8%
Cultural and recreational services	1.7%	2.1%	2.5%	0.9%
Education	0.8%	1.1%	0.0%	0.9%
Finance and insurance services	3.2%	3.7%	3.3%	2.8%
Health and community services	1.9%	1.6%	1.6%	2.4%
Manufacturing	30.2%	35.8%	16.4%	33.0%
Mining	1.1%	0.0%	1.6%	1.9%
Personal and other services	5.7%	4.2%	4.1%	8.0%
Property and business services	3.1%	2.6%	1.6%	4.2%
Retail trade	22.7%	17.4%	38.5%	18.4%
Transport and storage	0.4%	0.5%	0.8%	0.0%
Wholesale trade	9.2%	11.6%	4.1%	9.9%
Other	11.8%	11.6%	14.8%	10.4%

Premise type

Table 21 provides information on the types of premises inhabited by the businesses included in the VCR sample. About two thirds of the premises overall are stand-alone buildings of four floors or less. The proportion of this type of premise was even higher – 78.7% in the Endeavour Energy territory. No other premise type accounted for even 7% of the premises in any of the DNSP territories.

Table 21: Premise type of VCR business sample, by DNSP

Business activity type	Total (n = 524)	Ausgrid (n = 190)	Endeavour Energy (n = 122)	Essential Energy (n=212)
Enclosed shopping centre	4.6%	3.7%	2.5%	6.6%
Multi-level office (more than 5 floors)	3.4%	6.8%	0.8%	1.9%
Multi-level retail (more than 5 floors)	0.4%	1.1%		
Multi-level combined office/retail (more than 5 floors)	2.5%	4.7%		1.9%
Stand-alone building of one to four floors	67.9%	65.3%	78.7%	64.2%
Other	21.2%	18.4%	18.0%	25.5%

Use of on-site generation

On-site generation of electricity was reported by a relatively small percentage of the business customers in the VCR sample. As shown in Table 22, the use of on-site generation was most common in the Endeavour Energy territory, where just under 12% of the respondents reported some level of on-site generation. In the other two DNSP territories on-site generation was reported by only about 5% of the sample.

Of the types of on-site generation reported, solar energy systems (presumably photovoltaic systems) were mentioned most frequently.

Table 22: Use of on-site generation by the VCR business sample, by DNSP

Type of on-site generation used	Total (n = 574)	Ausgrid (n = 201)	Endeavour Energy (n = 147)	Essential Energy (n=226)
None	93.9%	94.5%	88.4%	96.9%
Solar	3.7%	2.5%	8.2%	1.8%
Petrol or diesel generator	1.6%	1.0%	2.7%	1.3%
Other	0.2%	0.5%	0.0%	0.0%
Don't know	0.7%	1.5%	0.7%	0.0%

5.2. Experience with power failures

5.2.1. Perceptions of reliability of supply

Both residential and business respondents were asked the following question:

Using a scale of 1 to 10 where 1 is totally unreliable and 10 is totally reliable, how reliable do you think your power supply is?

Figure 3 presents the results for all business and residential customers who responded to the survey, not just those included in the VCR sample. The larger sample is considered useful for discussion of these results as they provide a wider view of the perceptions of the state's electricity consumers.

Results indicate that both types of customers view their electricity supply as being quite reliable. 86% of the residential respondents gave scores of 8 or higher, and similarly high scores were given by 78% of the business respondents.

Figure 3: Perceptions of supply reliability – all respondents

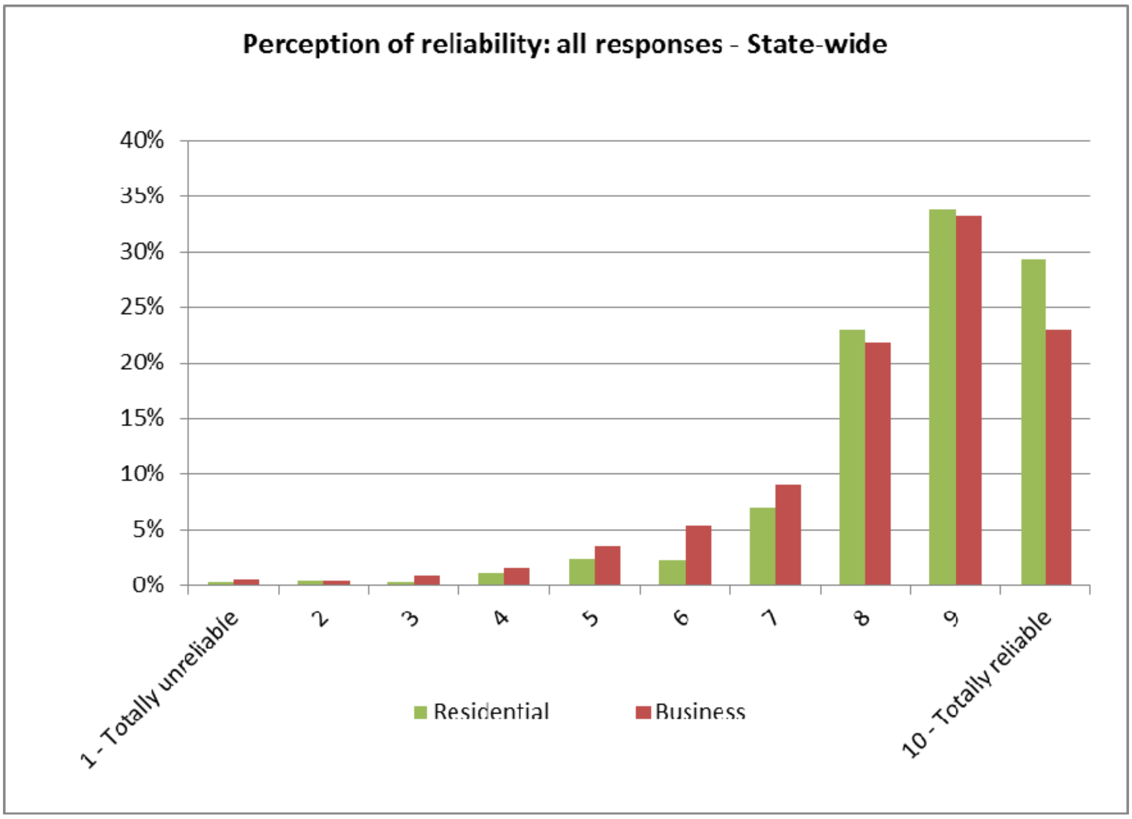


Figure 4 and Figure 5 provide similar information for residential and business customers respectively by DNSP. Results indicate that the perceptions of both types of customers are relatively high for each of the DNSPs. One difference in the patterns is seen in the views of Ausgrid's residential customers. The largest percentage of these customers gave Ausgrid a perfect score of ten – totally reliable. The most common score given by the residential customers of the other DNSPs and the business customers of all three of the DNSPs was nine.

These results indicate that customers are likely to be relatively satisfied with the level or supply reliability they currently receive from their DNSP.

Figure 4: Perceptions of supply reliability – residential respondents by DNSP

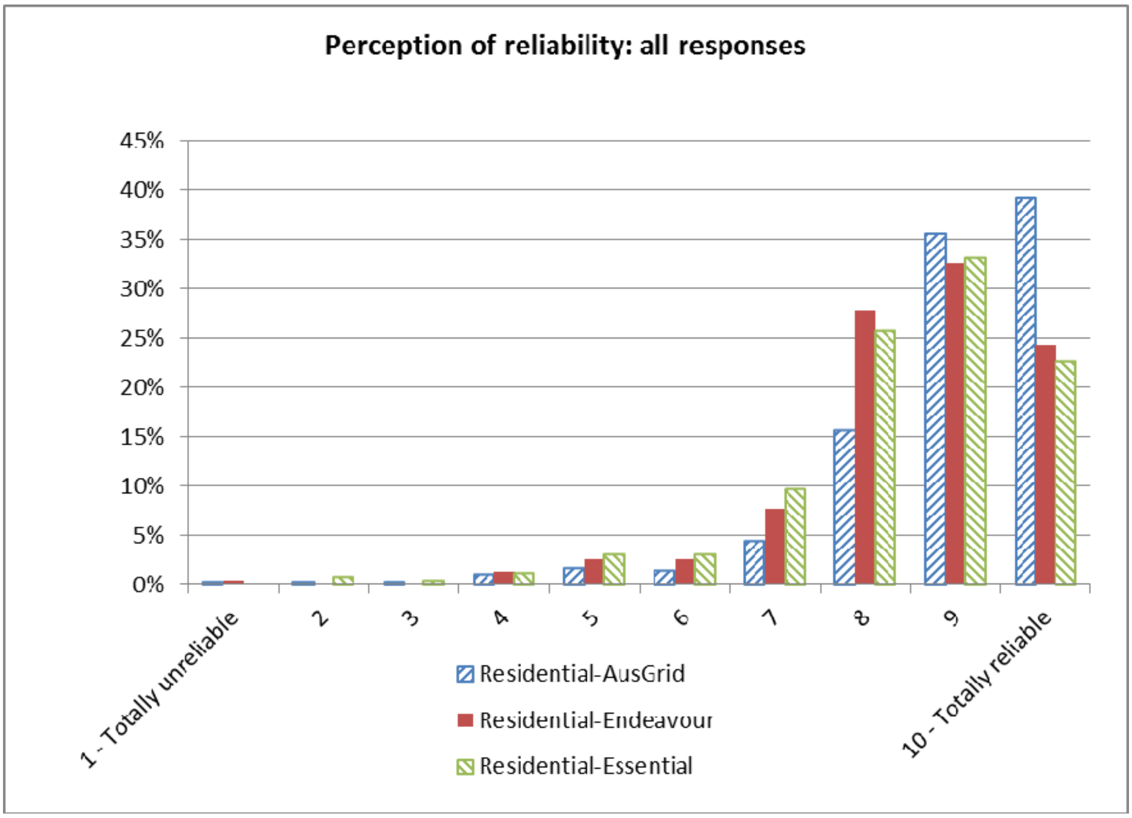


Figure 5: Perceptions of supply reliability – business residential respondents by DNSP

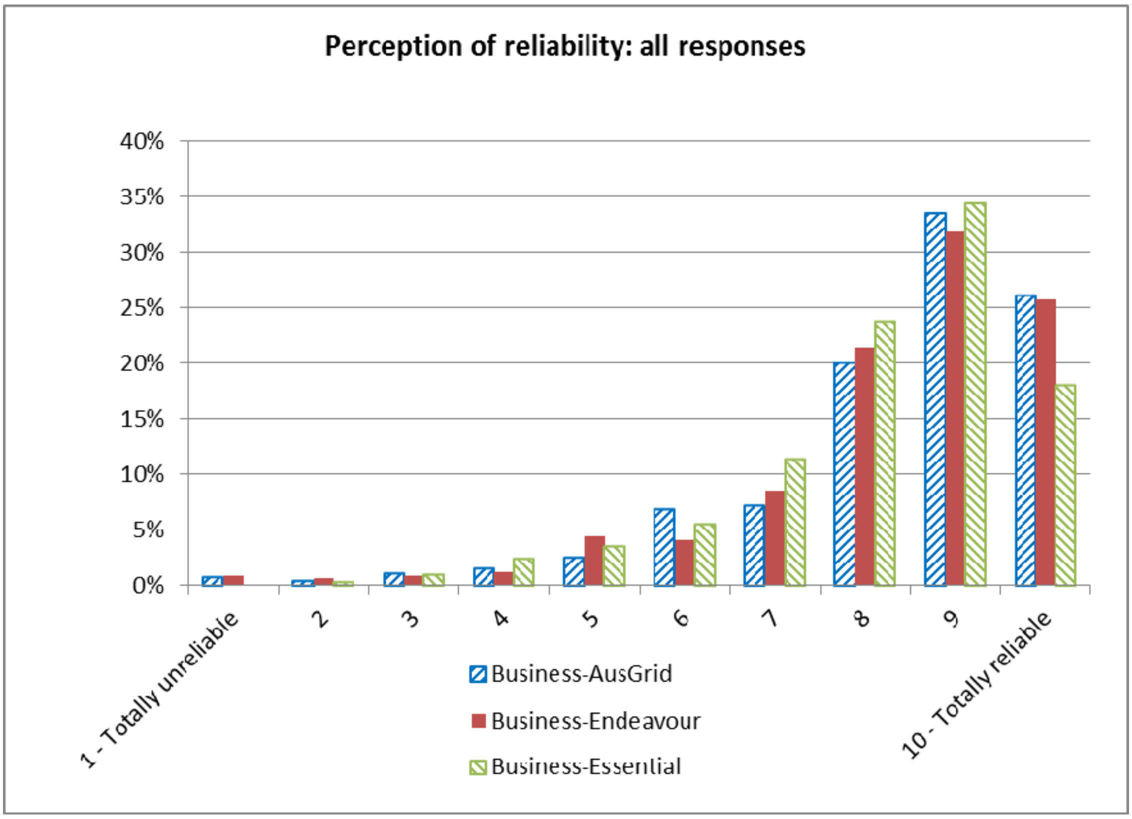


Figure 6 and Figure 7 display the perceptions of reliability of residential and business customers respectively, by feeder type.

Results here also indicate a relatively high level of satisfaction for all feeder types, but it is clear that satisfaction is higher for residential customers than for business customers and highest for CDB feeders. The fact that CBD customers tend to rate the reliability of their supply higher relative to those on other feeder types may reflect the higher reliability standards that apply in the CBD area. However, it should also be noted that the relatively smaller sample size (41) for CBD feeder customers means that results for this sector must be treated with a high degree of caution.

Figure 6: Perceptions of supply reliability – residential respondents by feeder type

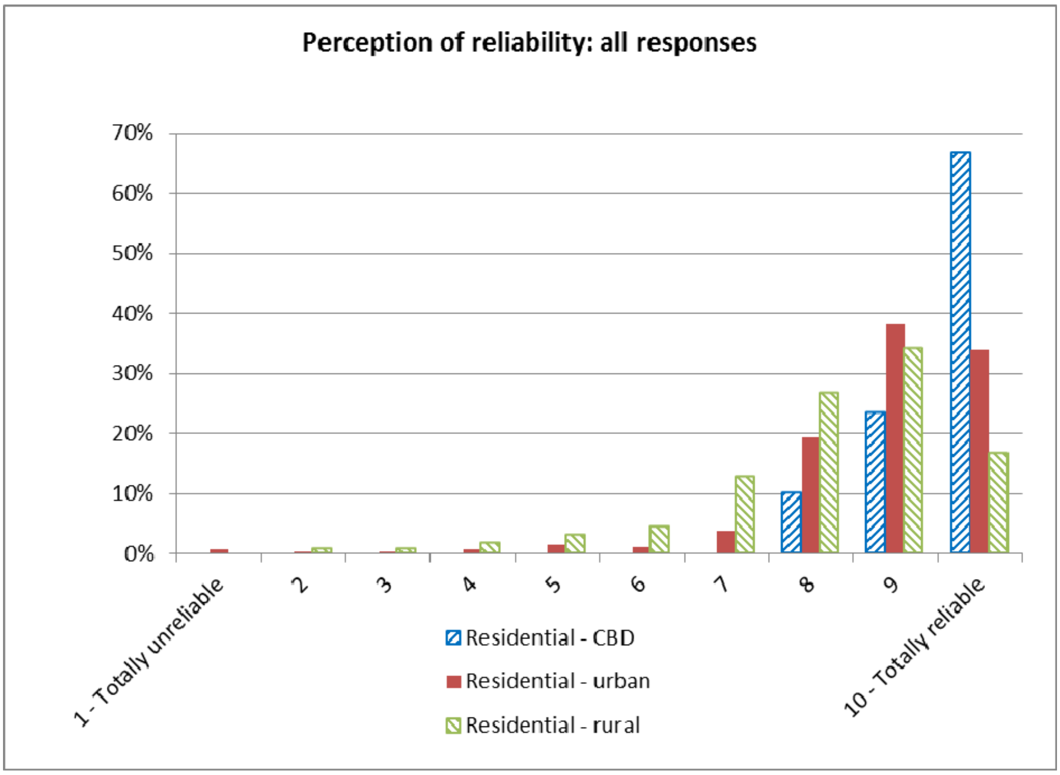
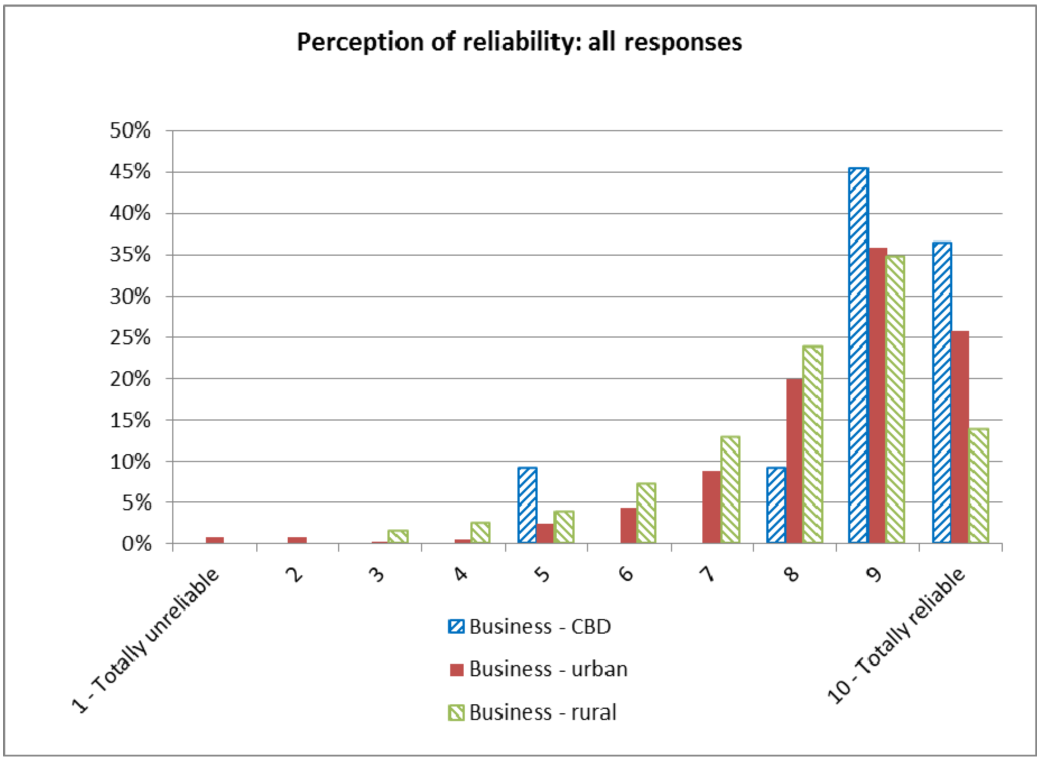


Figure 7: Perceptions of supply reliability – business respondents by feeder type



5.2.2. Views on the worst time for power failures to occur

Both residential and business respondents were asked to specify the worst time for them to experience a power failure in terms of season of the year, day of the week and time of day. This was done to get the respondent thinking in specific terms about the inconvenience or damage he or she would experience as a result of a power failure in order to provide better, more considered estimates of the mitigation actions that might be taken or the costs incurred. However, the results also provide very useful information about when reliability is of most concern to customers.

Table 23 shows that while winter tends to be worst season for supply interruptions for residential customers, with almost half citing it, supply interruptions in the summer were deemed to be the most inconvenient by a relatively large percentage of these customers – just under another third. These results are not surprising given the importance of space conditioning to residential customers.

By contrast, the majority of business respondents (53.7%) reported that the damage they incur due to power outages does not vary significantly by season. However, a sizeable proportion – 28.9% -- cited summer as the worst time to suffer a power failure.

Table 23: Worst season of the year for supply interruptions

Sector	Number of respondents	Summer	Winter	Spring/Autumn	No season worse than any other
Residential	1,139	31.4%	48.1%	0.5%	19.9%
Business	967	28.9%	8.2%	9.3%	53.7%

Table 24 and Table 25 present information on the day of the week that residential and business respondents felt would be the worst time for supply interruptions to occur. Responses show that the day of the week does not make a great deal of difference in terms of the inconvenience experienced by residential customers due to supply interruptions, but there is a clear and not surprising view among business customers that supply interruptions occurring during the week are the most damaging to businesses.

Table 24: Worst day of the week for supply interruptions – residential respondents, by season

Day of the week	Summer	Winter	Spring/Autumn	No season worse than any other
Monday – Friday	16.8%	24.6%	16.7%	18.1%
Saturday/Sunday	27.4%	18.2%	33.3%	7.5%
No day is worse than any other	55.9%	57.1%	50.0%	74.4%

Table 25: Worst day of the week for supply interruptions – business respondents, by season

Day of the week	Summer	Winter	Spring/Autumn	No season worse than any other
Monday - Friday	46.6%	68.4%	64.4%	63.4%
Saturday/Sunday	16.8%	6.3%	4.4%	4.6%
No day is worse than any other	36.6%	25.3%	3.3%	32.0%

Table 26 and Table 27 provide information on the time of day that residential and business respondents reported as being the worst time to experience a power failure across all seasons and the season they had identified as being the worst for them.

As can be seen in Table 26, residential customers overwhelmingly find the period from 6PM to 9PM as the most disruptive regardless of season. This is not surprising given that these hours encompass the dinner hour and family entertainment and homework times. Interestingly, the 6AM to 9AM hours when family members are presumably getting ready for work and school was chosen as the most inconvenient time by fewer respondents than either the 6PM to 9PM time period and the 3PM to 6PM time period.

Table 26: Worst time of day for supply interruptions – residential respondents

Season	6am to 9am	9am to 3pm	3pm to 6pm	6pm to 9pm	9pm to 6am	No time of day worse than any other
All days, all seasons	10.3%	7.6%	14.2%	54.7%	4.5%	8.7%
All days, winter	11.5%	4.7%	15.7%	59.9%	4.2%	4.0%
All days, summer	8.1%	13.7%	17.3%	48.6%	3.4%	8.9%

* Residential respondents were asked to nominate the single most inconvenient period of day for loss of supply.

Table 27 shows parallel information for businesses that responded to the questionnaire. As can be seen, standard business hours (i.e., 9AM to 6PM) were deemed by business respondents to be the most inconvenient times for supply interruptions, regardless of season. However, a material percentage of business respondents also cited the hours of 6AM to 9AM as being problematic.

Table 27: Worst time of day for supply interruptions – business respondents

Season	6am - 9am	9am - noon	Noon -3pm	3pm - 6pm	6pm - 9pm	9pm - midnite	Midnite - 6am	No time of day worse than any other
All days, all seasons	23.0%	50.4%	40.2%	33.5%	7.8%	2.8%	3.1%	27.6%
All days, summer	19.7%	48.7%	44.8%	34.4%	12.5%	2.2%	3.9%	19.7%

* Business respondents could nominate multiple periods through the day when loss of supply was highly inconvenient. This results in the sum of the percentage of business respondents selecting difference time periods exceeding 100%.

5.3. Value of customer reliability

All the VCR measures reported and discussed in the following Sections 5.3.1 and 5.3.2 are derived from the 21 component VCRs as outlined Table 28 as weighted averages across combinations of the rows and columns of Table 28 – see the discussion on “Methodology” in Section 3.2.

Table 28: Components of all aggregated VCR measures

	Ausgrid			Endeavour Energy		Essential Energy	
	CBD feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders
Residential	✓	✓	✓	✓	✓	✓	✓
Business <160 MWhpa	✓	✓	✓	✓	✓	✓	✓
Business ≥ 160 MWhpa	✓	✓	✓	✓	✓	✓	✓

We believe there is sufficient data to deliver reasonably reliable estimates of VCR for the residential and small business customer sectors:

- at an overall state-wide level – that is, aggregated across all DNSPs and feeder types;
- by feeder type state-wide[28] – for example, the state-wide urban feeder VCR would be a weighted average of the urban feeder VCR in each of the Ausgrid, Endeavour Energy and Essential Energy DNSP territories; and

28 Except for CBD feeders.

- by DNSP for all feeder types - for example, the Endeavour Energy VCR would be a weighted average of the urban feeder and rural feeder VCRs in the Endeavour Energy DNSP territory.

The estimate of VCR for larger business needs to be treated with some caution at level of anything less than state-wide given the sample sizes involved.

Although VCRs are reported at a disaggregated level for all DNSPs, customer sectors and feeder types, smaller sample sizes on which individual VCRs are based means that less confidence is able to be placed in the accuracy of some measures. For a discussion on (sub-)sample sizes and the statistical variance of VCR estimates, see Section 5.4.

5.3.1. State level values of customer reliability

The estimated state-wide values of customer reliability across customer sectors and feeder types is shown in Table 29.

Table 29: State-wide VCRs by sector and feeder type ($/kWh)

Customer sector	All feeders	CBD feeders	Urban feeders	Rural feeders
Residential	$20.71	$32.27	$23.05	$15.11
Business <160 MWhpa	$413.12	$295.87*	$452.12	$302.49
Business ≥ 160 MWhpa	$53.30	$80.54*	$29.96	$128.50*
Total	**$94.99**	**$120.52**	**$93.88**	**$93.86**

* The VCR quoted here is based on a sample size of 30 observations or less. Values provided for illustrative purposes and should be used with caution.

The state-wide average VCR, across all feeder types and all DNSP territories, is estimated to be $94.99 per kWh.

Aggregating across all feeder types by customer sector, small business (<160 MWhpa) has the highest VCR and residential customers the lowest VCR.

It is not possible to determine from the results of the VCR surveys why the results differ as much as they do between sectors or why the various sectors place such apparently different values on the reliability of their electricity supply. In this regard, however, it is important to note that the VCR is defined in terms of the value of each kWh that the customer does not receive. Because customers' usage varies significantly, a customer with a lower VCR may still experience higher costs than another customer with a higher VCR but lower consumption level in any given power interruption.

Consider, for example three customers: a residential customer that consumes 6 MWhpa, and two business customers, one that consumes 100 MWhpa and another that consumes 1,000 MWhpa. Table 30 shows the cost each would incur due to a one-hour supply interruption, based on their respective VCR values.

Table 30: Total cost incurred by different customer sectors due to a 1 hour supply interruption

Type of customer	Annual consumption (MWhpa)	Consumption in an hour (kWh)	VCR ($/kWh)	Cost of a 1 hour outage ($)
Residential	6	0.68	$20.71	$14
Small business	100	11.42	$413.12	$4,716
Large business	1000	114.16	$53.30	$6,084

Even so, the VCR for small business (state-wide $413.12 per kWh) is very much higher than those of the other sectors and significantly higher than the VCR found for similar customers in previous VCR surveys (as is discussed further in Section 5.8). The high value within this sector may reflect the reliance of such businesses on electronic forms of commerce. For example, if the electricity supply were interrupted at the worst possible time (which is when respondents were asked to consider the costs they would incur due to a power failure), say across the lunch-time period in an urban commercial centre:

- cafes and restaurants might not be able to operate at all; and
- retailers would probably be unable to operate cash registers or process eftpos transactions.

In these circumstances, such businesses could lose a substantial proportion of the value of their normal day's trade and we could expect a relatively high VCR.

By contrast, larger businesses (≥ 160 MWhpa) who are more energy intensive in their operations:

- are more likely to have more even values of activity through a day and are less susceptible to "peak value" interruptions; and
- have more energy per dollar of output embedded in their product and thus place a lower value per kWh on their product.

The estimate of the VCR for larger businesses (state-wide $53.30 per kWh) needs to be treated with some caution, however. Due to the relatively small number of responses received from this customer sector (74) we cannot be certain we have captured responses from a sufficiently representative sample of larger businesses.

For households, interruption to electricity supply more likely represents an inconvenience and largely deferred or totally foregone electricity consumption. Hence the VCR for the residential sector might be expected to be lower than that for businesses.

In examining the sectoral VCRs by feeder type, care needs to be taken given the sizes of the samples involved in some key categories – specifically, CBD feeders for all customer sectors and rural feeders for larger business. Taking account of the estimates based on small sample sizes we can tentatively conclude that the VCR for all customer sectors tends to be higher on CBD and urban feeders, possibly because these customers have become used to higher levels of electricity reliability (SAIFI)[29] and become more dependent on reliable supply.

5.3.2. DNSP values of customer reliability

Our DNSP territory specific estimates of the VCR by customer sector, as compared to the corresponding state-wide estimates, are outlined in Table 31.

Table 31: VCRs by DNSP and sector ($/kWh)

Customer sector	State-wide	AugGrid	Endeavour Energy	Essential Energy
Residential	$20.71	$22.77	$19.75	$17.82
Business <160 MWhpa	$413.12	$408.48	$563.46	$202.82
Business ≥ 160 MWhpa	$53.30	$34.83	$33.99*	$130.57*
Total	**$94.99**	**$86.79**	**$110.71**	**$90.71**

* The VCR quoted here is based on a sample size of 30 observations or less. Values provided for illustrative purposes and should be used with caution.

Our DNSP territory specific estimates of the VCR by customer sector and by feeder type are outlined in Table 32, Table 33 and Table 34.

Table 32: Ausgrid VCRs by sector and feeder type ($/kWh)

Customer sector	All feeders	CBD feeders	Urban feeders	Rural feeders
Residential	$22.77	$32.27	$24.79	$11.46
Business <160 MWhpa	$408.48	$295.87*	$434.60	$313.87
Business ≥ 160 MWhpa	$34.83	$80.54*	$25.72*	$35.64*
Total	**$86.79**	**$120.52**	**$87.14**	**$56.69**

* The VCR quoted here is based on a sample size of 30 observations or less. Values provided for illustrative purposes and should be used with caution

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29 On the basis of information supplied by DNSPs, customers on CBD feeders experience 0.06 interruptions per GWh; customers on urban feeders 1.00 interruptions per GWh; and customers on rural feeders 8.33 interruptions per GWh.

Table 33: Endeavour Energy VCRs by sector and feeder type ($/kWh)

Customer sector	All feeders	Urban feeders	Rural feeders
Residential	$19.75	$20.41	$16.08
Business <160 MWhpa	$563.46	$570.29	$501.77
Business ≥ 160 MWhpa	$33.99*	$36.71*	$11.06*
Total	**$110.71**	**$115.65**	**$75.36**

* The VCR quoted here is based on a sample size of 30 observations or less. Values provided for illustrative purposes and should be used with caution.

Table 34: Essential Energy VCRs by sector and feeder type ($/kWh)

Customer sector	All feeders	Urban feeders	Rural feeders
Residential	$17.82	$22.51	$16.34
Business <160 MWhpa	$202.82	$122.41	$251.88
Business ≥ 160 MWhpa	$130.57*	$24.75*	$183.61*
Total	**$90.71**	**$42.69**	**$111.08**

* The VCR quoted here is based on a sample size of 30 observations or less. Values provided for illustrative purposes and should be used with caution.

5.4. Statistical reliability of VCR results

In order to provide some indication of the likely accuracy of the estimate of the VCR, we can examine the standard error of the mean of the estimate of a VCR. The standard error of the mean (SEM) is a measure of how far a sample mean is likely to be from the true population mean.

Use of the SEM with regard to the analysis undertaken here assumes:

- the population of values of the economic damage (or costs of mitigating actions) per kWh of USE for each customer sector is normally distributed;[30] and
- the sample on which the VCR estimate is based is representative[31] of the population.

30 The population, in this sense, refers to the value of USE per kWh from every possible relevant business or household, not just those that have been surveyed. In probability theory, the "normal distribution" is a continuous probability distribution that has a bell-shaped probability density function, informally known as the bell curve. A normal distribution is often used as a first approximation to describe random variables that cluster around a single mean value. [Description paraphrased from Wikipedia.]

31 To be "representative" of a population, a sample needs to be both random and sufficiently large.

Subject to the above conditions being met, then, in general terms:

There is a 95% chance that the true VCR for any population lies within a range defined by "±1.96 x standard error" of the estimated VCR of that population.

This is usually termed the **95% confidence interval**.

A characteristic of such analysis is that as the sample from which the estimate of the VCR is drawn falls substantially below 30, the 95% confidence interval grows wider[32] – for example, for a sample of 10 observations:

There is a 95% chance that the true VCR for any population lies within a range defined by "±2.26 x standard error" of the estimated VCR of that population.

Table 35 to Table 38 outline weighted average VCRs and the standard errors (and the sample sizes on which they are based) for each customer sector:

- by feeder type state-wide (columns [B], [C] and [D] in Table 35) – a weighted average of the VCRs across all DNSP territories for a single feeder type;
- by DNSP territory overall (columns [F], [G] and [H] in Table 37) - a weighted average of the VCRs across all feeder types in a single DNSP territory; and
- state-wide overall (column [A] in Table 35, or columns [E] in Table 37) - a weighted average of the VCRs across all feeder types and across all DNSP territories.

Table 35: State-wide VCRs and standard errors by feeder type ($/kWh)

Customer sector	All feeders [A]		CBD feeders [B]		Urban feeders [C]		Rural feeders [D]	
	VCR ($/kWh)	Std error ($/kWh)	VCR ($/kWh)	Std error ($/kWh)	VCR ($/kWh)	Std error ($/kWh)	VCR ($/kWh)	Std error ($/kWh)
Residential	$20.71	$1.08	$32.27	$5.89	$23.05	$1.47	$15.11	$1.08
Business <160 MWhpa	$413.12	$26.93	$295.87	$84.43	$452.12	$34.64	$302.49	$32.84
Business ≥ 160 MWhpa	$53.30	$9.60	$80.54	$41.78	$29.96	$7.36	$128.50	$36.90
Total	**$94.99**	**$5.91**	**$120.52**	**$36.37**	**$93.88**	**$6.40**	**$93.86**	**$14.08**

32 Based on the "t-distribution" rather than the normal distribution.

Table 36: Sample sizes involved in state-wide VCR estimates (no. of usable survey responses)

	All feeders	CBD feeders	Urban feeders	Rural feeders
Residential	718	30	383	306
Business <160 MWhpa	497	6	306	185
Business ≥ 160 MWhpa	74	5	47	22
Total	**1,288**	**41**	**735**	**512**

* Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration. Column and row totals may not add exactly due to rounding.

Table 37: State-wide VCRs and standard errors by DNSP Territory ($/kWh)

Customer sector	State-wide [E]		Ausgrid [F]		Endeavour Energy [G]		Essential Energy [H]	
	VCR ($/kWh)	Std error ($/kWh)	VCR ($/kWh)	Std error ($/kWh)	VCR ($/kWh)	Std error ($/kWh)	VCR ($/kWh)	Std error ($/kWh)
Residential	$20.71	$1.08	$22.77	$1.88	$19.75	$1.68	$17.82	$1.56
Business <160 MWhpa	$413.12	$26.93	$408.48	$45.97	$563.46	$47.46	$202.82	$25.59
Business ≥ 160 MWhpa	$53.30	$9.60	$34.83	$11.02	$33.99	$9.80	$130.57	$37.46
Total	**$94.99**	**$5.91**	**$86.79**	**$8.57**	**$110.71**	**$8.65**	**$90.71**	**$15.44**

Table 38: Sample sizes* involved in state-wide VCR estimates (no. of usable survey responses)

	State-wide	Ausgrid	Endeavour Energy	Essential Energy
Residential	718	251	232	236
Business <160 MWhpa	497	164	194	139
Business ≥ 160 MWhpa	74	35	24	15
Total	**1,288**	**449**	**450**	**389**

* Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration. Column and row totals may not add exactly due to rounding.

These tables demonstrate that the larger is the sample on which the VCR estimate is based:

- the smaller (as a proportion of the VCR estimate) the standard error is likely to be; and
- the more confident we can be in the accuracy of the estimate of the VCR.

The interpretation we can give to the final row of column [A] in Table 35 is that if we were to undertake repeated random sampling of NSW businesses and households using samples of similar size to that of our actual survey, then we would expected 95 out of 100 surveys to produce a state-wide average VCR in a range between $83.42 / kWh and $106.57 / kWh.[33]

Relative standard errors (that is, standard error as a percentage of the estimate of the relevant VCR) are detailed in Appendix E.

5.5. Low income perspective

In estimating a VCR for "low income" households we stratified the sample to include only those respondents whose annual household income was $50,000 or less **and** who were in paid the Energy Concession Rate on their bill In total, 181 (25.2%) of the 718 residential respondents for whom information was available to calculate a VCR met this definition of low income[34].

As can be seen in Table 39 below, the VCR for low income households is almost 25 per cent lower than the VCR for all residential households in NSW[35]. It also shows that the VCR for low income households on urban feeders is slightly higher than the VCR for low income households on rural feeders. This pattern is consistent with the average residential VCR results for urban and rural feeders discussed above.

Table 39: Residential VCRs, std errors and sample sizes – overall vs low income ($/kWh)

	State-wide all residential	State-wide* low income	Urban feeders low income	Rural feeders low income
VCR	$20.71	$15.62	$16.27	$14.02
Standard error	$1.08	$1.58	$2.63	$1.83
Sample size**	718	181	83	94

* Not weighted by feeder type or DNSP representation in the total. There are too few observations to separately report a low income VCR for CBD feeders, although the CBD observations available were used in calculating the overall state-wide low income VCR.
** Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration.

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33 $83.42 = $94.99 - (1.96 * $5.91); and $106.57 = $94.99 + (1.96 * $5.91)

34 Because not all respondents provided mitigation costs for every interruption duration, the average sample size on which the VCR was based is lower than the total number of respondents for whom some mitigation cost information was provided

35 Note that the VCR for all residential households includes low income households, so the difference between low income and non-low income is actually greater than 25 per cent.

The fact that low income customers have a lower VCR than other customers should not necessarily be interpreted to mean that low income households place a lower value on reliability than do other customers. It may also mean that, due their lower incomes and reduced lower ability to make discretionary purchases, they have selected fewer or lower-cost actions in the questionnaire as those they would take to mitigate the impact of interruptions to their electricity supply.

The questionnaire provided residential respondents with the option of doing nothing in response to an outage[36]. Table 40 compares the proportion of low income respondents who indicated that they would "do nothing" with the proportion of the other (i.e., non-low income) respondents who indicated that they would "do nothing"

Table 40: Proportion of respondents likely to “do nothing” in face of an outage

	5 mins to 1 hour	1 hour to 4 hours	4 hours to 8 hours	8 hours to 24 hours
Household income ≤ $50k pa and concession	53%	43%	30%	18%
Household income > $50k pa and NO concession	55%	29%	9%	6%

As can be seen, the proportion of customers who indicated they would do nothing for short outages of one hour or less is similar for low income households and all other households. This is not surprising as a short outage would be likely to have only limited impacts on most households, and as a result most households are likely to be able to deal with such an outage without needing to take any mitigation actions.

However, for longer outages, low income households are significantly more likely to do nothing in response to an outage compared to other households. For outage durations of four to eight hours and eight to 24 hours, the questionnaire responses indicate that low income households are three times more likely to do nothing than other households. This suggests that low income households do have a more limited ability to deal with outages than other households.

This suggests that the lower income of these households may make them less likely to spend money to mitigate the cost of outages. That fact (if true) might mean that the VCR for these customers underestimates the inconvenience caused by outages, as they simply endure the inconvenience while the higher income of other customers makes them more likely to say they would take actions in response to an outage, which results in them having a higher apparent VCR. So, while lower income customers may be less willing to take actions (or indeed less willing to pay for reliability improvements) it does not mean that they do not experience the same level of inconvenience. In fact, to the extent that they take fewer mitigation actions due to their income constraints they may in fact experience more inconvenience than non-low income households that do take mitigation actions.

36 Such a response results in the customer have a zero VCR for the supply interruption duration for which no action would be taken

5.6. Customer preferences regarding investments to improve reliability (residential customers only)

Residential customers were asked the following question:

Electricity networks can invest money in infrastructure and systems to reduce how often power failures happen and how long they last. They can also invest in systems that can tell customers about how long the power is likely to be out when a failure does occur. The amount of money they spend on this infrastructure would affect your electricity bill.

If the utility was going to invest money in one of those approaches, which would you want them to pursue?

___ *Infrastructure to reduce the number of power failures that occur*

___ *Systems to reduce how long outages last when they do occur*

___ *Communications systems telling you how long an outage is likely to last*[37]

As shown in Table 41, the majority of customers – just under 60% - prefer investing in infrastructure that would reduce the frequency of supply interruptions. Preferences were relatively evenly split between the other two options with investments in communications systems that would let customers know how long an outage would last being slightly more preferred to investments in systems that would reduce how long outages last.

Table 41: Customer preferences for reliability related investments

Investment option	Percentage of customers preferring
Infrastructure to reduce the number of power failures that occur	59.0%
Systems to reduce how long outages last when they do occur	16.8%
Communications systems telling you how long an outage is likely to last	24.2%
Number responding	1,139

As shown in Table 42 and Table 43 this order and relative level of preference was consistent across each of the DNSPs and feeder type.

37 Answer choices were rotated so that they were not presented in the same order to each respondent.

Table 42: Customer preferences for reliability related investments by DNSP

Investment option	Percentage preferring by DNSP		
	Ausgrid	Endeavour Energy	Essential Energy
Infrastructure to reduce the number of power failures that occur	61.4%	57.8%	57.7%
Systems to reduce how long outages last when they do occur	16.9%	17.0%	16.2%
Communications systems telling you how long an outage is likely to last	22.0%	25.2%	26.2%
Number responding	414	464	260

Table 43: Customer preferences for reliability related investments by feeder type

Investment option	Percentage preferring by feeder type		
	CBD (Ausgrid only)	Urban	Rural
Infrastructure to reduce the number of power failures that occur	56.7%	62.2%	55.2%
Systems to reduce how long outages last when they do occur	13.3%	17.7%	16.9%
Communications systems telling you how long an outage is likely to last	30.0%	20.1%	27.9%
Number responding	30	384	308

As shown in Table 44, however, preferences by income are somewhat different, with lower income customers exhibiting a higher relative preference than higher income customers for communications systems that would let customers know how long an outage would last, and a lower relative preference for infrastructure improvements that would reduce the number of outages.

Table 44: Customer preferences for reliability related investments by income level

Investment option	Percentage preferring by income					
	Less than $25K	$25 to $50K	$51 to $75K	$76 to $100K	$101 to $125K	Over $125K
Infrastructure to reduce the number of power failures that occur	46.9%	56.7%	61.9%	64.1%	53.7%	67.7%
Systems to reduce how long outages last when they do occur	15.3%	15.0%	17.3%	16.9%	24.4%	17.2%
Communications systems telling you how long an outage is likely to last	37.9%	28.3%	20.8%	19.0%	22.0%	15.1%
Number responding[38]	177	240	168	142	82	192

5.7. Customers' willingness to pay for increased reliability and willingness to accept reduced reliability

The MCE's terms of reference to the AEMC requested that customers' "willingness to pay . . . for a range of reliability outcomes" be estimated.

This is a somewhat different question to the question posed in the calculation of the VCR, and there is a well-developed body of literature regarding methodological approaches for addressing customers' willingness to pay (WTP) for different attributes and features of products and services. One part of the approach that is generally accepted is to test customers' willingness to accept (WTA) a lower level of service as well as to pay for a higher level of service.

Application of a battery of questions that would address customers' willingness to pay for increased reliability and/or accept a lower level of reliability could not be feasibly developed and tested in the time available for the AEMC's review. In addition, a questionnaire that combined a robust battery of WTP/WTA questions with the question required by the VCR methodology would have been excessively long. Therefore, a simplified battery of questions was developed to address these issues and approximately half of the residential sample was asked the willingness to pay questions and the other half was asked the willingness to accept questions. Sections 5.7.1 and 5.7.2 below report customers' responses to those questions. Given the cursory level of questioning on these matters, however, the results should be seen as indicative rather than definitive.

38 66 respondents did not report their household income.

5.7.1. Willingness to pay (WTP) for increased reliability

To address customers' willingness to pay for increased electricity supply reliability half of the residential respondents, selected randomly, were asked the following question:

Let's suppose that the electricity company could reduce both the number of power outages and their length if they invested money in infrastructure, but you would need to pay more on your electricity bill.

Would you be willing to pay $XX more per year on your bill to reduce the total time your power would be out due to power failures by 60 minutes per year? [Note: $XX for each respondent is calculated as 1% of the midpoint of the bill range they select in Q 11].

The amount of the bill increase posed to each respondent – the amount mentioned as the $XX value in the question above – was calculated to approximate 1% of the respondent's annual electricity bill. This was done by using the midpoint of the range of bill size that the respondent had selected as best representing the amount they paid annually for electricity.

Respondents could answer "yes", "no" or "don't know / maybe". Those who answered "yes" were then asked:

Would you be willing to pay more than that?

If they also answered "yes" to that question they were then asked:

How much more would you be prepared to pay?

___ [2 x $XX]

___ More than [2x $XX]

___ More than [$XX] but less than [2 x $XX]

___ None of the above (Do not read)

Table 45 below shows the responses received to these questions. It should be noted that the responses in Table 45 represent all customers who answered the WTP question regardless of whether we received consumption information for them and were therefore able to include them in the VCR calculation. This provided a larger sample, and thereby increased statistical reliability, for the calculation of customers' WTP. As shown in Table 45 below, a total of 541 respondents were asked the WTP questions.

Table 45: Customers' willingness to pay for supply interruption to be reduced by 60 minutes over the course of a year

Per cent of customers who reported they would be willing to pay:	% of customers (base = 541)
At least 1% more to reduce the total time their power would be out due to power failures by 60 minutes per year	60.8%
Of those, per cent that reported they would be willing to pay:	
1% more	29.0%
between 1% and 2% extra	7.4%
2% more	7.4%
more than 2% extra	15.0%
could not quantify	2.0%

As can be seen, just over 60% of those asked would be willing to pay at least 1% more on their electricity bills to reduce the amount of time their electricity supply was interrupted by 60 minutes over the course of a year.

5.7.2. Willingness to accept (WTA) a lower level of reliability

The other half (approximately) of the residential respondents were asked a similar question, but focussed on their willingness to accept more time in which their electricity supply would be interrupted in exchange for a reduction in their annual bill. The specific questions these respondents were asked were as follows:

Let's suppose that the electricity company didn't invest money in infrastructure and your power could be out for up to 60 minutes more per year. However your annual electricity bill would fall.

Would you be prepared to have additional power outages of up to 60 minutes more per year if your annual bill was $XX[39] *lower than it is now?*

Respondents could answer "yes", "no" or "don't know / maybe". Those who answered "no" were then asked:

How much more would your bill have to be reduced by for you to accept additional power failures of up to 60 minutes more a year?

___ [1.5 times $XX]

___ [2 times $XX]

39 The amount of the bill decrease posed to each respondent was calculated to approximate 1% of the respondent's annual electricity bill. This was done by using the midpoint of the range of bill size that the respondent had selected as best approximating the amount of his/her annual bill.

___ More than [2 times $XX]

___ None of the above (Do not read)

Table 46 below shows the responses received to these questions. As in the case of the WTP questions, it should be noted that the 528 responses in Table 46 represent all customers who answered the WTA questions regardless of whether we received consumption information for them and were therefore able to include them in the VCR calculation.

Table 46: Customers' willingness to accept an additional 60 minutes of supply interruption over the course of a year

Per cent of customers who reported they would be willing to accept an increase of 60 minutes per year of interruptions to their electricity supply if their bill was decreased by:	% of customers (base = 528)
1%	27.3%
1.5%	0.9%
2%	3.8%
more than 2%	34.1%
could not quantify or would not accept	33.9%

In summary, about a third of the respondents would be willing to accept 60 minutes more of supply interruptions annually if their bills were reduced by up to 2%. Another third (approximately) would require more than a 2% reduction, although exactly how much more was not determined in the survey. The remaining third were unable to say whether they would accept an increase in supply interruption at all, or at what level of discount on the annual bill they would be willing to do so. The fact that these latter respondents did not say "yes" to "more than 2%" would seem to indicate that either they are either unwilling to accept increased supply interruptions at all (or at any discount they thought would be a reasonable response), or that these respondents simply found it too hard to quantify the discount they would require.

However, it is also clear that the bill reductions required by these respondents for a 60-minute increase in supply interruptions are skewed to higher amounts than the amounts the other half of the respondents would be willing to pay for an equivalent reduction in the amount of time their electricity supply was interrupted. Although it might be expected that customers' willingness to pay for increased supply reliability and their willingness to accept increased supply outages wold be symmetrical, the literature on this topic is consistent in finding that customers' WTP and WTA are not symmetrical with regard to electricity supply. That is, most studies have found that customers are much less accepting of reductions in supply reliability than they are interested in increased supply reliability, and therefore would require higher payments in compensation for reduced supply reliability than they would be willing to pay for increased reliability.

5.7.3. Comparison of WTP, WTA and VCR values

The VCR and the WTP/WTA metrics answer different questions and are measured differently. The VCR represents the inconvenience or costs incurred by customers due to supply interruptions, and is measured in dollars per kWh not provided. WTP and WTA measure the amount of money (in dollars or per cent of annual bill) that customers

- would be willing to pay for improved supply reliability (i.e., fewer supply interruptions or shorter interruptions) in the case of WTP; or
- would require as compensation for accepting more or longer supply interruptions, in the case of WTA. In this study increased (decreased) supply reliability was represented by experiencing 60 minutes less (or more) of supply interruption over the course of a year.

In this section we compare the answers provided to the VCR, WTP and WTA questions by converting each of the measures to a common base:

- the cost that customers would experience due to an additional 60 minutes of supply interruption (VCR);
- the amount that customers would be willing to pay to experience 60 minutes less interruption per year (WTP); and
- the cost that customers would require in order to accept being subject to an additional 60 minutes of supply interruption over the course of a year (WTA).

In each of these cases, the measure will be expressed as dollars per 60 minutes (more or less) of interruption per year.

Calculation of this value for the VCR is shown in Table 47: The calculation is done through the following steps:

- First, the annual consumption of the average residential customer state-wide is calculated by adding the amount of electricity consumed by the residential customers of all three distribution companies and dividing that by the total number of those residential customers.
- The amount of electricity in kilowatt hours is then calculated by dividing the average annual consumption by 8760, the number of hours in a year.
- Finally, the state-wide residential VCR (as discussed in section 5.3.1 above and shown in Table 29), which is measured as the dollars per kilowatt hour of electricity not served, is multiplied by the number of kilowatt hours the average customer uses per hour to provide the residential VCR for one hour of average electricity use.

Table 47: Inconvenience/cost of 60 minutes of supply interruption over the course of a year to the average residential customer, based on the VCR

	Ausgrid	Endeavour Energy	Essential Energy	Total
Total residential consumption, 2010-11 (MWh) as reported by the DNSPs	9,813,269	5,919,698	4,772,088	20,505,055
No residential customers as reported by the DNSPs	1,434,227	1,181,764	710,627	3,326,618
State wide average annual consumption (MWh)				6.164
kWh in an average hour of consumption				0.703
State-wide residential VCR (see Table 29)				$20.71
Cost incurred due to 60 minutes of supply interruption				$14.56

Responses to the WTP and WTA questions were provided in dollar terms. As explained above, the dollar amounts presented to each respondent in these questions were calculated as the relevant percentage of the midpoint of the dollar range the respondent had selected as best representing his or her annual bill. Each customer's WTP or WTA could then be calculated by noting the highest value that the respondent answered "yes" to in either the WTP or the WTA questions. An average value could then be calculated across the values obtained. Table 48 summarises the findings of this process.

Table 48: WTP and WTA of residential customers for a decrease/increase of 60 minutes of power interruptions over the course of a year

Per cent of customers who reported they would be willing to pay or would require to accept particular levels of their annual electricity bill for 60 minutes less or more interruption to their electricity supply over the course of a year:	Willing to pay % of customers (base = 541)	Willing to accept % of customers (base = 528)
Per cent of annual bill customer is willing to pay or would require as a discount to accept		
1%	29.0%	27.3%
between 1% and 2%	7.4%	0.9%
2%	7.4%	3.8%
more than 2%	15.0%	34.1%
could not quantify or would not pay any amount	41.2%	33.9%
Average WTP/WTA ($/yr) for 60 minutes less/more minutes of supply interruption over the course of a year	$12.34	$28.54**

* Respondents were NOT asked whether they would accept less than a 1% reduction in the annual bill in order to accept 60 minutes of additional outages per annum. We assume that those who would accept a bill reduction of less than 1% would also accept a bill reduction of 1% or greater.

As can be seen, while the VCR value is higher than the estimate of customers' willingness to pay for increased reliability of their electricity supply, it is only marginally so. Some of this difference is also undoubtedly due to the facts that:

- In developing the VCR, respondents were presented with discrete choices of mitigation activities, which will result in a certain degree of lumpiness in the value calculated for each respondent and the value calculated across the sample.
- In developing the WTP and WTA estimates, respondents were presented with a dollar value that was calculated as the midpoint of the dollar range they said contained the value of their annual electricity bill, and then were only presented with discrete values to which they could agree or disagree. In addition, in developing the estimate we used 2.5% to represent the value of the answer "more than 2%". This is likely to have underestimated to some extent the WTP and WTA of respondents in both groups and therefore the overall WTP and WTA values.

Therefore, while customers' WTP was not addressed in the way it would be in a study entirely devoted to that methodology, the responses from reasonably sized samples of residential customers (most of whom also provided responses to the VCR questions) provide results that are not incongruent with the VCR values that have been determined.

By contrast, the WTA value is more than double the WTP and materially higher than the VCR. As discussed above, the fact that WTA is significantly higher than WTP is consistent with the literature and the findings of previous studies. Simply put, these figures reveal that customers on average are very resistant to reductions in the reliability of their electricity supply and will typically require much higher discounts to accept reductions in reliability than they are prepared to pay for increases.

In fact, it is highly likely that the $28.54 figure shown in Table 48 above underestimate the level of discount that customers would require. This is because in developing the $28.54 figure:

- We used 2.5% to represent the value of the answer "more than 2%". This is likely to have materially underestimated the specific discount that many of the respondents in this group would actually require.
- We excluded the 33.9% of respondents who could not quantify the level of discount they would require. It is important to note that these respondents did not select "more than 2%". This may indicate that they would either not be willing to have the reliability of their electricity supply reduced at any price (in which case they should be omitted from the calculation), or that they would require a discount very significantly higher than 2%.

5.8. Summary and implications of results

5.8.1. Caveats regarding the NSW VCR results

There are several important caveats that should be kept in mind when using the NSW (and in some cases, any) VCR results. These include:

- The VCR is likely to over-state the damages or inconvenience associated with most power failures. This is the case for several reasons, including
  - The respondents are asked to consider the inconvenience or monetary damages they would incur if the electricity supply were to be interrupted at the time that is worst (i.e., most inconvenient or most costly) to them. Clearly, not all supply failures occur at that time but the calculation of the VCR treats them as if they all do. Put another way, reducing the number or duration of outages that occur at times other than the time nominated by customers as the 'worst' time is quite likely to not have the same value as reducing supply interruptions at the worst time.
  - Some businesses – particularly manufacturing plants, but some commercial establishments as well - may be able to shift work from a plant suffering a supply failure to another location, thereby reducing the damage incurred.
- The VCR is calculated based on the average number of kWh used per hour by the customer. It is likely that the customer will be using a higher than average amount of electricity at the time he or she defines as being the 'worst time' for a power failure. The use of a higher number of kWh in the calculation of the VCR would reduce the dollar amount of the VCR. This is not done because it is not possible to know the consumption of the customer at that 'worst' time.

- The VCRs presented for CBD feeders are based on a very small number of responses and should be treated with extreme caution. The VCR for large business customers is also based on a relatively small number of responses (though not as small as the number of responses for CBD feeders) and should also be treated with caution.

- The VCR values presented here should not be taken as point estimates. There is a material error band around several of the VCRs reported here. These error bands should be kept in mind when comparing VCRs across sectors, feeders, or DNSPs.

Having said that, we believe that the results by feeder type represent a significant advance in the application and usefulness of the VCR approach. VCR by feeder type is likely to be of significantly more value in helping DNSPs assess the value of reliability improvements to their networks, and should provide a much better tool for government departments and the AER in setting reliability standards and incentive mechanisms.

5.8.2. Comparison to Victorian results

Table 49 compares the VCRs determined in this study for NSW with the VCRs that were obtained in Victoria in 2007. Although the VCR for NSW is expressed in 2011-12 dollar values, he values shown for Victoria have been indexed by AEMO to 2010-11 dollar values using an indexation method developed by VENCorp[40].

Table 49: NSW 2012 VCR compared to 2007 Victoria 2007 VCR results ($2011-12)

Customer sector	All feeders	CBD feeders	Urban feeders	Rural feeders
Residential	$20.71	$32.27	$23.05	$15.11
Business <160 MWhpa	$413.12	$295.87*	$452.12	$302.49
Business ≥ 160 MWhpa	$53.30	$80.54*	$29.96	$128.50*
Total	**$94.99**	**$120.52**	**$93.88**	**$93.86**

Victoria 2007 (indexed by AEMO to $2010-11)

Sector	VCR ($/kWh)
Residential	$23.80
Agricultural	$130.26
Commercial	$103.77
Industrial	$41.24
Total	$57.88

40 See VENCorp, *Methodology for Extrapolating VCR Between Surveys, 2008/09 - 2011/12*, 15 April 2009. The values reported in Table 49 are as reported in AEMO, *Victorian Annual Planning Report, Electricity and Gas Transmission Network Planning for Victoria*, 2011, p 15. It should be noted that the NSW VCR results are in 2011/12 dollars.

As can be seen, the 2012 NSW value for the residential sector is not very different from the corresponding indexed Victorian value. In fact, the NSW value is a bit lower.

Direct comparison of the results for non-residential customers is difficult, however, due to the fact that different segmentation schemes were used in the two studies. The Victorian value of $41.24 for industrial customers is lower than $53.30 identified for businesses with consumption greater than 160 MWhpa in NSW. However, the NSW sample in this category includes commercial as well as industrial customers, and commercial customers may tend to have higher VCRs on average than industrial customers.

The really significant difference between the 2012 NSW results and the indexed 2007 Victorian results occurs with regard to small business customers. The VCR of NSW businesses with annual electricity consumption less than 160 MWh is about four times higher than the VCRs of the agricultural and commercial customers surveyed in Victoria in 2007. This is a very significant difference and it also drives the increase in the overall NSW VCR as compared to the 2007 Victorian result.

It is not possible to know with any degree of accuracy why the result in the small business NSW customer sector is so much higher than the most similar customer sectors in the Victorian survey. It should be recalled that the Victorian VCR survey was conducted five years ago and it may be that over that time small businesses have become more dependent on the internet and other innovations in electronic technology and systems. The result of this dependence may be that they are less capable of maintaining their business functions when the electricity supply is interrupted, and therefore incur high opportunity costs of USE. Unfortunately, there is no way of determining the specific causes of the value of the VCR for this sector, or the relative contribution of each such cause to the VCR without extensive additional surveying.

5.9. Areas for improvement in future VCR surveys

Areas that should be considered for improving the application of the VCR approach used in future studies include:

- More attention and resource devoted to methods for securing better response rates and participation by larger customers and other small but important parts of the network, such as CBD feeders.
- Further investigation of the impact of survey delivery method on response rate and the quality of responses. The survey in this study was conducted using methods different to those applied previously. However, the fact that this study was conducted at a different time and with different customers than previous studies makes it impossible to identify to what extent differences in results are due to the survey delivery method as compared to other more substantive factors.
- As was done in this case, the mitigation choices offered to residential customers should be updated every time the VCR survey is undertaken.

- Further, some additional work would appear to be warranted with regard to the very high VCR observed among small business customers, as this appears to be a material difference to the VCR results obtained in Victoria in 2002 and 2007. This additional work could be done through follow-up interviews with a subset of the small business respondents. Another possibly useful approach would be to consider the use of the Economic Principle of Substitution for very small business customers. It might be worth using that approach with half of a small business sample and the direct cost approach with the other half, and then comparing VCR results.

- Finally, a more robust comparison of the results of the VCR approach with those of choice modelling for WTP and WTA should be considered.

Appendix A: Questionnaires

POWER FAILURES IN YOUR HOME

Final Questionnaire

1.0 INTRODUCTION

Good morning/afternoon/evening. My name is ………from Wallis Consulting Group. We're calling you on behalf of the government regulator the AEMC, the body responsible for making sure that Australia's electricity and gas markets run efficiently. We are conducting a confidential survey with residents across NSW to help us work out how power failures can and do affect people and how to plan in the face of unforeseen circumstances like fires, flooding and other events that disrupt the power. This interview should take around 17 minutes.

Continue.. 1 Continue with study
Make Appointment.. 2 Make appointment
Refused Ineligible .... 3 TERMINATE
Business/Farm contact for business survey .... 4 Continue with study

CONFIDENTIALITY: This study is completely confidential and none of the answers you give to me will be passed on in a way that could identify you or your household. We take confidentiality very seriously and work under the Australian Market and Social Research Society's code of professional behaviour, which sets out stricter rules for protecting personal information than the Commonwealth Privacy Act.

We're also talking with businesses and farmers. Firstly can I ask if you conduct any farming operations from the phone number I've called?

YES.. 1 Continue with study
NO.. 2 Ask next screener

If yes

Is your electricity bill...

Mostly for your home .... 1 Continue
Evenly divided between home and the farm.................................. 2 Continue
Mostly for the farm .... 3 Go to other study

OTHER STUDY: We'd like to talk with you about your farming operations. Could I call you back for this purpose? What would be the best time and number to call you on?

RECORD RESPONDENT NUMBER and TIME FOR CALL BACK

One of the objectives of this study is to work out the cost of power failures to New South Wales consumers. To do this we need to know how much electricity the households we have interviewed use. In order to be able to include your total electricity consumption in that total at the end of this survey I'm going to ask you if you'd give me your meter number which is on your bill.

This number will be provided to your distributor with no other information. They will be able to tell us accurately how much electricity your household used over the last year. This information will be appended to your de-identified survey answers.

Some of the other questions I'm going to ask you might be easier to work out if you have a bill handy, too. Do you have an electricity bill handy, too?

YES .... 1 Ask respondent to get bill
NO, but I can find one .... 2 Arrange appointment
No, I don't keep bills / do not wish to provide NMI .... 3 TERMINATE

If *NO, but could find one* ask respondent to locate a bill and arrange a convenient time for us to call back

RECORD RESPONDENT NUMBER and TIME FOR CALL BACK

If YES,

Ask who the electricity supplier is and advise where to locate the meter (NMI) number on the bill. For each of the retailers the instructions are:

- AGL – NMI is on the top right hand side of the back page, underneath the text box with the read date.
- Australian Power and Gas – NMI is on the top right hand side of the back page of bill.
- Country Energy – NMI is located on the back of the bill underneath the heading "Electricity Charge based on actual reads."
- Energy Australia - NMI is on the top left of the Electricity Usage Report (which is on the front of the 2nd page of the bill.
- Integral energy (Integral first and Origin – Origin only is below) – NMI is on the front page of the bill underneath resident's address.
- Lumo – NMI is on the top left of the back page underneath the heading "Your Electricity Usage" and "Meter Reading."
- Origin – NMI "Code" is on the back page of bill, underneath the category "**For supply at."**
- Red Energy – NMI is on the back page of the bill, within the **"Current Transactions"** section.
- TRUenergy – NMI is on the back page of the bill on the top left underneath your account number

Please could I have the NMI number?

Enter NMI number carefully and read it back to respondent – note these are usually 8 – 11 digits long.

For quality control and coaching purposes this call might be monitored. Please could you tell me if you do NOT want this call to be monitored.

OK TO MONITOR 1
DO NOT MONITOR 2

Thank you, very much. In this survey we are interested in understanding the impact of unplanned power failures on your household. We are not including losing power in your home because a fuse has blown, where you have been told in advance about a planned outage or the lights dim but do not go out completely. When we talk about a power failure, we mean a complete interruption of electricity affecting one or more areas for periods lasting from a few minutes to a few days.

2.0 Experience with power failures in the past

1. I'd like to start by asking you to rate the reliability of the power supply to your home. Using a scale of 1 to 10 where 1 is totally unreliable and 10 is totally reliable, how reliable do you think your power supply is? *(RECORD NUMBER)*

2. Now I'd like you to think back over the last two years since the beginning of 2010. To the best of your memory, how many times has your household experienced a power failure that has affected your home and others in the area that lasted more than a minute? *(RECORD NUMBER OF POWER FAILURES)*

3. /3b. How long did this/these last... (READ OUT) *(NUMBER FROM Question 2)*
   a) More than 24 hours
   b) More than 8 hours and up to 24 hours
   c) More than 4 hours and up to 8 hours
   d) Between 1 and 4 hours
   e) Up to an hour?
   f) Don't know (DO NOT READ)

   (RECORD NUMBER - COMPUTER AND INTERVIEWER CHECK TOTALS)

4. I am now going to read you a list of some electrical household appliances. For each one, I'd like you to tell me if you use it in your home.

   Interviewer mark all

   Do you use...at home?

	Item	**YES**	**NO**	**N/A**
a	Clothes washer	1	2	3
b	TV	1	2	3
c	Electric Cooking	1	2	3
d	Electric Heating	1	2	3
e	Electric Hot water	1	2	3
f	Air Conditioning	1	2	3
g	Refrigerator	1	2	3
h	Radio/ CD	1	2	3
i	A computer	1	2	3

3.0 The impacts of power failures on your household

Now I'd like you to think about the **WORST** possible time for a power failure to happen to this household

5. Firstly, if a power failure occurred, in which season of the year would it cause the most inconvenience for you and your household?

SINGLE RESPONSE ONLY

Spring.. 1
Summer 2
Autumn... 3
Winter... 4
No season is worse.. 5

6. Which day of the week would be worst?

SINGLE RESPONSE ONLY

Monday to Thursday 1
Friday 2
Saturday... 3
Sunday.. 4
No day is worse than any other 5

7. What would be the worst possible time for a power failure to occur?

SINGLE RESPONSE ONLY

6am to 9am 1
9am to 3pm... 2
3pm to 6pm... 3
6pm to 9pm... 4
9pm to midnight 5
Midnight to 6am 6
No time is worse than any other 7

4.0 Options for dealing with future power failures

8. In your household do you have one or more .... *(READ OUT)*

MULTI RESPONSE 1 – 5 SINGLE RESPONSE ONLY 6

Gas or oil lanterns..	1
Portable gas stoves or barbeques (**not electric**)	2
Portable kerosene or LPG heaters	3
Backup power supply for your computer	4
Solar panels supplying power to your home (not water heating only)	5
None of the above (DO NOT READ)...	6

9. Now I'm going to ask you some questions that are extremely important to this survey. They are a bit repetitive and I need you to listen very carefully to the options I will read to you. I'd like you to imagine you have been told that more frequent unplanned and widespread power failures can be expected in the future. Now I'd like you to think about what you would do if your household was to suffer a power failure at the **WORST** possible time and day for you.

   Firstly, there are three main things that you could do in the event of a power failure. One is to do nothing and wait for the power to come back on, another is to leave your home and go somewhere else where there is power and the third is to buy things like ice, candles, gas lamps or even generators that would help you cope at home.

   a) If you were to suffer more frequent power failures between 5 minutes and 1 hour in duration than you currently do, which of the following actions would you be very likely to undertake Would you....(READ OUT)?

   Do nothing...1 Go to 9b
   Leave your home for somewhere else..2 Go to 9c
   Buy or use things like ice, candles, a gas lamp or a barbecue or portable gas stove to help you cope with the lack of electricity? ....3 Go to 9c
   Don't know (Do not read) ....4 Go to 9c

   b) How about if the power failures were longer. Let's suppose they were usually between 1 and 4 hours in length. Would you ... (READ OUT)?

   Do nothing...1
   Leave your home for somewhere else..2
   Buy or use things to help you cope?...3
   Don't know (Do not read) 4

   c) Now let's imagine the power failed more frequently for anywhere from 4 to 8 hours. Would you ... (READ OUT)?

   Do nothing...1
   Leave your home for somewhere else..2
   Buy or use things to help you cope?...3
   Don't know (Do not read) 4

   d) And finally, what would you do if the power was off for more frequently anywhere from 8 to 24 hours. Would you ... (READ OUT)?

   Do nothing...1
   Leave your home for somewhere else..2
   Buy or use things to help you cope?...3
   Don't know (Do not read) 4

Ask all who say "Do nothing" to all questions

9e. Why would you just wait for the power to come back on?
(Probe for whether they can't afford to take other actions)

For those who would do something at each level of power failure (i.e. if nothing to all do not ask, if nothing to 5 mins – 1 hour but something to the others ask only with regard to the longer durations)

I'm going to ask you whether you'd take any or a number of actions, each of which has a different cost, if the power failed for 5 minutes to 1 hour. Please tell me the things you would definitely or be very likely to do.

If the power failed for (TIME) would you...... (programmer note to remind respondent of length of power failure, periodically)

OPTIONS YES, NO

		5 minutes to 1 hour	1 to 4 hours	4 to 8 hours	8 to 24 hours
A	Buy or use candles or a torch to provide some lighting for up to 1 hour in the evening	$0.50	$2	$2	$2
B	(Ask if Q8, 1 = No) Buy a gas lantern, to provide better lighting	$13	$14	$16	$21
	(Ask if Q8, 1 = Yes) Use your gas lantern, to provide better lighting	$2.50	$2.50	$5.00	$5.00
C	(Ask if Q8, 2 = No) Buy a portable gas stove or barbeque for cooking & boiling water	$23	$23	$26	$29
	(Ask if Q8, 2 = No) Use your portable gas stove or barbeque for cooking & boiling water	$2.50	$2.50	$5.00	$7.50
D	(Ask if Q8, 3 = No) Buy a portable kerosene or LPG space heater, to provide heating for one room	$53	$56	$59	$68
	(Ask if Q8, 3 = No) Use your portable kerosene or LPG space heater, to provide heating for one room	$2.50	$2.50	$5.00	$7.50
E	Hire a small emergency generator so you can use a few important appliances	N/A	N/A	$90	$100
F	Go to an internet cafe or somewhere where you could use a computer	$10	$10	$10	$10
G	Buy some ice and put it in your refrigerator or Eskie	$5	$10	$15	$20
H	Stay in a hotel for the night	N/A	N/A	N/A	$100 / per room
I	Drive to a relative or friend's home and stay with them	$10	$10	$10	$10
J	Go to a restaurant for one meal (specify cost to you)	If yes 10a	If yes 10a	If yes 10a	If yes 10a
K	Go to a restaurant for two meals (Specify cost to you)	If yes 10a	If yes 10a	If yes 10a	If yes 10a

Q9J If respondent answers YES to J or K,
How much do you estimate this would cost your for the entire household to (READ J and/or K)

5.0 Information preferences and willingness to pay/accept

Electricity networks can invest money in infrastructure and systems to reduce how often power failures happen and how long they last. They can also invest in systems that can tell customers about how long the power is likely to be out when a failure does occur. The amount of money they spend on this infrastructure would affect your electricity bill.

If the utility was going to invest money in one of those approaches, which would you want them to pursue? (READ OUT)

ROTATE

Infrastructure to reduce the number of power failures that occur 1
Systems to reduce how long outages last when they do occur.. 2
Communications systems telling you how long an outage is likely to last............................ 3

Willingness to pay/accept

11 How much do you estimate you spend on electricity each year in total?
If the respondent can't estimate: Would it be... (READ OUT)?

Less $500 1
$500 to $999.. 2
$1,000 to $1,499... 3
$1,500 to $1,999... 4
$2,000 to $2,499... 5
$2,500 to $2,999... 6
$3,000 to $3,499... 7
$3,500 or more.. 8
No idea.. 9
Refused... 0

Willingness to pay (ask 50% of respondents)

12 Let's suppose that the electricity company could reduce both the number of power outages and their length if they invested money in infrastructure, but you would need to pay **more** on your electricity bill.

Would you be willing to pay $XX more per year on your bill to reduce the total time your power would be out due to power failures by 60 minutes per year? **[Note: $XX for each respondent will be calculated as 1% of the midpoint of the bill range they select in Q 11.]**

Yes.. 1
No.. 2
Don't know/Maybe (Do not read) 3

If Yes to Q12
12a You mentioned that you would be willing to pay $XX. Would you be willing to pay more than that?

Yes .... 1 (GO TO 12 b)
No.. 2 (GOTO 6.0)
Don't know/Maybe (Do not read) 3

12b How much more would you be prepared to pay ...?

[2 x $XX] 1
More than [2x $XX] 2
More than [$XX] but less than [2 x $XX]... 3
None of the above (Do not read) 4

Willingness to accept (Ask 50% of respondents)

13 Let's suppose that the electricity company didn't invest money in infrastructure and your power could be out for up to 60 minutes more per year. However your annual electricity bill would fall.

Would you be prepared to have additional power outages of up to 60 minutes more per year if your annual bill was $XX lower than it is now? **[Note: $XX for each respondent will be calculated as 1% of the midpoint of the bill range they select in Q 11.]**

Yes 1
No.. 2 (GO TO 13a)
Don't know/Maybe (Do not read) 3

If Yes to Q13
13a How much more would your bill have to be reduced by for you to accept additional power failures of up to 60 minutes more a year?

[1.5 times $XX].. 1
[2 times $XX]... 2
More than [2 times $XX] 3
None of the above (Do not read) 4

6.0 Demographics

Thank you so much for your patience. Now I just have a few more questions about you and your household, to help us analyse the information. All these details are strictly confidential and will only be analysed as a group, not individually.

D1 Which of the following best describes the type of dwelling you live in? (READ OUT)

SINGLE RESPONSE ONLY

Separate House 1
Semi-detached, row or terrace house, town house 2
Flat, unit or apartment.. 3
Other (Specify).. 4

D1a Is your home...? (READ OUT)

SINGLE RESPONSE ONLY

Owned outright.. 1
Being purchased.. 2
Rented privately by you 3
Public housing 4
Other (Specify).. 5

D1b What is your postcode (write in)

2XXX

D2 Including yourself, how many people live in your household?

a) Adults, aged 21 and over.. *(RECORD NUMBER)*
b) Children and teenagers, ages 0 to 20 .... *(RECORD NUMBER)*

D3 Gender (DO NOT READ)

Male 1
Female 2

D4 Which of the following best describes the highest education level you have completed?

SINGLE RESPONSE ONLY

Primary school or equivalent 1
High school level or equivalent... 2
TAFE I technical college I trade school 3
University level.. 4
Other (Specify).. 5

D5 Which of the following best represents your household's total annual income, before taxes or any other deductions from pay?

SINGLE RESPONSE ONLY

Less than $25,000 1
$25,000 to less than $50,000 2
$51,000 to less than $75,000 3
$76,000 to less than $100,000 4
$101,000 to less than $125,000 5
$126,000 or more.. 6
Undisclosed 7

D5a Do you pay the energy concession rate or the full rate shown on the bill?

SINGLE RESPONSE ONLY

Energy Concession Rate 1
Full Rate.. 2
Don’t know 3

D6 Do you operate a business from your home?

SINGLE RESPONSE ONLY

Yes... 1 *(Continue)*
No.. 2 *(Go to D7)*

If YES
D6a if you had a power failure at the WORST time would this affect (READ OUT)

SINGLE RESPONSE ONLY

Only your household activities..1
Mostly household activities...2
Household and business activities, with household activities affected more 3
Household and business activities, with business activities affected more................................4
Only your business activities 5
Don't Know...6

D7 Finally, are there any further comments you would like to make about the effects of power failures or the reliability of your power supply?

OPEN

On behalf of the Australian Energy Market Commission and Wallis Consulting Group, thank you for your help with this survey, the information you have provided will help to ensure that the residents of New South Wales have an economical and reliable supply of electricity. Your views count and we're glad you made them known to us. Just in case you missed it, my name is ………., from Wallis Consulting Group. As I mentioned, this survey is totally confidential. No information that you have given me will be passed on in a way in which you or your answers could be identified.

Thanks for your time.

WG 3945
7th February 2012

POWER FAILURES IN YOUR BUSINESS

Final Questionnaire

RECRUITMENT

Good morning/afternoon. My name is ………from Wallis Consulting Group. We're calling you to get your business' opinions on the effects that power failures can and do have on businesses on behalf of the government regulator, the AEMC. This is the body responsible for making sure that Australia's electricity and gas markets run efficiently. We're conducting a confidential survey with electricity users across NSW to help us work out how power failures can and do affect businesses and how to plan in the face of unforeseen circumstances like fires, flooding and other events that can disrupt the power. It's really important that people from all parts of the business community have the opportunity to give their opinions Please may I speak with the person who would be in the best position to judge the effects that power failures might have on this business?

WHEN SPEAKING TO CORRECT PERSON, REINTRODUCE AS NECESSARY

We'd like to send you a link to a confidential online survey which will take you about 15 minutes to complete. You don't have to complete it all in one go if you need to take a break.

S1 Which of the following describes the type of business activities you undertake at your location

Farming ....1CHECK QUOTAS
Manufacturing and/or industrial processing ....2CHECK QUOTAS
Commercial activities such as wholesale or retail trade or services....3CHECK QUOTAS
Other (specify and make appointment to call back).............................4CHECK QUOTAS
Other that is obviously none of 1-3 (DO NOT READ)..........................5CLARIFY/TERMINATE

S1a How many sites does your organisation operate from in New South Wales?

Only one 1
More than one 2
Don't know... 3

S2 Can I also ask you to make a rough estimate of your annual electricity usage or the amount you spend? Do you think it would be...?

NOTE: PRICES ARE IN VERY ROUGH TERMS

Less than 160MWhpa (Less than $3,000 per month)..1
Between 160 and 749 MWhpa (between $3,000 and $17,000 per month) 2
More than 750 MWhpa (More than $17,000 per month) 3
Don't know...4**ASK S2a**

IF S2 = Don't know ASK S2a

S2a Compared to ALL other businesses, would you say you are a light, medium or heavy user of electricity?

Light..1
Medium 2
Heavy 3
(Don't know) 4

S2 I'll need your name, e-mail address and a daytime phone number I can contact you on in case the e-mail bounces. We'd like you to complete the survey in the next week or two. Are you able to do this?

Yes 1
No.. 2 TERMINATE

Details

Name of respondent: --

E-mail address (READ back to respondent): ---

Daytime phone number: --

Thanks very much for agreeing to take part in this important study. We'll send you the survey link and instructions for completing the survey shortly.

In case you didn't catch it, I'm ………from Wallis Consulting Group.

WG 3945
7th February 2012

ONLINE SURVEY

Thanks for agreeing to participate in this important study on the effects of power failures on NSW businesses for the government energy regulator, the AEMC. Wallis Consulting Group is collecting information from businesses and farming operations which will be collated to help the AEMC to understand how much power failures cost the business and farming community. This will help it to ensure that NSW businesses receive a reliable yet cost effective power system. None of the information you provide will be passed on in a way in which your organisation or you could be identified.

The survey should only take you around 15 minutes to complete and it would be a good idea to complete the separate grid included below before you start to complete the survey as this information is of key importance to the survey and it will make completing the questionnaire easier for you. It would be very helpful if we could have your permission to access your organisation's electricity usage for the past year. All we'll need is your authorisation to access the information and the NMI number which is on your electricity bill. You may have more than one electricity meter and each one will have its own NMI. As a market research company we are bound by the Australian Market and Social Research Society's code of professional behaviour which has rules about data protection that exceed the requirements of the Commonwealth Privacy Act. Any information you provide will be solely for the purposes of making an estimate of the effects of power cuts on businesses in NSW.

Printable grid for farmers

Printable grid for other businesses

If you have any questions about the survey, please contact Ben Bishop or Katherine Rich of Wallis Consulting Group on 03 9621 1066.

INTRODUCTION

Whenever we talk about a power failure in this survey, we mean a complete interruption of electricity affecting one or more areas for periods lasting at least a few minutes and possibly several hours, or even a few days. Sometimes, a power failure may involve the power switching off and on again perhaps several times over a matter of minutes, but please regard such a problem as only a single failure event.

SCREENING VERIFICATION

The next few questions about your business allow us to tailor the questionnaire to suit your circumstances

S1 Which of the following describes the type of business activities you undertake at your location...

Farming ....1CHECK QUOTAS
Manufacturing and/or industrial processing ....2CHECK QUOTAS
Commercial activities such as wholesale or retail trade or services....3CHECK QUOTAS
Other (specify and make appointment to call back).............................4CHECK QUOTAS
Other that is obviously none of 1-3 (DO NOT READ)..........................5CLARIFY/TERMINATE

S1a How many sites does your organisation operate from in New South Wales?

Only one 1
More than one 2
Don't know.. 3

Ask if more than one site –others to

S2a How many people work at this site?

1-19 1
20 - 49 2
50 - 99 3
100+ 4
Don't know.. 5

S2b How many people work for this business in New South Wales in total?

1-19 1
20 - 49 2
50 - 99 3
100+ 4
Don't know.. 5

Experience with power failures in the past

1. Please rate the reliability of the power supply to your business/farm.

   Using a scale of 1 to 10 where 1 is totally unreliable and 10 is totally reliable, how reliable do you think your power supply is? *(radar buttons)*

2. To the best of your memory, how many times has your (*from S1*) experienced a power failure in the last two years -- that is, since January 2010? Only include power failures that lasted at least 5 minutes and affected a number of properties other than just your facility. *(RECORD NUMBER*

   (Enter number of *power failures)*

3. Thinking about this/these [if more than one - number of power failures from Q2], how long did this/they last? Please write the number of outages for each time listed below, and please check that the totals agree. Your best estimate will be helpful.

   Up to 1 hour...(RECORD NUMBER)
   For more than 1 hour and up to 4 hours ....*(RECORD NUMBER)*
   For more than 4 hours and up to 8 hours.....................................*(RECORD NUMBER)*
   For more than 8 hours and up to 24 hours...................................*(RECORD NUMBER)*
   For more than 24 hours and up to 48 hours ....*(RECORD NUMBER)*
   For more than 48 hours...*(RECORD NUMBER)*
   Don't know...*1*
   TOTAL..Show Total from Q3

4. Does this site routinely generate any of its own electricity?

   Yes 1
   No...2
   Don't know...3

   If yes to Q4
5. How do you generate your own electricity (please mark all that apply)

   Solar 1
   Wind 2
   Cogeneration..3
   Petrol or diesel generators 4
   Other (please write in)...5
   I'd rather not say..6

6. (If yes to Q5, add in addition to this energy source) Which of the following type, or types, of power supply backup equipment does your business/farm have for use in the event of a power failure?

   1-4 MULTI

   Standby Generator...1
   Uninterruptible power supply (UPS)...2
   Some other battery system (e.g. not UPS) 3
   Other (please write in)*..4*
   No backup equipment 5

   IF Yes to 1-4 Q2 ASK for each Yes response ASK

2a How many hours can the load be carried for by (ANSWER from Q6) a? *(RECORD NUMBER)*

   Standby Generator...*(RECORD NUMBER)*
   Uninterruptible power supply (UPS)...*(RECORD NUMBER)*
   Battery system...*(RECORD NUMBER)*
   Other..(RECORD NUMBER)

The impacts of power failures on your business

Power companies typically give their customers a minimum of 48 hours advance notice for planned power failures. But this is not always possible – for example, when failures are caused by unpredictable events such as storms, bush fires, or road accidents. These unplanned power failures can vary from seconds to days. The impacts on electricity users can range from a minor inconvenience (like having to reset a digital clock) to a loss of a more tangible nature (such as the shutdown of a manufacturing operation or a retail business).

This section of the survey is about the impacts of widespread unplanned power failures, and the losses businesses incur as a result of such events. The losses vary considerably from business to business, but they could include:

NOTE – program to show appropriate responses - for Businesses

- Lost production or sales revenues
- Paid staff unable to work
- Spoilage of perishable goods and products
- Damage to business equipment
- Damage to the environment

For farms

- Spoilage of perishable produce
- Loss of livestock
- Damage to equipment
- Damage to the environment

7. For your activities at this location what would be the **worst** possible season for a power failure to occur?

   SINGLE RESPONSE ONLY

   Spring (September/October/November) 1
   Summer (December/January/February) 2
   Autumn (March/April/May)... 3
   Winter (June/July/August) 4
   No season is worse than any other... 5

8. What would be the **worst** possible day of the week for a power failure to occur?

   SINGLE RESPONSE ONLY

   Monday to Friday.. 1
   Saturday 2
   Sunday 3
   No day is worse than any other.. 4

9. What would be the worst possible time or times for a power failure to occur?
   MULTIPLE RESPONSE

   6am to 9am 1
   9am to noon 2
   Noon to 3pm... 3
   3pm to 6pm 4
   6pm to 9pm 5
   9pm to midnight.. 6
   Midnight to 6am.. 7
   No time is worse than any other.. 8

The costs of power failures to your business

To complete the next question, it will be easier if you use the separate sheet provided at the start of the survey and fill the answers in. If you need to download it please click here. If you haven't done this already, and you need to exit the survey, please press the “quit & resume” button, complete the sheet and then return to the survey when you are ready using the link provided in the email invite.

10. If a power failure occurred, without warning, at the WORST TIME for your business/farm, what would be the loss in dollars to your business? Please estimate your losses in $ for each power failure duration shown in the box below.

    (If BUSINESS HAS A BACKUP POWER SUPPLY – ANY AT Q2, PUT THESE WORDS IN) If you have a backup power supply and if this supply is normally in operation during a power failure please estimate the losses to your business of a failure based on the assumption that the backup supply is used to the fullest extent possible during the interruption.

    Enter the $ costs corresponding to each of the impacts *(if applicable to your business/farm)* for each of the durations listed*)*
    (Individual categories are provided for your convenience. If there are other categories in which your business would incur costs, please add these up and put the total in the “Other costs in total” category. (If you have difficulty in classifying the impacts and costs please fill in Totals only))

PROGRAMMING NOTE – SHOW EACH LENGTH OF FAILURE, STARTING WITH 20 MINUTES AND WORKING UPWARDS – ALLOW RESPONDENTS TO ENTER TOTAL ONLY. SAME ORDER

Farming Grid

Experience	**Length of power failure**					
	20 mins	1 hour	2 hours	4 hours	8 hours	24 hours
Costs of operating backup electrical equipment						
Loss of livestock						
Loss of dairy, egg, fruit or vegetable produce						
Damage to farm equipment						
Paid staff unable to work						
Overtime labour costs to make up lost production						
Sales foregone from production that can't be made up						
Costs to bring farm back to normal operation						
Costs to repair possible damage to the environment						
Loss of take-or-pay irrigation water						
Any other costs in total						
Total(computer to calculate so respondent can check)						

Business grid

Experience	**Length of power failure**					
	20 mins	1 hour	2 hours	4 hours	8 hours	24 hours
Costs of operating backup electrical equipment						
Damage to or spoilage of raw materials or products used in the business						
Damage to or spoilage of finished product						
Damage to plant or equipment						
Costs of paid staff unable to work due to the outage						
Overtime labour costs to make up lost production or to catch up on other business activities						
Sales lost due to the power failure that cannot be recovered						
Cost to recover data lost from computer systems						
Costs to repair possible damage to the environment						
Any other costs to bring operations back to normal						
Any other costs (in total)						
Total (computer to calculate so respondent can check)						

Your business/Farm

To make sure that the results of this survey are representative of all NSW organisations please provide the following details about your business/farm.

11. (BUSINESS ONLY) Which of the following best describes the type of business activities carried out at this location?

Agriculture, forestry and fishing 1
Accommodation, cafes and restaurant 2
Communications 3
Construction 4
Cultural and recreation Services 5
Education 6
Electricity, gas and water 7
Finance and insurance services 8
Health and community services 9
Manufacturing 10
Mining 11
Personal and other services 12
Property and business services 13
Retail trade 14
Transport and storage 15
Wholesale trade 16
Other (specify) 17

(FARMS ONLY) Which of the following best describes the type of agricultural activity carried out at this location?

SINGLE RESPONSE ONLY

Dairy cattle 1
Beef cattle 2
Poultry for meat or eggs 3
Pigs 4
Sheep 5
Cotton 6
Rice 7
Cereal grains 8
Vegetables 9
Fruit 10
Nursery 11
Greenhouse or hydroponics 12
Other (specify) 13

Businesses only Q12-15

12. Do you own or rent your premises?

Own/paying off .... 1 (Skip to Question 15)
Rent .... 2 (Please continue below)
Don't know .... 3 (Skip to Question 15)

13. Is your landlord responsible for supplying electrical services such as air conditioning, hot water or lifts to your business?

SINGLE RESPONSE ONLY

Yes .... 1 (Skip to Question 15)
No .... 2 (Please continue below)
Don't know .... 3 (Skip to Question 15)

14. Please indicate which of the following services are supplied by your landlord. Please mark all that apply.

MULTI RESPONSE

Air conditioning and ventilation 1
Space heating 2
Hot water 3
Lifts 4
Car park lighting and ventilation 5

15. Which **one** of the following **best** describes the type of premises in which your business is located?

SINGLE RESPONSE ONLY ALLOWED

Enclosed shopping centre 1
Multi-level office (more than 5 floors) 2
Multi-level retail (more than 5 floors) 3
Multi-level combined office/retail (more than 5 floors) 4
Standalone Building of one to four floors 5
Other (Please Specify) 6

Farming operations only others to Q19

16. Is the electricity bill for your farming operation combined with the bill for your household?

No, my farm and household electricity accounts are separate .... 1 *(Please skip to Question 19)*
Yes, my farm and household electricity accounts are combined .... 2 *(Please continue below)*

17. Please indicate which of the following electrical appliances you have in your household

Central space heating 1
Individual room heaters 2
Central air conditioning 3
Individual room air conditioners 4
Large off-peak storage hot water 5
Small electric hot water unit 6
Electric cook top and oven 7
Solar power? 8

FOR EACH OF 17 = 2, 4 OR 6 – ASK 18

18. How many (answer from 17) do you have?
Individual room heaters .... *(Type NUMBER)*
Individual room air conditioners .... *(Type NUMBER)*
Small electric hot water unit .... *(Type NUMBER)*

19. If you have any other comments you'd like to make about the effects of power failures or the reliability of your power supply, please type them in here

NMI number release:

We would now like you to provide your NMI number (this is your meter number). The reason for this is that it would be very helpful if we could work out the total energy consumed by all respondents to this survey so that we can estimate the effects that power failures will have on New South Wales farms and businesses.

I know the NMI 1
I don't know how to find the NMI 2
I'd rather not provide it.. 3 GOTO "NO"

Here are examples of bills from different retailers. The NMI is highlighted in yellow.

(List of pictures of retailer bills and NMI locations)

Please enter your NMI number in the space given below (TYPE IN NMI)
I still can't find it .... (GO TO HELP)

HELP: Enter your details and press "submit" and someone from Wallis Consulting will call you as close to the time you've nominated as possible. Please note, help is available from 9am until 8pm Monday – Friday and 10 am – 5pm on Weekends – excluding public holidays.

Name

Phone Number

Preferred time for call

If you have any comments to make about the actual survey, please make them here... (i.e. if a question was difficult to answer, or it wasn't clear what the question was asking, etc).

NO: Providing your NMI is not compulsory. However, it will be extremely helpful and we can assure you that the electricity usage information will be appended to de-identified data. This data will be analysed in aggregate, not at an individual business level.

I still do not wish to provide it ....1 GO TO END
Okay, I will provide the NMI ....2 GO TO NMI NUMBER RELEASE

ALL

On behalf of the AEMC and Wallis Consulting Group

Thanks very much for completing this survey!

Please click "Next" to submit your answers

POWER FAILURES IN YOUR BUSINESS

CATI (telephone) Questionnaire – FINAL

PRE-RECRUITED

INTRO 1 Good morning/afternoon. My name is ………from Wallis Consulting Group. We're calling you to get your business' opinions on the effects of power failures on businesses. This research is being conducted on behalf of the government regulator, the AEMC. This is the body responsible for making sure that Australia's electricity and gas markets run efficiently.

We're conducting a confidential survey with electricity users across NSW to help us work out how power failures can and do affect businesses and how to plan in the face of unforeseen circumstances like fires, flooding and other events that can disrupt the power. It's really important that people from all parts of the business community have the opportunity to give their opinions.

Please may I speak with the person who would be in the best position to judge the effects that power failures might have on this business?

Continue 1
Change number .... 2 CHANGENUM

INTRO 2

WHY: Taking part in this research will help to ensure that NSW businesses receive a reliable yet cost effective power system.

WHY ME: It is important we speak with all types of businesses as we are trying to ascertain the potential effect of power outages on the NSW business community.

CONFIDENTIALITY: As a market research company we are bound by the Australian Market and Social Research Society's code of professional behaviour which has rules about data protection that exceed the requirements of the Commonwealth Privacy Act. Any information you provide will be solely for the purposes of making an estimate of the effects of power cuts on businesses in NSW.

I WOULD PREFER TO DO IT ONLINE: You can complete it online if you wish, can I please confirm your email address?

Continue 1
Make appointment 2
Prefer to complete online .... 3 GOTO CHECK EMAIL
Refused .... 4 GOTO REF
Have already done the survey .... 5 TERM: THANKS

IF INTRO 2 = 4 "REFUSED"

REF RECORD REASON

MULTI

Not relevant as I don't have power outages 1
I do not have access to the NMI 2
I cannot answer questions about the impact of outages on my business 3
Too busy 4
I don't want to 5
Other (specify) 6

CHECK EMAIL Can I confirm that your email address is [EMAIL] Correct / Change

ASK ALL (INCLUDING “CHECK EMAIL”, IF “CHECK EMAIL”, ASK NMI THEN CLOSE WITH DATA)

S3 One of the objectives of this study is to determine the cost of power failures to New South Wales farms and businesses. To do this we need to know how much electricity each business and farm uses. The electricity distributors are also assisting this research and are supplying the energy consumption associated with meter numbers. Unlike electricity retailers, the distributors do not have any billing information, so they will not know which business corresponds to which meter number. Also, the meter numbers are supplied with no other identifying information, so your business will remain anonymous throughout this process.

IF PREFER TO DO ONLINE DISPLAY: We have found that it can be helpful to have someone assist in finding and identifying the NMI on the bill, rather than trying to find it online.

Do you have a bill to hand, or should I call back later?

[IF APPOINTMENT, PLEASE PROVIDE AS MUCH DETAIL AS POSSIBLE, SUCH AS HARD OR SOFT APPOINTMENT, NAME IF IT IS SOMEONE DIFFERENT]

YES .... 1 RECORD NMI
No, but I can find one .... 2 APPOINTMENT
No, I will not prove the NMI .... 3 TERMINATE

S3DATA

ENTER NMI NUMBER CAREFULLY and READ IT BACK TO RESPONDENT
[NOTE: If they CANNOT find the NMI, you can collect a meter number as a last resort]

For quality control and coaching purposes this call might be monitored. Please could you tell me if you do NOT want this call to be monitored.

OK TO MONITOR 1
DO NOT MONITOR 2

INTRODUCTION

First I'd like to clarify what we mean by power failure. Whenever we talk about a power failure in this survey, we mean a complete interruption of electricity affecting one or more areas for periods lasting at least a few minutes and possibly several hours, or even a few days. Sometimes, a power failure may involve the power switching off and on again perhaps several times over a matter of minutes, but please regard such a problem as only a single failure event.

Experience with power failures in the past

1. I'd like to start by asking you to rate the reliability of the power supply to your [BUS/FARM]. Using a scale of 1 to 10 where 1 is totally unreliable and 10 is totally reliable, how reliable do you think your power supply is?

   (RECORD NUMBER)

2. Now I'd like you to think back over the last two years since the beginning of 2010.To the best of your memory, how many times has your [BUS/FARM] experienced a power failure that has affected your [BUS/FARM] and others in the area that lasted more than five minutes?

   (RECORD NUMBER of POWER FAILURES)

3. How long did [this/these] last?
   - a) Up to 1 hour .... (RECORD NUMBER)
   - *b)* For more than 1 hour and up to 4 hours .... *(RECORD NUMBER)*
   - *c)* For more than 4 hours and up to 8 hours .... *(RECORD NUMBER)*
   - d) For more than 8 hours and up to 24 hours .... *(RECORD NUMBER)*
   - e) For more than 24 hours and up to 48 hours .... *(RECORD NUMBER)*
   - *f)* For more than 48 hours .... *(RECORD NUMBER)*
   - g) Don't know (DO NOT READ) *1*

   (RECORD NUMBER – COMPUTER AND INTERVIEWER CHECK TOTALS)

4. Does this site routinely generate any of its own electricity?

   Yes .... 1 GO TO Q5
   No .... 2 GO TO Q6
   Don't know .... 3 GO TO Q6

5. How do you generate your own electricity *(MULTI RESPONSE)*

   Solar 1
   Wind 2
   Cogeneration 3
   Petrol or diesel generators 4
   Other (please write in) 5
   I'd rather not say 6

6. [IF ANY AT Q5: Apart from those you just mentioned,]which of the following type, or types, of power supply backup equipment does your [BUS/FARM] have for use in the event of a power failure?

   1-4 MULTI

   Standby Generator .... 1 GO TO 6B
   Uninterruptible power supply (UPS) .... 2 GO TO 6B
   Some other battery system (e.g. not UPS) .... 3 GO TO 6B
   Other (specify) .... 4 GO TO 6B
   No backup equipment .... 5 GO TO Q7

IF Yes to 1-4 Q2 ASK for each "Yes" response at Q2

6b And how many hours can the load be carried for by (ANSWER from Q6) a? *(RECORD NUMBER)*

a) Standby Generator .... *(RECORD NUMBER)*
b) Uninterruptible power supply (UPS) .... *(RECORD NUMBER)*
c) Battery system .... *(RECORD NUMBER)*
d) Other .... *(RECORD NUMBER)*

The impacts of power failures on your business

Now I'd like to talk about the impact of power failures on your business.

Power companies typically give their customers a minimum of 48 hours advance notice for planned power failures. But this is not always possible – for example, when failures are caused by unpredictable events such as storms, bush fires, or road accidents.

These UNPLANNED power failures can vary from seconds to days. The impacts on electricity users can range from a minor inconvenience (like having to reset a digital clock) to a loss of a more tangible nature (such as the shutdown of a manufacturing operation or a retail business).

This section of the survey is about the impacts of widespread unplanned power failures, and the losses businesses incur as a result of such events. The losses vary considerably from business to business, but they could include:

[NOTE – program to show appropriate responses]

For Businesses [BUS/FARM = BUSINESS]

- Lost production or sales revenues
- Paid staff unable to work
- Spoilage of perishable goods and products
- Damage to business equipment
- Damage to the environment

For farms [BUS/FARM = FARM]

- Spoilage of perishable produce
- Loss of livestock
- Damage to equipment
- Damage to the environment

Now I'd like you to think about the WORST possible time for a power failure to occur

7. Firstly, if a power failure occurred, in which season of the year would it cause the most inconvenience to your activities at this location?

   SINGLE RESPONSE ONLY

   Spring (September/October/November) 1
   Summer (December/January/February) 2
   Autumn (March/April/May).. 3
   Winter (June/July/August) 4
   No season is worse than any other.. 5

8. What would be the **worst** possible day of the week for a power failure to occur?
SINGLE RESPONSE ONLY

Monday to Friday.. 1
Saturday.. 2
Sunday 3
No day is worse than any other.. 4

9. And what would be the worst possible time or times for a power failure to occur?
MULTIPLE RESPONSE

6am to 9am 1
9am to noon 2
Noon to 3pm.. 3
3pm to 6pm 4
6pm to 9pm 5
9pm to midnight.. 6
Midnight to 6am.. 7
No time is worse than any other... 8

The costs of power failures to your business

Now I am going to ask you some questions about the costs to your business if a power failure occurred, without warning, at the WORST TIME for your [BUS/FARM] and how these costs would change depending on the length of the power failure.

[PRESENT PARAGRAPH IF Q6 = 1-4]
If your backup power supply is normally in operation during a power failure, please estimate the losses to your business of a failure based on the assumption that the backup supply is used to the fullest extent possible during the interruption.

I am going to ask you to consider power failures of 20 minutes, one hour, two hours, four hours, eight hours and twenty four hours duration. You can estimate the total cost to your business for each duration, or you may find it easier to estimate costs in a number of categories such as...

For farms [BUS/FARM = FARM]

- Loss of livestock or produce
- Damage to farm equipment
- Paid staff unable to work
- Sales foregone from production that can't be made up
- Costs to repair possible damage to the environment

For business [BUS/FARM = BUSINESS]

- Damage to or spoilage of raw materials or products used in the business
- Damage to plant or equipment
- Costs of paid staff unable to work due to the outage
- Sales lost due to the power failure that cannot be recovered
- Cost to recover data lost from computer systems

10. Would you like to estimate costs in total amount or for specific categories?

Total.. 1 GO TO 11
Categories .... 2 GO TO 10a

10a Which categories would you like to use?
(MULTI RESPONSE)

ASK LIST AS APPROPRIATE [BUS/FARM]

Lengths to use for Q10b and Q11

1. twenty minutes
2. one hour
3. two hour
4. four hour
5. eight hour
6. twenty-four hour

LOOP EACH CATEGORY IN EACH LENGTH (I.E. ASK ALL CATEGORIES FOR A 20 MIN POWER FAILURE FIRST]

Q10b For a [length] power failure, what do you estimate the cost to your business would be for [category]?

[RECORD $ AMOUNT]

Q11 For a [length] power failure, what do you estimate the total cost to your business would be?

NOTE: ALLOW DK. IF DK TO ALL Q10b/Q11 THEN TERMINATE

TERM TEXT: We appreciate that it is difficult to estimate these costs for some businesses. In order to calculate the cost to business we need to speak with businesses that can make these estimates. We really appreciate your help with the study, however as we will be unable to use this data we do not want to take any more of your time. Once again, thank you.

Your business/Farm

To make sure that the results of this survey are representative of all NSW organisations we need to ask you some questions about the details of your business/farm.

12. (BUSINESS ONLY) Which of the following best describes the type of business activities carried out at this location?

Agriculture, forestry and fishing.. 1
Accommodation, cafes and restaurant.. 2
Communications... 3
Construction 4
Cultural and recreation Services 5
Education 6
Electricity, gas and water 7
Finance and insurance services.. 8
Health and community services 9
Manufacturing... 10
Mining 11
Personal and other services.. 12
Property and business services 13
Retail trade 14
Transport and storage 15
Wholesale trade 16
Other (specify)... 17

ASK IF BUS/FARM = FARM

12a. Which of the following best describes the type of agricultural activity carried out at this location?
SINGLE RESPONSE ONLY

Dairy cattle 1
Beef cattle 2
Poultry for meat or eggs 3
Pigs... 4
Sheep 5
Cotton 6
Rice 7
Cereal grains 8
Vegetables 9
Fruit 10
Nursery... 11
Greenhouse or hydroponics 12
Other (specify).. 13

Businesses only Q12-15

13. Do you own or rent your premises?

Own/paying off .... 1 GO TO Q15
Rent.. 2 GO TO 14
Don't know.. 3 GO TO Q15

14. Is your landlord responsible for supplying electrical services such as air conditioning, hot water or lifts to your business?
SINGLE RESPONSE ONLY

Yes .... 1 GO TO Q15
No .... 2 GO TO Q16
Don't know .... 3 GO TO Q16

15. Please indicate which of the following services are supplied by your landlord. Please mark all that apply.

MULTI RESPONSE

Air conditioning and ventilation 1
Space heating 2
Hot water 3
Lifts 4
Car park lighting and ventilation 5

16. Which **one** of the following **best** describes the type of premises in which your business is located?
SINGLE RESPONSE ONLY ALLOWED

Enclosed shopping centre 1
Multi-level office (more than 5 floors) 2
Multi-level retail (more than 5 floors) 3
Multi-level combined office/retail (more than 5 floors) 4
Standalone Building of one to four floors 5
Other (Specify) 6

Farming operations only others to Q19

17. Is the electricity bill for your farming operation combined with the bill for your household?

No, my farm and household electricity accounts are separate .... 1 GO TO Q20
Yes, my farm and household electricity accounts are combined. 2 CONTINUE

18. Please indicate which of the following electrical appliances you have in your household
MULTI

Central space heating 1
Individual room heaters 2
Central air conditioning 3
Individual room air conditioners 4
Large off-peak storage hot water 5
Small electric hot water unit 6
Electric cook top and oven 7
Solar power? 8

FOR EACH OF 18 = 2, 4 OR 6 – ASK 19

19. How many (answer from 18) do you have?

Individual room heaters .... *(RECORD NUMBER)*
Individual room air conditioners .... *(RECORD NUMBER)*
Small electric hot water unit .... *(RECORD NUMBER)*

20. Do you have any other comments you'd like to make about the effects of power failures or the reliability of your power supply?

RECORD VERBATIM

On behalf of the Australian Energy Market Commission and Wallis Consulting Group, thank you for your help with this survey, the information you have provided will help to ensure that the farms and businesses of New South Wales have an economical and reliable supply of electricity. Your views count and we're glad you made them known to us. Just in case you missed it, my name is ………., from Wallis Consulting Group. As I mentioned, this survey is totally confidential. No information that you have given me will be passed on in a way in which you or your answers could be identified.

Thanks for your time.

Appendix B: Algorithms used in calculating the VCR

B.1 Calculation of VCRs for "sector / feeder / DNSP"

In generic terms, the average VCR per kWh for a specific interruption duration (j) for any DNSP / feeder / sector can be expressed as follows:[41]

$$VCR_j = \sum_{i=1}^{N} \left\{ \left[\left(\frac{Cost_{ij}}{Int_j} \right) / \left(\frac{kWh_i}{8750} \right) \right] * weight_i \right\} \quad [B1a]$$

$$= \sum_{i=1}^{N} \left(\frac{Cost_{ij}}{Int_j} * \frac{8760}{kWh_i} * \frac{kWh_i}{\sum_{i=1}^{N} kWh_i} \right) \quad [B1b]$$

$$= \frac{\sum_{i=1}^{N} Cost_{ij}}{\sum_{i=1}^{N} kWh_i} * 8760 \Big/ Int_j \quad [B1c]$$

where:

VCR_j = the value of customer reliability for duration j;

$Cost_{ij}$ = cost reported by business / household respondent i for duration j;

kWh_i = annual energy consumption of business / household respondent i; and

Int_j = number of hours of interruption of duration j.

Table 50 contains an example from the VCR calculation model relating to the application of equation [B1].

41 Note that in performing this calculation for each interruption duration, usable survey information is restricted to responses from businesses (households) who consciously identified a cost of economic damage (likely mitigation cost) ≥ zero, and for whom we were able to identify their annual electricity consumption. Survey responses from businesses (households) were excluded where either: (a) the assessment of economic damage (likely mitigation cost) was "don't know"; or (b) the annual electricity consumption could not be identified.

Table 50: Example calculation of VCR by interruption duration
[Small business* / urban feeders / Endeavour Energy]

Assumed interruption duration [Int_j]	Interruption costs from usable records [$\sum_{i=1}^{n} Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\sum_{i=1}^{n} kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]
20 minutes	$139,737	4,003,793	$917.20
1 hours	$314,095	4,180,369	$658.19
2 hours	$549,600	4,181,289	$575.72
4 hours	$884,029	4,153,080	$466.17
8 hours	$1,553,800	4,244,998	$400.80
24 hours	$1,951,994	4,123,417	$172.79

* Businesses whose annual electricity consumption is under 160 MWh.

The interpretation of the right-most column of Table 50 is that (for example) $466.17 represents the cost per kWh of USE that would be incurred if the average small business were to incur a 4 hour electricity supply interruption at the worst possible time.

In order to calculate a customer sector VCR, we need to weight the interruption duration VCRs . This is done by applying the probability of an outage of each of the relevant durations occurring. For each feeder type (CBD, urban, short rural and long rural) and DNSP (Ausgrid, Endeavour Energy, Essential Energy) we use the DNSP-supplied number of outages[42] that fall into the following duration buckets:

a) up to 20 minutes;

b) 21 to 60 minutes;

c) 61 minutes to 2 hours;

d) over 2 hours and up to 4 hours;

e) over 4 hours and up to 8 hours; and

f) over 8 hours and up to 24 hours.

The probability of occurrence of each outage duration is then calculated as the proportion of all outages that were of that duration.

To produce a customer sector VCR, the individual interruption duration VCRs are weighted across all durations as follows:

42 Distribution outages, excluding major event days, plus outages caused by transmission and generation.

$$VCR_s = \sum_j [VCR_j * P_j] \qquad [B2]$$

where:

VCR_s = the value of customer reliability for customer sector s; and

P_j = the probability of an interruption of duration j; and

$$\sum_j P_j = 1$$

Continuing the example from above, Table 51 shows the calculation of the VCR for small businesses on urban feeders in the Endeavour Energy DNSP territory.

Table 51: Example calculation of the VCR for one customer sector
[Small business* / urban feeders / Endeavour Energy]

Assumed interruption duration [Int_j]	Interruption duration VCR ($/kWh) [$VCR_j$]	Probability of an interruption** [P_j]	Duration weighted contribution to sectoral VCR ($/kWh) [$VCR_j$] * [$P_j$]
20 minutes	$917.20	0.083	$76.09
1 hours	$658.19	0.204	$134.47
2 hours	$575.72	0.366	$210.59
4 hours	$466.17	0.227	$106.00
8 hours	$400.80	0.099	$39.52
24 hours	$172.79	0.021	$3.62
All interruption durations		**1.000**	**$570.29**

* Businesses whose annual electricity consumption is under 160 MWh.
** Average probability over the 2008-09 to 2010-11 FYs.

In terms of Table 7 we have now completed the calculation for one cell – see Table 52.

Table 52: Example VCR for one customer sector / feeder type* / DNSP territory

Customer sector	Ausgrid			Endeavour Energy		Essential Energy	
	CBD feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders
Residential	?	?	?	?	?	?	?
Business <160 MWhpa	?	?	?	$570.29	?	?	?
Business ≥ 160 MWhpa	?	?	?	?	?	?	?

* Endeavour Energy and Essential Energy do not have CBD feeders.

A similar process is then followed to calculate average VCRs for each "customer sector" / "feeder type" / "DNSP territory". These base level VCRs are the building blocks for other locationally aggregated weighted average VCRs.

B.2 Calculation of VCRs by "feeder type state-wide" or "DNSP territory"

Using the 21 base level VCRs that are available in a completed version of Table 52 along with DNSP supplied information with respect to annual consumption in MWh by "customer sector" / "feeder type" / "DNSP territory", we are able to produce weighted average VCRs for three logical aggregation levels:

1. Aggregation level 1:
   a) all customer sectors plus any feeder type and any DNSP territory – 7 possible combinations;
   b) all feeder types plus any customer sectors and any DNSP territory – 9 possible combinations;
   c) all DNSP territories plus any customer sectors and any feeder type – 7 possible combinations;
2. Aggregation level 2:
   a) all customer sectors and all feeder types plus any DNSP territory – 3 possible combinations;
   b) all customer sectors and all DNSP territories plus any feeder type – 3 possible combinations;
   c) all feeder types and all DNSP territories plus any customer sector – 3 possible combinations;
3. Aggregation level 3: customer sectors, all feeder types and all DNSP territories – that is, an overall state-wide VCR.

In order to weight the results across customer sectors for each DNSP and feeder type, we use DNSP supplied data on annual metered energy by "customer sector" / "feeder type" / "DNSP territory". Given this information, the sectoral weightings for a given "customer sector" / "feeder type" / "DNSP territory" are specified algebraically as follows:

$$Weight_{sfd} = \frac{MWh_{sfd}}{\sum_{s=1}^{3} MWh_{sfd}} \qquad [B3]$$

where:

MWh_{sfd} = aggregate annual energy served in customer sector s on feeder type f for DNSP territory d.

s = customer sector: residential households, small business, larger business;

f = feeder type: CBD feeders, urban feeders, rural feeders; and

d = DNSP territory: Ausgrid, Endeavour Energy, Essential Energy.

The VCR for aggregation 1a) - that is, for all s and any combination of f and d - would be specified algebraically as follows:

$$VCR_{fd} = \sum_{s=1}^{3}\left(VCR_{sfd} * \frac{MWh_{sfd}}{\sum_{s=1}^{3} MWh_{sfd}}\right) \qquad [B4]$$

where:

MWh_{fd} = aggregate annual energy served on feeder type f for DNSP territory d across all customer sectors;

VCR_{sfd} = the VCR for customer sector s on feeder type f for DNSP territory d; and

Continuing the earlier example, Table 53 calculates the average VCR for all customer sectors on urban feeders in the Endeavour Energy DNSP territory.

Table 53: Example calculation VCR for all customer sectors on one feeder type in one DNSP territory [urban feeders / Endeavour Energy]

Customer sector	Sectoral VCR $[VCR_{sfd}]$	Sectoral weights $[MWh_{sfd}]$*	Sectoral weights $[Weight_{sfd}]$**	Energy weighted contribution to VCR $[VCR_{sfd}] * [Weight_{sfd}]$
Residential	$20.41	5,100,734	37.4%	$7.64
Business <160 MWhpa	$570.29	2,172,248	15.9%	$90.90
Business ≥ 160 MWhpa	$36.71	6,355,904	46.6%	$17.12
All customer sectors		**13,628,885**	**100%**	**$115.65**

* Average annual energy over the 2008-09 to 2010-11 FYs.
** Reported weights might not add to 100% exactly due to rounding.

In terms of Table 7, we have now completed the calculation for three cells and one total for all sectors on one feeder type in one DNSP territory – see Table 54.

Table 54: Example VCR for all customer sectors on one feeder type in one DNSP territory

Customer sector	Ausgrid			Endeavour Energy		Essential Energy	
	CBD feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders	Urban feeders	Rural feeders
Residential	?	?	?	$20.41	?	?	?
Business <160 MWhpa	?	?	?	$570.29	?	?	?
Business ≥ 160 MWhpa	?	?	?	$36.71	?	?	?
All customer sectors	?	?	?	**$115.65**	?	?	?

The VCR for aggregation 1b) – that is, for all f and any combination of s and d – would be specified algebraically as follows:

$$VCR_{sd} = \sum_{f=1}^{3}\left(VCR_{sfd} * \frac{MWh_{sfd}}{\sum_{f=1}^{3} MWh_{sfd}}\right) \quad [B5]$$

where:

VCR_{fd} = the weighted average value of customer reliability across all feeder types for customer sector s in DNSP territory d.

The VCR for aggregation 1c) – that is, for all d and any combination of s and f – would be specified algebraically as follows:

$$VCR_{sf} = \sum_{d=1}^{3}\left(VCR_{sfd} * \frac{MWh_{sfd}}{\sum_{d=1}^{3} MWh_{sfd}}\right)$$ [B6]

where:

VCR_{sf} = the weighted average value of customer reliability across all DNSP territories for customer sector s on feeder type f.

The VCR for aggregation 2a) - that is, for all s and all f and any d - would be specified algebraically as follows:

$$VCR_{d} = \sum_{f=1}^{3}\left[\sum_{s=1}^{3}\left(VCR_{sfd} * \frac{MWh_{sfd}}{\sum_{s=1}^{3} MWh_{sfd}}\right) * \frac{MWh_{fd}}{\sum_{f=1}^{3} MWh_{fd}}\right]$$ [B7]

where:

VCR_{d} = the weighted average value of customer reliability across all customer sectors and all feeder types in DNSP territory d.

The VCR for aggregation 2b) - that is, for all s and all d and any f - would be specified algebraically as follows:

$$VCR_{f} = \sum_{d=1}^{3}\left[\sum_{s=1}^{3}\left(VCR_{sfd} * \frac{MWh_{sfd}}{\sum_{s=1}^{3} MWh_{sfd}}\right) * \frac{MWh_{fd}}{\sum_{d=1}^{3} MWh_{fd}}\right]$$ [B8]

where:

VCR_{f} = the weighted average value of customer reliability across all customer sectors and all DNSP territories on feeder type f.

The VCR for aggregation 2c) - that is, for all f and all d and any s - would be specified algebraically as follows:

$$VCR_{s} = \sum_{d=1}^{3}\left[\sum_{f=1}^{3}\left(VCR_{sfd} * \frac{MWh_{sfd}}{\sum_{f=1}^{3} MWh_{sfd}}\right) * \frac{MWh_{fd}}{\sum_{d=1}^{3} MWh_{fd}}\right]$$ [B9]

where:

VCR_{s} = the weighted average value of customer reliability across all feeder types and all DNSP territories in customer sector s.

The overall state-wide VCR can be calculated as follows:

$$VCR_{NSW} = \sum_{f=1}^{3} VCR_{f} * \frac{MWh_{f}}{\sum_{f=1}^{3} MWh_{f}} = \sum_{d=1}^{3} VCR_{d} * \frac{MWh_{d}}{\sum_{d=1}^{3} MWh_{d}}$$ [B10]

where:

MWh_f = aggregate annual energy served on feeder type f across all DNSP territories;

MWh_d = aggregate annual energy served for DNSP territory d across all feeder types; and

VCR_{NSW} = the state-wide weighted average value of customer reliability.

Appendix C: Detailed inputs to VCR calculations

Table 55: Ausgrid - CBD feeders

Customer sector	Assumed interruption duration [Int_j]	Number of usable records [N]	Interruption costs from usable records [$\Sigma_j Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\Sigma_i kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]	% standard error on USE estimate [$\%\mathcal{E}_{USE}$]	Probability of an interruption [P_j]
Residential							
	0.50 hours	30	$496	127,784	$68.00	33.6	0. 228
	2.5 hours	29	$865	126,734	$23.92	24.4	0. 441
	6 hours	30	$1,657	127,784	$18.93	20.2	0. 197
	16 hours	30	$4,299	127,784	$18.42	17.5	0. 134
Small business							
	20 minutes	6	$4,020	251,525	$420.02	62.9	0. 055
	1 hours	6	$8,275	251,525	$288.20	55.4	0. 173
	2 hours	6	$20,450	251,525	$356.11	61.4	0. 197
	4 hours	6	$37,000	251,525	$322.16	66.5	0. 244
	8 hours	6	$62,300	251,525	$271.22	67.4	0. 197
	24 hours	6	$106,400	251,525	$154.40	80.4	0. 134
Larger business							
	20 minutes	5	$61,800	6,812,153	$238.41	128.9	0. 055
	1 hours	5	$92,500	6,812,153	$118.95	114.4	0. 173
	2 hours	5	$152,000	6,812,153	$97.73	115.3	0. 197
	4 hours	5	$190,500	6,812,153	$61.24	109.8	0. 244
	8 hours	5	$323,000	6,812,153	$51.92	113.7	0. 197
	24 hours	5	$333,000	6,812,153	$17.84	111.8	0. 134

Table 56: Ausgrid - urban feeders

Customer sector	Assumed interruption duration [Int_j]	Number of usable records [N]	Interruption costs from usable records [$\Sigma_j Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\Sigma_i kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]	% standard error on USE estimate [$\%\mathcal{E}_{USE}$]	Probability of an interruption [P_j]
Residential							
	0.50 hours	181	$3,269	1,300,050	$44.05	16.0	0. 181
	2.5 hours	179	$8,336	1,288,174	$22.67	13.5	0. 581
	6 hours	181	$15,114	1,300,050	$16.97	8.9	0. 160
	16 hours	181	$28,537	1,300,050	$12.02	8.7	0. 079
Small business							
	20 minutes	125	$132,328	4,569,606	$761.02	29.1	0. 030
	1 hours	127	$286,265	4,606,406	$544.39	24.7	0. 151
	2 hours	125	$441,708	4,459,145	$433.87	24.3	0. 307
	4 hours	126	$932,055	4,594,978	$444.22	29.0	0. 273
	8 hours	128	$1,672,830	4,640,953	$394.69	28.3	0. 160
	24 hours	129	$1,927,035	4,667,078	$150.71	26.5	0. 079
Larger business							
	20 minutes	21	$137,481	76,041,462	$47.51	90.3	0. 030
	1 hours	21	$251,255	76,041,462	$28.94	89.2	0. 151
	2 hours	21	$438,566	76,041,462	$25.26	90.4	0. 307
	4 hours	20	$927,468	72,262,235	$28.11	96.1	0. 273
	8 hours	21	$1,537,041	76,041,462	$22.13	93.3	0. 160
	24 hours	21	$2,504,206	76,041,462	$12.02	88.3	0. 079

Table 57: Ausgrid - rural feeders

Customer sector	Assumed interruption duration [Int_j]	Number of usable records [N]	Interruption costs from usable records [$\Sigma_j Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\Sigma_i kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]	% standard error on USE estimate [$\%\mathcal{E}_{USE}$]	Probability of an interruption [P_j]
Residential							
	0.50 hours	41	$322	362,186	38.4	$15.58	0. 178
	2.5 hours	41	$1,140	362,186	26.7	$11.03	0. 605
	6 hours	40	$2,453	357,914	18.4	$10.01	0. 154
	16 hours	41	$4,930	362,186	17.6	$7.45	0. 063
Small business							
	20 minutes	31	$11,790	1,430,380	29.7	$216.61	0. 040
	1 hours	31	$77,490	1,430,380	66.3	$474.57	0. 138
	2 hours	31	$111,490	1,430,380	56.0	$341.40	0. 307
	4 hours	31	$205,025	1,430,380	50.7	$313.91	0. 298
	8 hours	31	$301,655	1,430,380	42.6	$230.93	0. 154
	24 hours	31	$358,505	1,430,380	37.2	$91.48	0. 063
Larger business							
	20 minutes	9	$38,100	8,044,860	68.8	$124.46	0. 040
	1 hours	9	$48,150	8,044,860	75.8	$52.43	0. 138
	2 hours	9	$78,050	8,044,860	81.2	$42.49	0. 307
	4 hours	9	$101,950	8,044,860	67.9	$27.75	0. 298
	8 hours	9	$82,600	8,044,860	57.0	$11.24	0. 154
	24 hours	8	$103,300	7,239,189	59.9	$5.21	0. 063

Table 58: Endeavour Energy – urban feeders

Customer sector	Assumed interruption duration [Int_j]	Number of usable records [N]	Interruption costs from usable records [$\Sigma_j Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\Sigma_i kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]	% standard error on USE estimate [$\%\mathcal{E}_{USE}$]	Probability of an interruption [P_j]
Residential							
	0.50 hours	166	$2,514	1,299,180	$33.90	16.4	0. 287
	2.5 hours	166	$5,647	1,298,547	$15.24	12.0	0. 593
	6 hours	166	$12,881	1,291,329	$14.56	9.2	0. 099
	16 hours	166	$22,658	1,294,644	$9.58	8.6	0. 021
Small business							
	20 minutes	141	$139,737	4,003,793	$917.20	19.7	0. 083
	1 hours	146	$314,095	4,180,369	$658.19	18.4	0. 204
	2 hours	145	$549,600	4,181,289	$575.72	18.1	0. 366
	4 hours	145	$884,029	4,153,080	$466.17	18.5	0. 227
	8 hours	148	$1,553,800	4,244,998	$400.80	18.8	0. 099
	24 hours	146	$1,951,994	4,123,417	$172.79	18.6	0. 021
Larger business							
	20 minutes	17	$58,380	21,069,129	$72.82	62.8	0. 083
	1 hours	18	$131,300	23,329,313	$49.30	65.1	0. 204
	2 hours	18	$178,750	23,329,313	$33.56	58.1	0. 366
	4 hours	18	$286,700	23,329,313	$26.91	53.5	0. 227
	8 hours	18	$433,880	23,329,313	$20.36	52.7	0. 099
	24 hours	18	$581,900	23,329,313	$9.10	51.6	0. 021

Table 59: Endeavour Energy - rural feeders

Customer sector	Assumed interruption duration $[Int_j]$	Number of usable records $[N]$	Interruption costs from usable records $[\Sigma_j Cost_{ij}]$	Annual energy consumption of relevant customers (kWh) $[\Sigma_i kWh_i]$	Interruption duration VCR ($/kWh) $[VCR_j]$	% standard error on USE estimate $[\%\mathcal{E}_{USE}]$	Probability of an interruption $[P_j]$
Residential							
	0.50 hours	65	$887	539,878	$28.77	27.9	0. 183
	2.5 hours	65	$2,042	518,602	$13.80	17.8	0. 654
	6 hours	66	$4,450	549,102	$11.83	16.1	0. 131
	16 hours	66	$7,686	549,102	$7.66	15.2	0. 032
Small business							
	20 minutes	49	$29,215	1,262,198	$608.28	37.3	0. 046
	1 hours	49	$93,502	1,262,198	$648.93	30.1	0. 137
	2 hours	49	$145,400	1,262,198	$504.56	24.9	0. 330
	4 hours	49	$247,440	1,262,198	$429.33	25.3	0. 325
	8 hours	50	$626,260	1,270,968	$539.55	33.9	0. 131
	24 hours	49	$939,200	1,262,198	$271.60	34.0	0. 032
Larger business							
	20 minutes	6	$1,800	3,354,553	$14.10	98.8	0. 046
	1 hours	6	$5,900	3,354,553	$15.41	84.3	0. 137
	2 hours	6	$8,800	3,354,553	$11.49	76.4	0. 330
	4 hours	6	$14,900	3,354,553	$9.73	75.9	0. 325
	8 hours	6	$29,000	3,354,553	$9.47	77.4	0. 131
	24 hours	6	$35,500	3,354,553	$3.86	73.1	0. 032

Table 60: Essential Energy - urban feeders

Customer sector	Assumed interruption duration [Int_j]	Number of usable records [N]	Interruption costs from usable records [$\Sigma_i Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\Sigma_i kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]	% standard error on USE estimate [$\%\mathcal{E}_{USE}$]	Probability of an interruption [P_j]
Residential							
	0.50 hours	36	$482	224,064	$37.69	31.2	0. 344
	2.5 hours	36	$940	224,064	$14.70	23.0	0. 582
	6 hours	36	$2,254	224,064	$14.69	20.9	0. 055
	16 hours	36	$4,112	224,064	$10.05	20.2	0. 019
Small business							
	20 minutes	33	$8,831	1,124,952	$206.30	36.7	0. 068
	1 hours	34	$15,990	1,130,028	$123.95	29.9	0. 276
	2 hours	34	$30,050	1,130,028	$116.47	27.6	0. 432
	4 hours	34	$54,400	1,130,028	$105.43	28.0	0. 150
	8 hours	34	$126,585	1,130,028	$122.66	27.6	0. 055
	24 hours	34	$212,650	1,130,028	$68.69	31.0	0. 019
Larger business							
	20 minutes	8	$24,302	9,067,647	$70.43	62.0	0. 068
	1 hours	8	$25,500	9,067,647	$24.63	59.5	0. 276
	2 hours	8	$40,300	9,067,647	$19.47	56.0	0. 432
	4 hours	8	$96,400	9,067,647	$23.28	52.9	0. 150
	8 hours	8	$151,200	9,067,647	$18.26	50.2	0. 055
	24 hours	8	$325,400	9,067,647	$13.10	52.4	0. 019

Table 61: Essential Energy - rural feeders

Customer sector	Assumed interruption duration [Int_j]	Number of usable records [N]	Interruption costs from usable records [$\Sigma_j Cost_{ij}$]	Annual energy consumption of relevant customers (kWh) [$\Sigma_i kWh_i$]	Interruption duration VCR ($/kWh) [$VCR_j$]	% standard error on USE estimate [$\%\mathcal{E}_{USE}$]	Probability of an interruption [P_j]
Residential							
	0.50 hours	198	$2,691	1,523,911	$30.94	16.1	0. 248
	2.5 hours	198	$5,050	1,523,780	$11.61	11.7	0. 590
	6 hours	201	$13,435	1,546,013	$12.69	8.7	0. 109
	16 hours	201	$22,718	1,546,013	$8.05	8.5	0. 053
Small business							
	20 minutes	104	$52,095	2,662,140	$514.27	56.4	0. 068
	1 hours	104	$57,449	2,646,386	$190.17	24.9	0. 180
	2 hours	105	$108,200	2,670,651	$177.45	21.9	0. 351
	4 hours	105	$333,783	2,670,651	$273.71	34.7	0. 239
	8 hours	105	$972,084	2,674,381	$398.01	44.1	0. 109
	24 hours	105	$1,597,676	2,689,836	$216.80	52.3	0. 053
Larger business							
	20 minutes	7	$38,676	1,910,453	$532.02	83.5	0. 068
	1 hours	7	$53,030	1,910,453	$243.16	64.3	0. 180
	2 hours	7	$76,560	1,910,453	$175.53	55.8	0. 351
	4 hours	7	$90,700	1,910,453	$103.97	57.7	0. 239
	8 hours	7	$174,740	1,910,453	$100.15	51.1	0. 109
	24 hours	7	$611,000	1,910,453	$116.73	73.3	0. 053

Table 62: Low income residential

Customer sector	Assumed interruption duration $[Int_j]$	Number of usable records $[N]$	Interruption costs from usable records $[\Sigma_j Cost_{ij}]$	Annual energy consumption of relevant customers (kWh) $[\Sigma_i kWh_i]$	Interruption duration VCR ($/kWh) $[VCR_j]$	% standard error on USE estimate $[\%\mathcal{E}_{USE}]$	Probability of an interruption $[P_j]$
State-wide							
	0.50 hours	179	$1,778	1,041,982	$29.89	17.3	0. 234
	2.5 hours	180	$3,526	1,048,240	$11.79	14.5	0. 592
	6 hours	181	$7,622	1,059,811	$10.50	11.2	0. 120
	16 hours	182	$14,458	1,064,083	$7.44	10.5	0. 054
Urban feeders							
	0.50 hours	83	$831	474,191	$30.68	27.5	0. 229
	2.5 hours	83	$1,732	474,191	$12.80	23.7	0. 583
	6 hours	83	$3,392	474,191	$10.44	18.8	0. 130
	16 hours	83	$6,382	474,191	$7.37	18.4	0. 058
Rural feeders							
	0.50 hours	92	$855	559,667	$26.77	22.9	0. 235
	2.5 hours	93	$1,661	565,926	$10.28	18.2	0. 596
	6 hours	94	$4,122	577,496	$10.42	13.9	0. 116
	16 hours	95	$7,744	581,769	$7.29	12.3	0. 053

Table 63: VCR components by business type

Customer sector	Assumed interruption duration $[Int_j]$	Number of usable records $[N]$	Interruption costs from usable records $[\Sigma_j Cost_{ij}]$	Annual energy consumption of relevant customers (kWh) $[\Sigma_i kWh_i]$	Interruption duration VCR ($/kWh) $[VCR_j]$	% standard error on USE estimate $[\%\mathcal{E}_{USE}]$	Probability of an interruption $[P_j]$

Customer sector	Assumed interruption duration $[Int_j]$	Number of usable records $[N]$	Interruption costs from usable records $[\Sigma_j Cost_{ij}]$	Annual energy consumption of relevant customers (kWh) $[\Sigma_i kWh_i]$	Interruption duration VCR ($/kWh) $[VCR_j]$	% standard error on USE estimate $[\%\mathcal{E}_{USE}]$	Probability of an interruption $[P_j]$
Agricultural							
	20 minutes	11	$3,550	804,568	$115.96	81.9	0. 059
	1 hours	11	$7,750	804,568	$84.38	80.0	0. 175
	2 hours	11	$23,260	804,568	$126.63	72.8	0. 343
	4 hours	12	$38,830	822,092	$103.44	71.5	0. 249
	8 hours	12	$64,340	822,092	$85.70	76.0	0. 120
	24 hours	12	$80,860	822,092	$35.90	66.9	0. 054
Commercial							
	20 minutes	315	$316,593	26,551,098	$313.36	32.8	0. 059
	1 hours	322	$713,554	26,670,044	$234.37	31.0	0. 175
	2 hours	319	$1,190,270	26,524,716	$196.55	32.1	0. 343
	4 hours	320	$2,350,313	26,654,360	$193.11	34.6	0. 249
	8 hours	324	$4,103,208	26,740,798	$168.02	33.5	0. 120
	24 hours	321	$5,782,975	26,630,462	$79.26	32.3	0. 054
Manufacturing / industrial							
	20 minutes	181	$328,812	110,108,795	$78.48	57.7	0. 059
	1 hours	184	$618,837	112,476,996	$48.20	55.4	0. 175
	2 hours	184	$1,009,756	112,475,983	$39.32	54.7	0. 343
	4 hours	182	$1,626,137	108,657,212	$32.77	56.0	0. 249
	8 hours	186	$2,741,566	112,521,959	$26.68	54.2	0. 120
	24 hours	185	$3,895,160	111,716,288	$12.73	55.5	0. 054

Table 64: Business type VCRs, std errors and sample sizes ($/kWh)

	State-wide	Agricultural*	Commercial*	Manufacturing / industrial*
VCR	$94.99	$102.99	$199.37	$38.58
Standard error	$5.91	$39.63	$31.46	$10.36
Sample size**	1,288	12	320	184

* Not weighted by feeder type or DNSP.
** Sample sizes identified here are actually an average of the sample sizes used to estimate a value of USE for each interruption duration.

Appendix D: Calculation of standard errors

As indicated in Section 3.2.1, the value of customer reliability for duration j is calculated as follows:

$$VCR_j = \frac{\sum_{i=1}^{N} Cost_{ij}}{\sum_{i=1}^{N} kWh_i} * 8760 \Big/ Int_j \qquad [D1]$$

That is, the base level VCR is comprised of two variables each with their own distribution, mean and standard error. The standard error of the mean (SEM) for each of $Cost_{ij}$ and kWh_i is given by:

$$SEM_{Cost} = \frac{\sigma_{Cost}}{\sqrt{N-1}} \qquad [D2]$$

$$SEM_{kWh} = \frac{\sigma_{kWh}}{\sqrt{N-1}} \qquad [D3]$$

where:

SEM	=	standard error of the mean;
σ	=	standard deviation; and
N	=	size of the sample used in calculating $\sum_{i=1}^{N} Cost_{ij}$ and $\sum_{i=1}^{N} kWh_i$.

The error in value of USE per kWh is thus derives from the errors associated with the variables underlying the calculation of the value of USE per kWh, such that:

$$\%\varepsilon_{USE} = \sqrt{(\%SEM_{Cost})^2 + (\%SEM_{kWh})^2} \qquad [D4]$$

where:

$\%\varepsilon_{USE}$	=	the error of the estimation of the value of USE per kWh as a percentage of the estimated value of USE per kWh;
$\%SEM_{Cost}$	=	standard error of the mean of $Cost_i$ as a percentage of the mean of $Cost_i$; and
$\%SEM_{kWh}$	=	standard error of the mean of kWh_i as a percentage of the mean of kWh_i.

The above method of calculation is used to produce the figures in the second last column of each of the tables in Appendix C.

The standard errors associated with a sectoral VCR are calculated as follows:

$$\sigma_{VCR(sfd)} = \sqrt{\sum_{j}\left[\left(\%\varepsilon_{USE} * VCR_j * P_j\right)^2\right]} \qquad [D5]$$

where:

VCR_j = the value of customer reliability for duration j;

P_j = the probability of an interruption of duration j;

s = customer sector: residential households, small business, larger business;

f = feeder type: CBD feeders, urban feeders, rural feeders;

d = DNSP territory: Ausgrid, Endeavour Energy, Essential Energy;

$\sigma_{VCR(sfd)}$ = the standard error associated with estimates of the VCR in customer sector s on feeder type f for DNSP territory d.

The standard errors associated with subsequent weighted average VCRs aggregated at a higher level are as follows:

$$\sigma_{VCR(fd)} = \sqrt{\sum_{s}\left[\left(\sigma_{VCR(sfd)} * \frac{MWh_{sfd}}{\sum_{s=1}^{3} MWh_{sfd}}\right)^2\right]} \qquad [D6]$$

$$\sigma_{VCR(sd)} = \sqrt{\sum_{f=1}^{3}\left[\left(\sigma_{VCR(sfd)} * \frac{MWh_{sfd}}{\sum_{f=1}^{3} MWh_{sfd}}\right)^2\right]} \qquad [D7]$$

$$\sigma_{VCR(sf)} = \sqrt{\sum_{d=1}^{3}\left[\left(\sigma_{VCR(sfd)} * \frac{MWh_{sfd}}{\sum_{d=1}^{3} MWh_{sfd}}\right)^2\right]} \qquad [D8]$$

$$\sigma_{VCR(s)} = \sqrt{\sum_{f=1}^{3}\left[\left(\sigma_{VCR(sf)} * \frac{MWh_{sf}}{\sum_{f=1}^{3} MWh_{sf}}\right)^2\right]} \qquad [D9]$$

$$\sigma_{VCR(f)} = \sqrt{\sum_{d=1}^{s}\left[\left(\sigma_{VCR(fd)} * \frac{MWh_{fd}}{\sum_{d=1}^{s} MWh_{fd}}\right)^{2}\right]} \qquad [D10]$$

$$\sigma_{VCR(d)} = \sqrt{\sum_{f=1}^{s}\left[\left(\sigma_{VCR(fd)} * \frac{MWh_{fd}}{\sum_{f=1}^{s} MWh_{fd}}\right)^{2}\right]} \qquad [D11]$$

$$\sigma_{VCR(NSW)} = \sqrt{\sum_{f=1}^{s}\left[\left(\sigma_{VCR(f)} * \frac{MWh_{f}}{\sum_{f=1}^{s} MWh_{f}}\right)^{2}\right]} = \sqrt{\sum_{d=1}^{s}\left[\left(\sigma_{VCR(d)} * \frac{MWh_{d}}{\sum_{d=1}^{s} MWh_{d}}\right)^{2}\right]} \qquad [D12]$$

where:

MWh_{sfd}	=	aggregate annual energy served in customer sector s on feeder type f for DNSP territory d;
MWh_{sf}	=	aggregate annual energy served in customer sector s on feeder type f across all DNSP territories;
MWh_{fd}	=	aggregate annual energy served on feeder type f for DNSP territory d across all customer sectors;
MWh_{f}	=	aggregate annual energy served on feeder type f across all DNSP territories;
MWh_{d}	=	aggregate annual energy served for DNSP territory d across all feeder types;
$\sigma_{VCR(fd)}$	=	the standard error associated with estimates of the VCR on feeder type f for DNSP territory d across all customer sectors.
$\sigma_{VCR(sd)}$	=	the standard error associated with estimates of the VCR in customer sector s for DNSP territory d across all feeder types.
$\sigma_{VCR(sf)}$	=	the standard error associated with estimates of the VCR in customer sector s on feeder type f across all DNSP territories.
$\sigma_{VCR(s)}$	=	the standard error associated with estimates of the VCR on customer sector s across all feeder types and DNSP territories.

$\sigma_{VCR(f)}$ = the standard error associated with estimates of the VCR on feeder type f across all customer sectors and DNSP territories.

$\sigma_{VCR(d)}$ = the standard error associated with estimates of the VCR for DNSP territory d across all customer sectors and feeder types.

$\sigma_{VCR(NSW)}$ = the standard error associated with estimates of the state-wide VCR all customer sectors, feeder types and DNSP territories.

Appendix E: Relative standard errors

Table 65: State-wide VCRs ($/kWh) and relative standard errors (% of VCR) by feeder type

	All feeders		CBD feeders		Urban feeders		Rural feeders	
Customer sector	VCR ($/kWh)	Relative std error (%)	VCR ($/kWh)	Relative std error (%)	VCR ($/kWh)	Relative std error (%)	VCR ($/kWh)	Relative std error (%)
Residential	$20.71	5.2%	$32.27	18.2%	$23.05	6.4%	$15.11	7.2%
Business <160 MWhpa	$413.12	6.5%	$295.87	28.5%	$452.12	7.7%	$302.49	10.9%
Business ≥ 160 MWhpa	$53.30	18.0%	$80.54	51.9%	$29.96	24.6%	$128.50	28.7%
Total	**$94.99**	**6.2%**	**$120.52**	**30.2%**	**$93.88**	**6.8%**	**$93.86**	**15.0%**

Table 66: Sample sizes involved in state-wide VCR estimates (no. of usable survey responses)

	All feeders	CBD feeders	Urban feeders	Rural feeders
Residential	718	30	383	306
Business <160 MWhpa	497	6	306	185
Business ≥ 160 MWhpa	74	5	47	22
Total	**1,288**	**41**	**735**	**512**

Table 67: State-wide VCRs ($/kWh) and relative standard errors (% of VCR) by DNSP Territory

	State-wide		Ausgrid		Endeavour Energy		Essential Energy	
Customer sector	VCR ($/kWh)	Relative std error (%)	VCR ($/kWh)	Relative std error (%)	VCR ($/kWh)	Relative std error (%)	VCR ($/kWh)	Relative std error (%)
Residential	$20.71	5.2%	$22.77	8.2%	$19.75	8.5%	$17.82	8.7%
Business <160 MWhpa	$413.12	6.5%	$408.48	11.3%	$563.46	8.4%	$202.82	12.6%
Business ≥ 160 MWhpa	$53.30	18.0%	$34.83	31.6%	$33.99	28.8%	$130.57	28.7%
Total	**$94.99**	**6.2%**	**$86.79**	**9.9%**	**$110.71**	**7.8%**	**$90.71**	**17.0%**

Table 68: Sample sizes involved in state-wide VCR estimates (no. of usable survey responses)

	State-wide	Ausgrid	Endeavour Energy	Essential Energy
Residential	718	251	232	265
Business <160 MWhpa	497	164	194	139
Business ≥ 160 MWhpa	74	35	24	15
Total	**1,288**	**449**	**450**	**389**