Wholesale electricity costs for 2022

A final report for the Essential Services Commission | 22 October 2021

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1 Introduction

Frontier Economics has been engaged to advise the Essential Services Commission (ESC) on allowances for wholesale electricity costs for calendar year 2022 for retailing electricity to small customers, for the purposes of determining the Victorian Default Offer (VDO).

1.1 Background

The ESC is required to determine prices for the VDO to apply from 1 January 2022. To inform this the ESC needs forecasts of retailers' wholesale electricity costs and of retailers' costs of complying with environmental programs for calendar year 2022.

1.2 Frontier Economics' engagement

Frontier Economics has been engaged by the ESC to provide advice on two aspects of the VDO:

- The wholesale electricity cost (WEC) component of retailers' cost to supply small customers from 1 January 2022.
- The retailers' costs of complying with the Large-scale Renewable Energy Target (LRET) and the Small-scale Renewable Energy Scheme (SRES) in supplying small customers from 1 January 2022.

1.3 This final report

This final report sets out our advice to the ESC on the WEC and costs of complying with the LRET and the SRES, for retailers in each of the five Victorian distribution network areas. This report is structured as follows:

- Section 2 provides an overview of the approach used to estimate wholesale energy costs.
- Section 3 discusses the half-hourly prices and half-hourly load used in our analysis.
- Section 4 discusses the contract prices used in our analysis.
- Section 5 discusses the contract position used in our analysis.
- Section 6 provides our estimate of the WEC.
- Section 7 provides our estimates of the costs of complying with the LRET and SRES.

In addition to this report, we also provide spreadsheets setting out details of half-hourly load and price forecasts, contract positions resulting from our modelling, and calculations for determining the WEC.

1.4 Previous advice to the ESC

Frontier Economics has previously advised the ESC on the WEC and the cost of complying with the LRET and the SRES for financial year 2019/20, calendar year 2020 and calendar year 2021.[1] This final report adopts substantially the same approach for estimating WEC and the costs of complying with the LRET and the SRES for 2022 as we adopted for 2021 and previously.

1.5 Changes since the draft report

We have made a number of changes since our draft report as a result of the availability of new information:

- We have used more recent ASXEnergy contract prices.
- We have used more recent LRET certificate prices.

[1] Frontier Economics, *Wholesale Electricity Costs*, A report for the Essential Services Commission, 22 October 2020. Available on the ESC's website: https://www.esc.vic.gov.au/sites/default/files/documents/RPT%20-%20Frontier%20-%20wholesale%20electricity%20costs%20-%20report%20for%20ESC%20final%20decision%20on%202021%20VDO%20-%2020201030.pdf

2 Approach to assessing WEC

Under the settlement rules in the National Electricity Market (NEM), retailers are responsible for purchasing electricity to meet the load of their customers in the wholesale electricity market. A retailer will pay, for each half hour (or for each five minute period, following the introduction of five minute settlement), its customer's electricity load in that half-hour multiplied by the relevant regional reference price from the wholesale electricity spot market for that half hour. For customers in Victoria, the relevant regional reference price is the Victorian regional reference price.

These settlement payments that retailers face can be extremely volatile. Electricity load for small customers can vary significantly from one half hour to the next, and electricity spot prices can be anywhere between the Market Price Cap (which for 2021/22 is $15,100/MWh) and the market floor price (which is -$1,000/MWh).[2] Since retailers will typically commit to supply their customers at a specified retail price for a period of time, this volatility in settlement payments can result in retailers paying more for electricity than they receive for that electricity through the retail price they have agreed with their customers. At worst, this exposes the retailers to the risk of financial failure.

To manage the risks associated with volatile load and spot prices, retailers will typically seek to hedge their exposure to spot prices by entering into hedging arrangements. There are a number of ways that retailers can hedge their exposure to spot prices. The most common are the following:

- Vertical integration through ownership of an electricity generator. A retailer that owns a generator has what is known as a natural hedge: when the spot price is high, the retailer will have to pay the high spot price for its customer's load but, as the owner of a generator, will also receive the high spot price for its electricity generation.
- Power purchase agreements with a generator. Power purchase agreements provide a similar hedging benefit to vertical integration, but they do so through contractual arrangements between a retailer and a generator, rather than through ownership.
- Financial derivatives. There are a range of financial derivatives that are available to retailers (and generators) to hedge their exposure to volatile spot prices. The most common are swap contracts (which effectively lock-in a spot price for the counterparties) and cap contracts (which effectively cap the spot price for a retailer). These are traded both on the stock exchange and over-the-counter between participants.

Retailers' energy purchase costs are typically taken to be the average cost to a retailer of purchasing electricity from the wholesale market for its customers, taking into account both the retailer's settlement payments to the Australian Energy Market Operator (AEMO) and the financial outcomes from the retailer's hedging arrangements.

Regulatory practice in Australia has typically focused on estimating the energy purchase cost for a benchmark retailer. In doing so, regulators have typically assumed that the benchmark retailer

[2] AEMC, *Schedule of reliability settings,* 25 February 2021

will make use of exchange-traded financial derivatives to hedge its exposure to spot prices. The assumption that a benchmark retailer will use exchange-traded financial derivatives is typically based on the following reasoning:

- Any retailer of a reasonable size should be able to hedge its exposure to wholesale spot prices using exchange-traded financial derivatives, while vertical integration and entering power purchase agreements can be impractical for retailers with a smaller retail position in a market or with a less certain retail position.
- Prices for exchange-traded financial derivatives are transparent since they are traded on the ASX. In contrast, the costs of building generation plant or entering into power purchase agreements is less transparent.

In practice, it is clear that retailers in the NEM do adopt a mix of hedging strategies, including vertical integration and power purchase agreements. Retailers will presumably vertically integrate or enter into power purchase agreements because they think these strategies offer advantages that financial derivatives cannot; by excluding vertical integration and power purchase agreements from consideration, therefore, regulators will, if anything, tend to overstate the costs that retailers will face, or understate the risk management that retailers can achieve.

We follow this typical approach of assessing the WEC that retailers face based on an estimate of the cost that a prudent retailer would face in supplying electricity to their customers, having regard to the hedging contracts that a prudent retailer is likely to enter into. The hedging contracts that we base this analysis on are quarterly base swaps, peak swaps and base caps, traded on ASXEnergy.

To estimate WEC in this way, we need to answer four questions:

- What is the expected half-hourly load of the retailer's customers?
- What are the expected half-hourly spot prices that retailers will face?
- What is the cost of financial hedging contracts?
- What kind of hedging position is a prudent retailer likely to adopt?

From the answers to these questions, we can calculate the WEC that a retailer would face.

We address these questions in the sections that follow.

Response to submissions

In its submission on our draft report, the Consumer Action Law Centre questioned whether reductions in wholesale spot prices flow through to the VDO.

Specifically, the Consumer Action Law Centre referred to research by the Victoria Energy Policy Centre that suggests that first tier and second tier retailers are passing through less than half of the wholesale price variation in their retail offers. The Consumer Action Law Centre submitted that lower wholesale spot prices in Victoria should flow through to the VDO.

Our approach to calculating the WEC, as described above, ensures that wholesale price variations are passed through to the VDO, although the full impact of wholesale price variations takes some time to be passed through to the VDO. The principal mechanisms by which wholesale price variations are passed through to the VDO are the following:

- The forecast of wholesale spot prices for 2022 that we use to calculate WEC is based on the average price over the last 40 days for ASXEnergy contracts for 2022.

- The cost of purchasing contracts that we use to calculate WEC is based on the trade-weighted average price over the last 12 months. While recent changes in contract prices are accounted for in this 12-month trade weighted price, any recent changes are smoothed out over time by the approach of taking a 12-month trade weighted price.

3 Half-hourly spot prices and half-hourly load

This section addresses the first two questions we need to answer to estimate WEC:

- What is the expected half-hourly load of the retailers' customers?
- What are the expected half-hourly spot prices that retailers will face?

We deal with these questions together because we believe it is important to forecast half-hourly spot prices and half-hourly load in a way that accounts for the correlation between prices and load. After all, this correlation is a key driver of the risks that retailers face.

3.1 Historical data on half-hourly price and load

Our modelling of the WEC requires projections of half-hourly spot prices in Victoria and customer load to be supplied by retailers in Victoria.

In our view, the best source of data about half-hourly patterns of spot prices, half-hourly patterns of customer load, and the correlation between the two, is historical data. The historical data on prices and load will reflect all of the complex factors that drive both spot prices and customer load, and the interactions between them, which are difficult to accurately capture at the half-hourly level using forecasting models. These historical data on prices and load can then be scaled to account for any trends in prices and load over the forecast period.

Impact of five minute settlement

With the upcoming change to five minute settlement from 1 October 2021, it would be best to use historical five minute spot price and load data for the analysis of this report. This would allow us to best estimate the costs and risks associated with a retailer meeting their customers' load in the NEM in 2022.

The only historical five minute price available is the dispatch price. While this price will reflect the underlying demand and supply conditions in the electricity market during the five minute dispatch period, it is possible that the change to five minute settlement will change market participants strategic behaviour, so that these five minute dispatch prices are not a perfect guide to what would have been five minute settlement prices.

In any case, we would also require historical five minute load to match up against the five minute price. This historical data is currently unavailable.

For these reasons, for this report we continue to use the historical half hourly data we have used previously to estimate the WEC (although updated to include the latest data). As historical five minute settlement prices and load data becomes available in future we can make use of that data.

Thus, the historical data that we use is:

- For prices, the half-hourly spot prices for the Victorian regional reference node, as published by AEMO.

- For customer load, half-hourly load data that AEMO has directly provided to the ESC on customers with annual consumption less than 40MWh for each of the five distribution network areas in Victoria. AEMO has provided separate half-hourly load data for residential customers with annual consumption less than 40MWh and for business customers with annual consumption less than 40MWh.

We use this data directly provided by AEMO because it closely coincides with the customer groups to which the VDO will apply:

- For residential customers, the VDO will apply to all residential customers. The data provided by AEMO is only for residential customers with annual consumption less than 40MWh, but since very few residential customers will have annual consumption greater than 40MWh this is unlikely to make a material difference to the estimated WEC.
- For small business customers, the VDO will apply to small business customers, with small business customers defined as customers with aggregate consumption less than 40 MWh per annum. The data provided by AEMO aligns with the applicability of the VDO.

In contrast, the Manually Read Interval Meter (MRIM) data that is publicly available from AEMO includes aggregated half-hour electricity consumption for all type 5 meters in each of the five distribution network areas in Victoria. This includes a mix of residential and business customers with annual consumption up to 160MWh.

3.2 Selecting appropriate historical data

When using historical data on prices and load in this way, a useful starting point is to choose data on prices and load from an historical period that we think is likely to be most consistent with the forecast period. For example, the closure of coal-fired power stations may have substantial impacts on price levels and volatility. Likewise, the increasing adoption of rooftop solar PV is likely to materially affect load factors and prices over time.

The data that is directly provided by AEMO is for 2016/17 to 2020/21.[3]

Analysis of data

Figure 1 shows the annual load factor for the residential data for each Victorian DNSP for the last five financial years. We can see that there is a slight drop in load factor for every DNSP from 2016/17 to 2017/18, but since then the load factor has been relatively consistent until 2020/21 where there is a slight increase from the previous year.

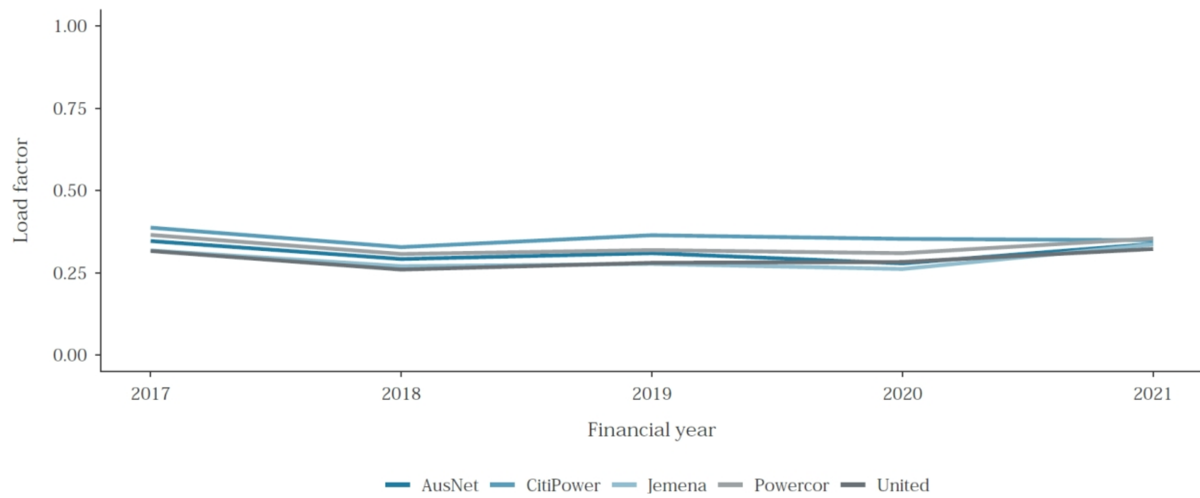
Figure 2 shows the annual load factor for business data for each Victorian DNSP for the last five financial years. We can see that there was a slight increase in the load factor from 2016/17 to 2017/18 for AusNet and Powercor, but that on the whole the load factors have remained relatively steady, except for AusNet which experienced a drop in load factor for 2020/21.

Figure 3 and **Figure 4** show the average daily profile for residential and business customers respectively for each Victorian DNSP for the last five financial years, normalised to the same annual consumption to highlight differences in the timing of daily consumption. These profiles are very

[3] AEMO provided revised historical data for the period 2016/17 to 2019/20. It is our understanding that this data reflects the most up-to-date and accurate reflection of actual load over the historical period. That being the case, we have utilised this revised data in our analysis but note that revisions to the historical period were relatively minor.

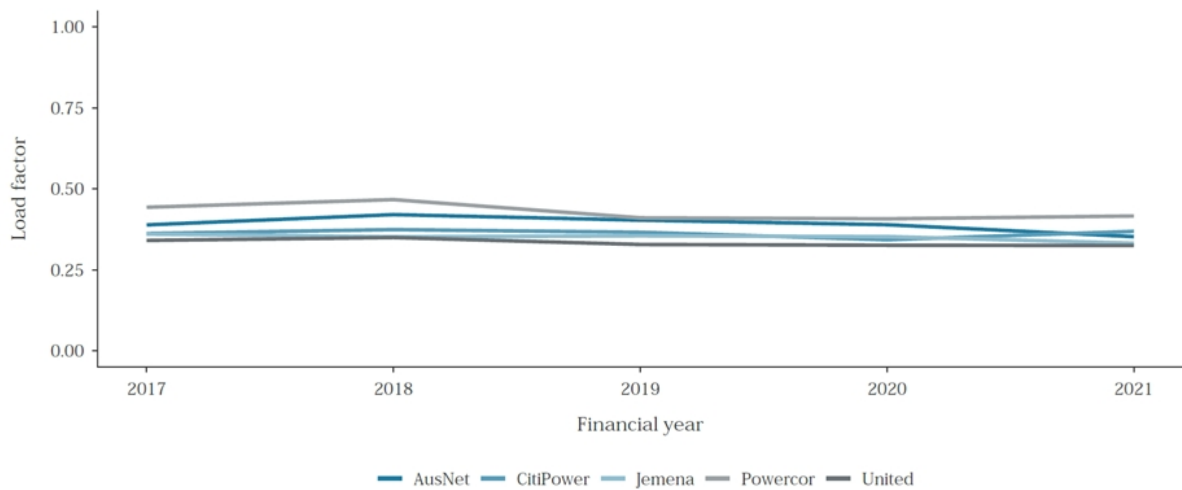
similar between years, with the principal change being relative reductions in load during the day for residential and business customers, with this reduction more evident in some network areas.

Figure 1: Load factor for residential customers



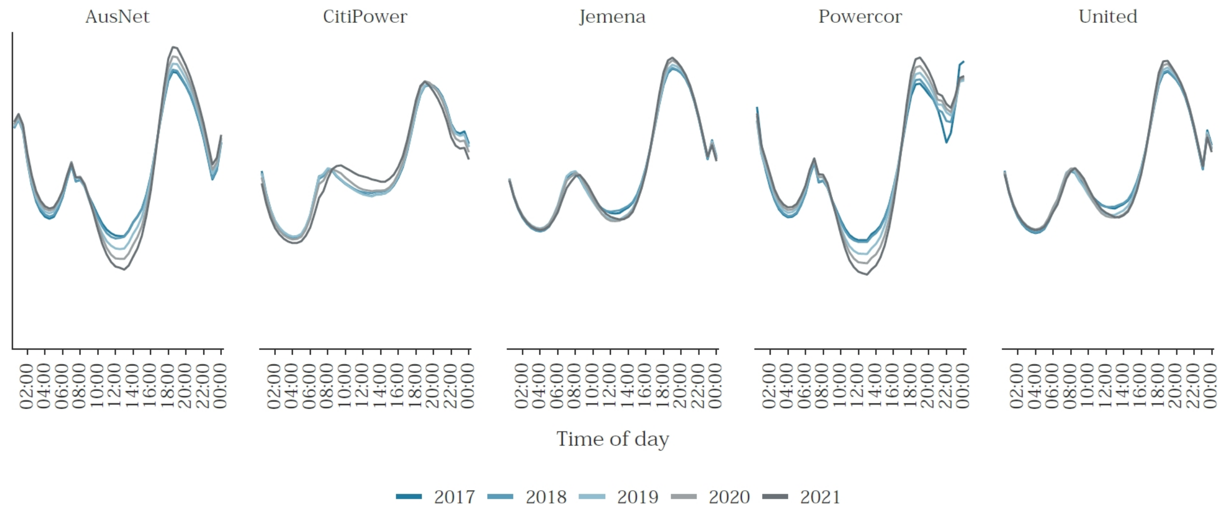
Source: Frontier Economics analysis of AEMO data

Figure 2: Load factor for business customers



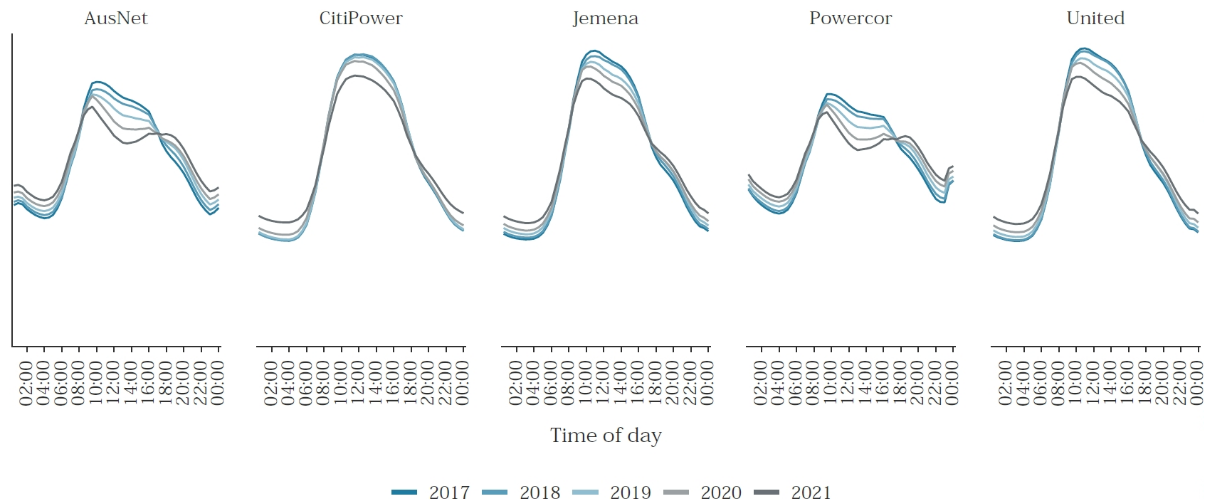
Source: Frontier Economics analysis of AEMO data

Figure 3: Average daily profile for residential customers



Source: Frontier Economics analysis of AEMO data

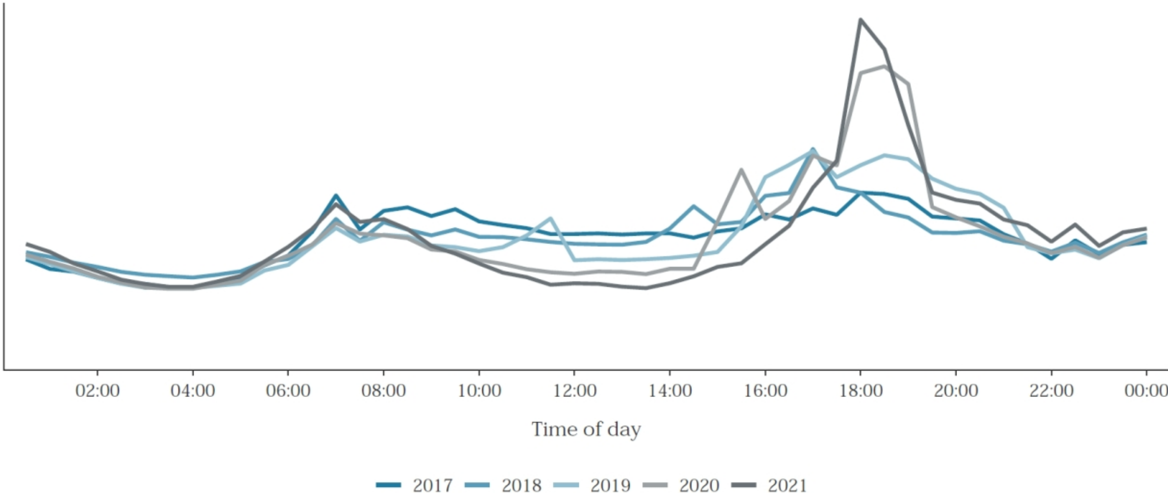
Figure 4: Average daily profile for business customers



Source: Frontier Economics analysis of AEMO data

Figure 5 shows the average daily profile for Victorian spot prices for the last five financial years. It is no surprise to see that there is greater volatility in daily patterns of spot prices than there is in daily patterns of customer load. However, in each case we do see similar patterns of low overnight prices, a price spike tending to occur in the morning, and further high prices tending to occur in the mid-afternoon to evening. The spot price data for 2019/20 and 2020/21 shows that price in the evenings were higher than in previous years, and also that these periods of higher prices persisted for longer, and occurred later in the evening, than they did in previous financial years.

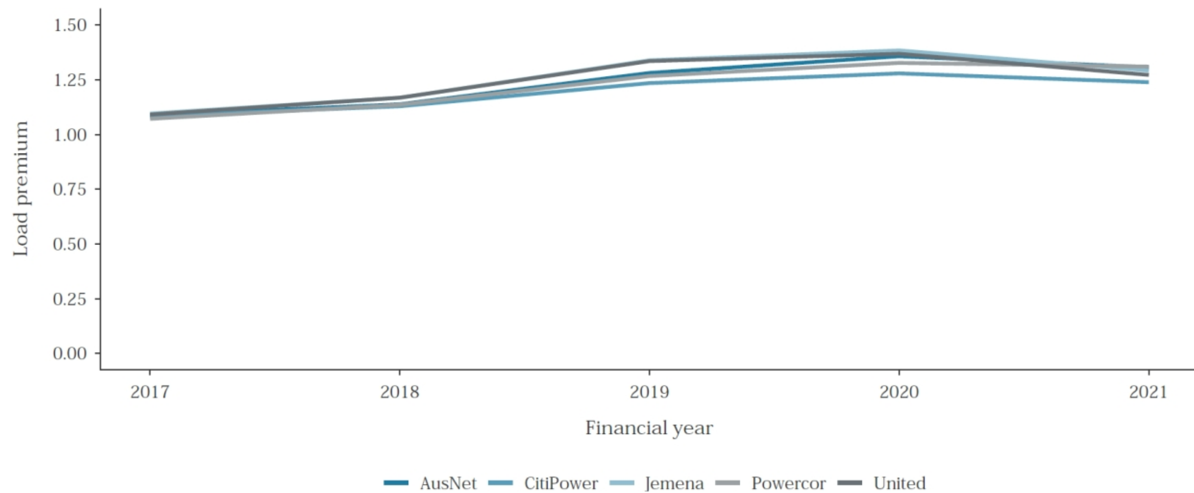
Figure 5: Average daily profile for Victorian spot prices



Source: Frontier Economics analysis of AEMO data

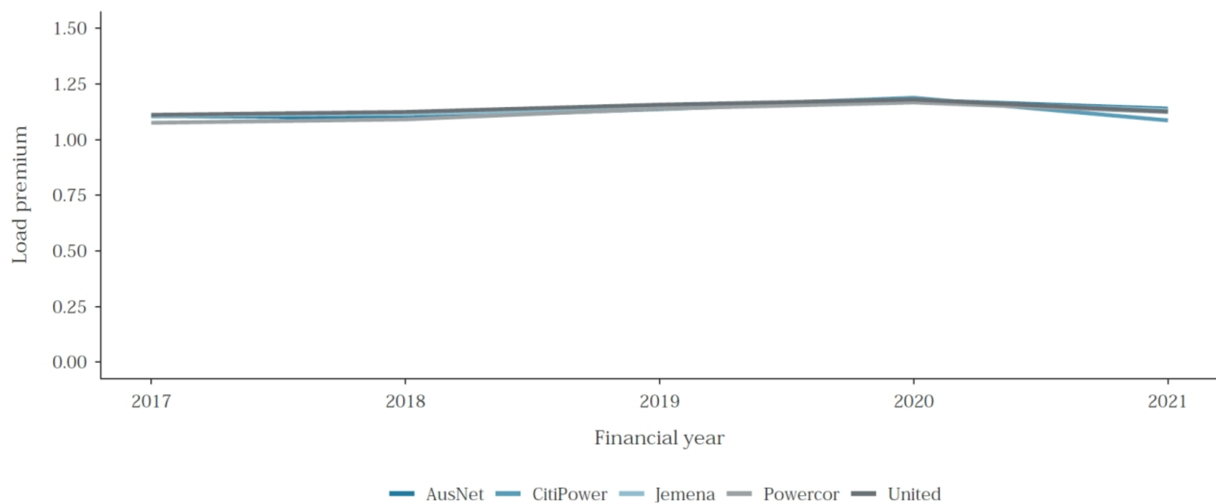
Figure 6 and **Figure 7** combine the historical customer load data and spot price data to report the load premium (calculated as the load-weighted price divided by the time-weighted price) for each customer type, for each Victorian DNSP and for each of the last five financial years. In our experience, the load-weighted spot price (and, by extension, the load premium) is a reasonable guide to the WEC. We can see from **Figure 6** and **Figure 7** that the load premium over 2016/17 and 2017/18 was reasonably constant, but increased more significantly since then, largely as a result of spot prices that remained higher for longer in the evening in 2018/19 and 2019/20. In 2020/21 the load premium fell slightly for both residential and business customers, indicating a load profile that is slightly less correlated with prices.

Figure 6: Load premium for residential customers, based on Victorian spot prices



Source: Frontier Economics analysis of AEMO data

Figure 7: Load premium for business customers, based on Victorian spot prices



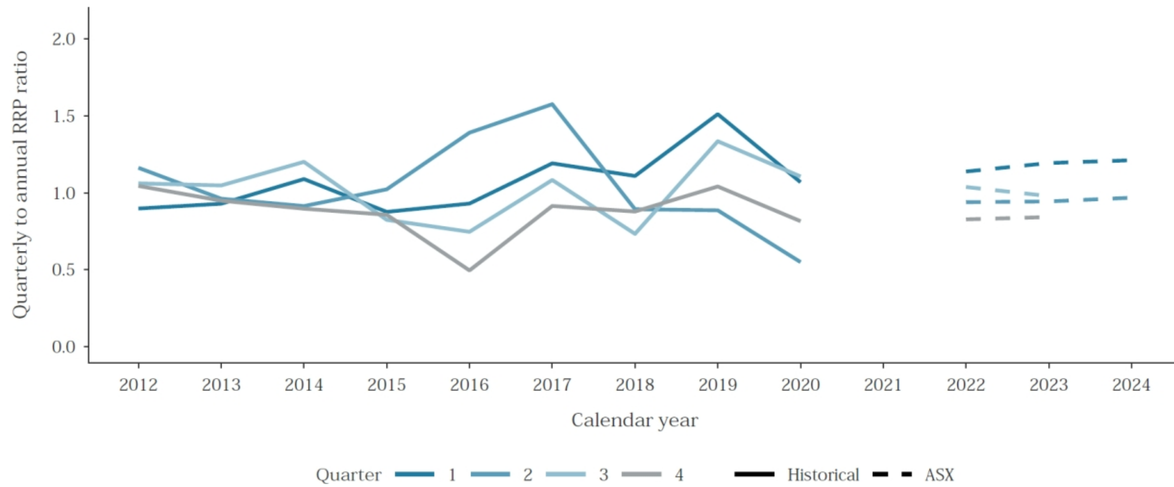
Source: Frontier Economics analysis of AEMO data

As well as examining historical data it can be useful to compare historical price outcomes with expectations of future prices, based on ASXEnergy contract prices. Since we will ultimately be scaling historical half-hourly prices to an average price based on ASXEnergy contract prices, it is helpful if the historical patterns in half-hourly prices are reasonably consistent with the pricing outcomes indicated by ASXEnergy contract prices.

Figure 8 examines quarterly patterns of spot prices and ASXEnergy prices. For each quarter, **Figure 8** presents the relationship between average quarterly prices and average annual prices: on an historical basis this relationship is based on historical Victorian spot prices; on a forecast basis this relationship is based on ASXEnergy base-load swap prices for Victoria. **Figure 8** reveals quite a degree of volatility in the relationship between quarterly prices over time: in recent years Q1 prices have been highest (although we note that in 2021 prices in Q2 have been higher than Q1). The overall trend in recent years is consistent with ASXEnergy data, which sees the highest prices for Q1 contracts from 2022 onwards. In any case, to minimise any potential issues with scaling historical half-hourly prices to ASXEnergy prices with a different quarterly pattern, we scale historical half-hourly prices to ASXEnergy prices on a quarterly basis, so that the quarterly patterns of prices observed in the ASXEnergy data is also reflected in our forecast half-hourly prices. This is discussed in more detail in Section 3.3.

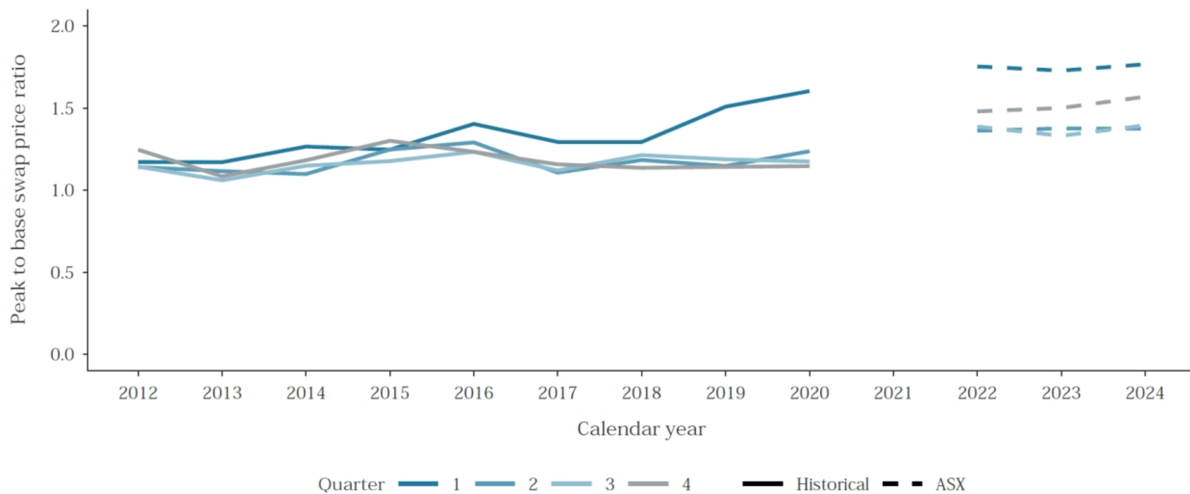
Figure 9 examines peak/off-peak patterns of spot prices and ASXEnergy prices. For each peak/off-peak period, **Figure 9** presents the relationship between average peak/off-peak prices and average annual prices: on an historical basis this relationship is based on historical Victorian spot prices; on a forecast basis this relationship is based on ASXEnergy base-load swaps prices for Victoria. **Figure 9** reveals that historically peak prices have tended to be higher than average and off-peak prices have tended to be lower than average (as would be expected) and that this pattern is also reflected in the ASXEnergy data.

Figure 8: Quarterly patterns of spot prices and ASXEnergy prices



Source: Frontier Economics analysis of AEMO data and ASXEnergy data

Figure 9: Peak/off-peak patterns of spot prices and ASXEnergy prices



Source: Frontier Economics analysis of AEMO data and ASXEnergy data

Based on the analysis of historical half-hourly load and half-hourly prices set out above, our approach for this report is to continue to adopt the approach that we adopted in our advice to the ESC for the VDO in 2021; that is, we continue to include all historical data available to us (in this case, data from 2016/17, 2017/18, 2018/19, 2019/20 and 2020/21) in a Monte Carlo simulation when forecasting half-hourly load and half-hourly prices. Implicit in this approach is the assumption that patterns of load and prices for each of these five historical years can provide useful information on patterns of load and price outcomes for 2022.

As we have seen above, there has been observable change in the average daily load profile for residential and small business customers over the period 2016/17 through to 2020/21. Load in the middle of the day has tended to fall over time, relative to load at other times of the day, for both residential and business customers and for all network areas – likely as a result of increased solar PV generation.

There have been more significant changes in price outcomes over the period 2016/17 through to 2020/21. In particular, the average daily profile for spot prices shows that the peak in spot prices in the mid-afternoon to evening period has become more pronounced each year from 2016/17 to 2020/21, has occurred later and has persisted longer. This is typically driven by an increasing number of high price events during the afternoon and evening in Q1. What is more, the analysis of ASXEnergy data that we have undertaken – including as summarised in **Figure 8** – suggests that the market is expecting similar high price events to occur during Q1 2022.

This raises the question of whether only using half-hourly prices (and load) from more recent years would be preferable to including data from all five historical years in a Monte Carlo simulation. For instance, as an alternative to using data from all five years from 2016/17 through to 2020/21 we could exclude data from 2016/17 on the basis that 2016/17 had relatively higher load during the day and had fewer high price events during the afternoon and evening in Q1 than subsequent years.

While trends in both load and spot prices suggest that data from more recent years is likely a better guide to future years, we note that the data on the load premium – which is the best guide to the WEC – suggests otherwise. In particular, as we noted above, the WEC for 2020/21 has fallen somewhat for both residential and business customers. This makes the load premium for 2020/21 more consistent with the load premium for those earlier years, particularly for business customers. For this reason, and because including a longer time series of data in our Monte Carlo analysis means we are more likely to capture the diversity of potential outcomes in the NEM, for this report we continue to use all available data, consistent with the approach that we have adopted in previous years.

Response to submissions

In response to our draft report, Powershop and Origin Energy made submissions on the historical period over which we should sample data.

Powershop submitted that, due to the unprecedented load shape changes impacting the energy market recently, modelling using data that could be up to five years old risks providing measurements of wholesale costs that may no longer have relevance to the market. Powershop submitted that our analysis should factor in the recent increases in negative pricing experienced during certain times of the day, which is not likely to be reflected in historical sampling.

Origin Energy submitted that over time load profiles have changed as a result of increased solar penetration. In particular, Origin Energy note that the load profile for residential customers has become peakier in the last two years and that this is likely to increase the cost of hedging. Specifically, Origin Energy considers that a peakier load will result in the need to purchase more cap contracts. Origin Energy recommends using a 3-year history to account for this change in load profile.

We agree with Powershop and Origin Energy that it is important to consider the effect that changes in pricing patterns and changes in load will have on the WEC over time. Changes in the generation mix and in system demand are likely to result in different patterns of prices, and rooftop PV and other changes in customers appliances and housing stock are likely to result in different patterns of load.

Our view is that it is important to consider changes in prices and changes in load *together*, because it is the combination of the two that ultimately drives WEC. And our view is that it is important to consider the full set of price and load outcomes throughout the year. While we agree with Powershop that increases in the instance of negative prices will affect the WEC (potentially changing retailers' hedging strategies and certainly changing settlement and difference payments) and we agree with Origin Energy that reduced load during the day will affect the WEC (likely changing retailers' hedging strategies and certainly changing settlement and difference payments), spot price outcomes for the year will also be a key determinant of the WEC. One of the things that we observe about spot prices during 2020/21 is that there were fewer high spot prices during peak times in summer in 2020/21 than was typical in earlier years. Because of this, confining our sampling of historical years to the most recent year or years would reduce the extent to which the WEC would reflect the high spot prices that, prior to 2020/21, have typically occurred during peak times in summer. Indeed, our analysis suggests that confining our sampling of historical years to only the most recent year (2020/21) would result in a WEC that is generally slightly lower for residential customers than the WEC using our approach of sampling from the previous 5 historical years. Since we are not certain that the lower price outcomes that occurred during peak times in summer in 2020/21 will remain a feature of the market in future years, on balance our view is that there is good reason to continue to sample from a longer series of years.

More broadly, the importance of considering changes in prices and changes in load together is one of the reasons that we give weight to the historical trend in the load premium when considering how many historical years to include in our sampling. But, as long as the ESC sets the WEC using a method that involves sampling historical data, we would expect that this difficult question – how to balance using more recent and more relevant data with using data that includes a diversity of potential outcomes – will need to continue to be considered and addressed.

3.3 Projecting half-hourly load and spot prices

As discussed, rather than take a single one of the years from 2016/17 to 2020/21 as representative of outcomes in 2022, we perform a Monte Carlo simulation on the five years of half-hourly load and price data. In our view there are two benefits of using a Monte Carlo analysis:

- Any single year will be subject to unique market conditions that are unlikely to be repeated. This creates the risk that any single year may not be representative of conditions that might be expected in the future. However, using a Monte Carlo approach based, in this case, on five years of data increases the likelihood of basing our analysis on a representative set of conditions.
- Using a Monte Carlo analysis allows us to create a distribution of market conditions, providing some insight into the expected distribution of the WEC.

The Monte Carlo simulation is used to generate a year of half-hourly data by randomly drawing one day of data, from the pool of available historical days, for each day of the forecast year. This random drawing of data is done from a pool of like days (where days are classified according to day type – weekday/weekend – and quarter). The Monte Carlo simulation is then performed 500 times to get a distribution of simulated years, which allows us to choose a simulated year from within this distribution to use in the modelling.

For example, a single simulated year will be generated as follows:

- The first day of 2022 is 1 January 2022, which is a Saturday. Since this is a Saturday in Q1, the half-hourly load and spot data for the first day of 2022 will determined by randomly drawing a day's half-hourly data from all the Q1 weekend days that occurred in 2016/17 through to 2020/21.
- The second day of 2022 is 2 January 2022, which is a Sunday. Since this is a Sunday in Q1, the half-hourly load and spot data for the second day of 2022 will be determined by randomly drawing a day's half-hourly data from all the Q1 weekend days that occurred in 2016/17 through to 2020/21.
- And so on for the 365 days that make up 2022, having regard, for each day, to its type and its quarter.

This process is then repeated 500 times to generate 500 simulated years, each year made up entirely of historical outcomes in 2016/17 through to 2020/21.

For each of these simulated years, load and prices are drawn at the same time (i.e. from the same historical day) so that the correlation between load and prices is maintained.

Once we have completed this Monte Carlo simulation, we make a last adjustment to the consumption data, normalising each of the simulated years to 1 GWh of annual consumption. This maintains the load shape and correlation between load and prices, but each year now has a uniform annual consumption.

We also make a further adjustment to the half-hourly spot prices. We consider that historical half-hourly spot prices provide the best source of information about patterns of half-hourly spot prices and how these are correlated with half-hourly load, but historical spot prices are not necessarily a good predictor of the future average level of Victorian spot prices. There is no reason, for instance, that Victorian spot prices over the period 1 January 2020 to 31 December 2020 will, on average, be the same as Victorian spot prices for 2022. In our view, the best available public information about the average level of Victorian spot prices for 2022 is the contract prices published by ASXEnergy. These contract prices – particularly the prices of base swaps – provide the market's view on what will be the average spot price for 2022. Given this, for each simulated year, we assume that the average level of prices is consistent with ASXEnergy futures prices. Specifically, for each simulated year we scale the half-hourly prices so that the time-weighted average price in each quarter is equal to the relevant quarterly base swap prices for 2022 from ASXEnergy[4] (less an assumed contract premium of 5 per cent on the underlying prices). We use the 40-day average of ASXEnergy contract prices for quarterly base swap prices (up to 8 October 2021) as representing the market's current view of spot prices for each quarter of 2022.[5] This approach to generating half-hourly price forecasts results in:

4 An alternative approach would be to attempt to scale half-hourly prices having regard to each of base swaps, peak swaps and cap prices. However, the scaling process would require subjective judgements about how to simultaneously scale to each of these prices. Given there would be little on which to base these subjective judgements our preference is to scale only to base swap prices, which is a mechanical process. We note, however, that the calculation of the WEC does use each of the contract prices from ASXEnergy.

5 We note that there is a difference in the averaging period that we use for estimating spot prices for 2022 and the averaging period we use for calculating contract prices to be used in estimating the WEC for the VDO. As discussed, we use the most recent 40-day average ASXEnergy prices as the best guide to the market's view on spot prices that will occur in 2022. However, based on instructions from the ESC, we use 12-month trade weighted average ASXEnergy prices to set the contract price for retailers when determining the WEC. In our view, there is no necessity for these averaging periods to be consistent. One way to think about the WEC that we are calculating using this approach is that we are estimating the contract payments that a retailer would face if that retailer had purchased its contracts for 2022 over the last 12 months (at the same time as trade occurs on

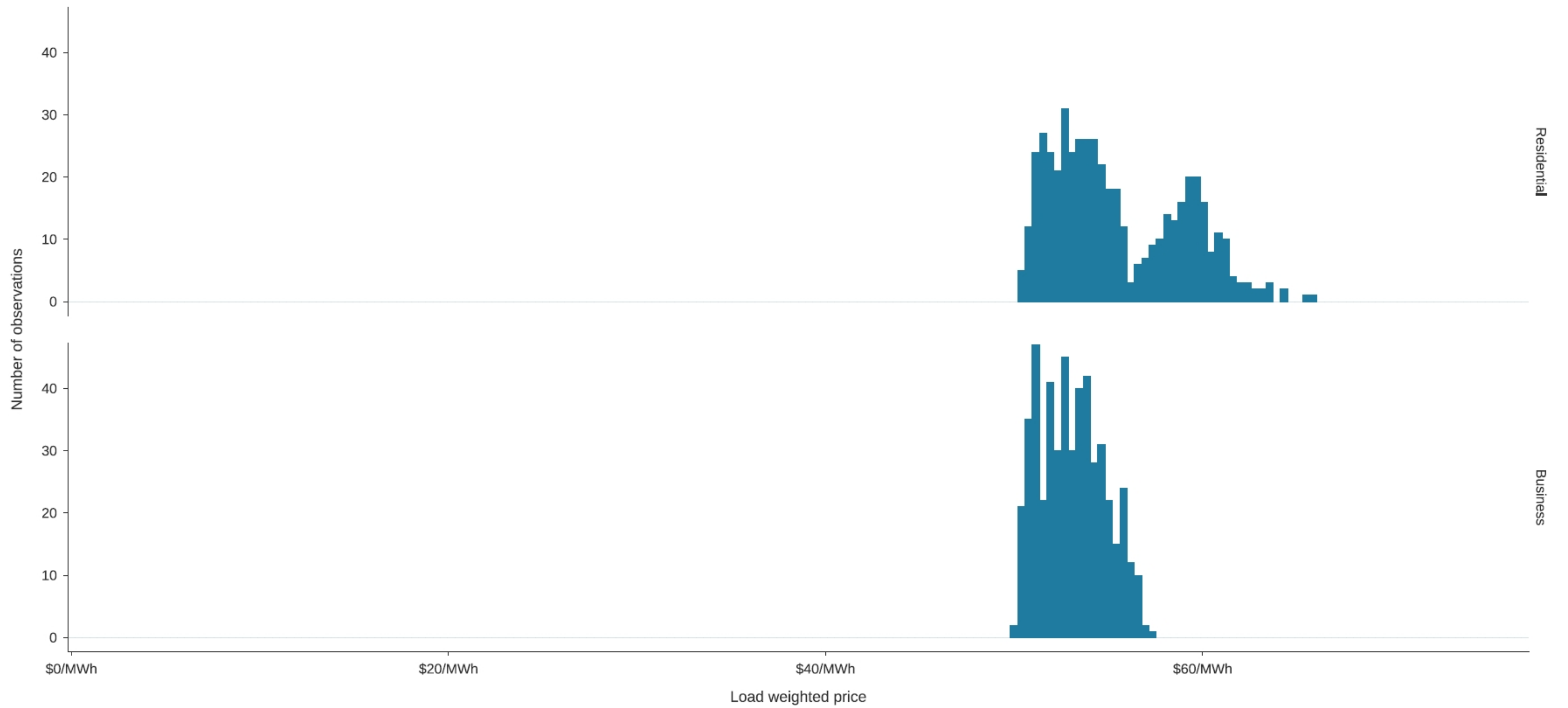
- The appropriate average level of spot prices (i.e. the time-weighted quarterly average price is consistent with ASXEnergy prices).
- The appropriate half-hourly profile of spot prices (i.e. the half-hourly profile of prices, and load, are consistent with historical outcomes).

Analysis of data

An indication of the results of our Monte Carlo simulation can be provided by calculating the load-weighted price for each of the 500 simulated years. As we discussed, in our experience the load-weighted price is a reasonable guide to the WEC. **Figure 10** through **Figure 14** show the distribution of load-weighted prices for each of the 500 simulated years from our Monte Carlo analysis, for each distribution area and for each customer type. As discussed, the average spot price in each of these simulated years is the same – based on the 40-day average ASXEnergy base swap price – but the half-hourly profile of both spot prices and load are different. It should be clear from **Figure 10** through **Figure 14** that the Monte Carlo simulation has resulted in a distribution of load-weighted prices driven by differences in the half-hourly patterns of spot prices and load.

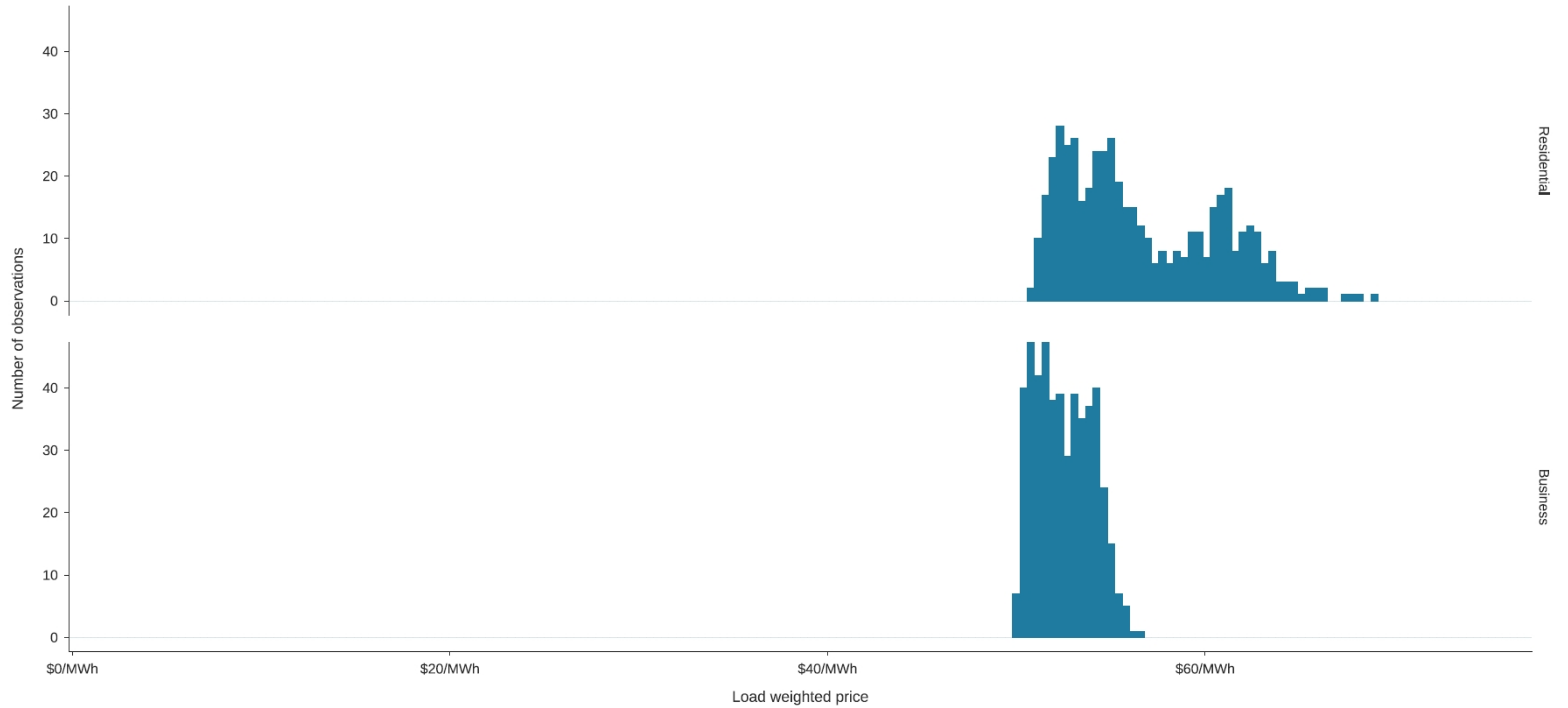
ASXEnergy) and uses those contracts to hedge the risk it would face based on current expectations of spot prices.

Figure 10: Distribution of load-weighted price for simulated years for residential and business load – CitiPower



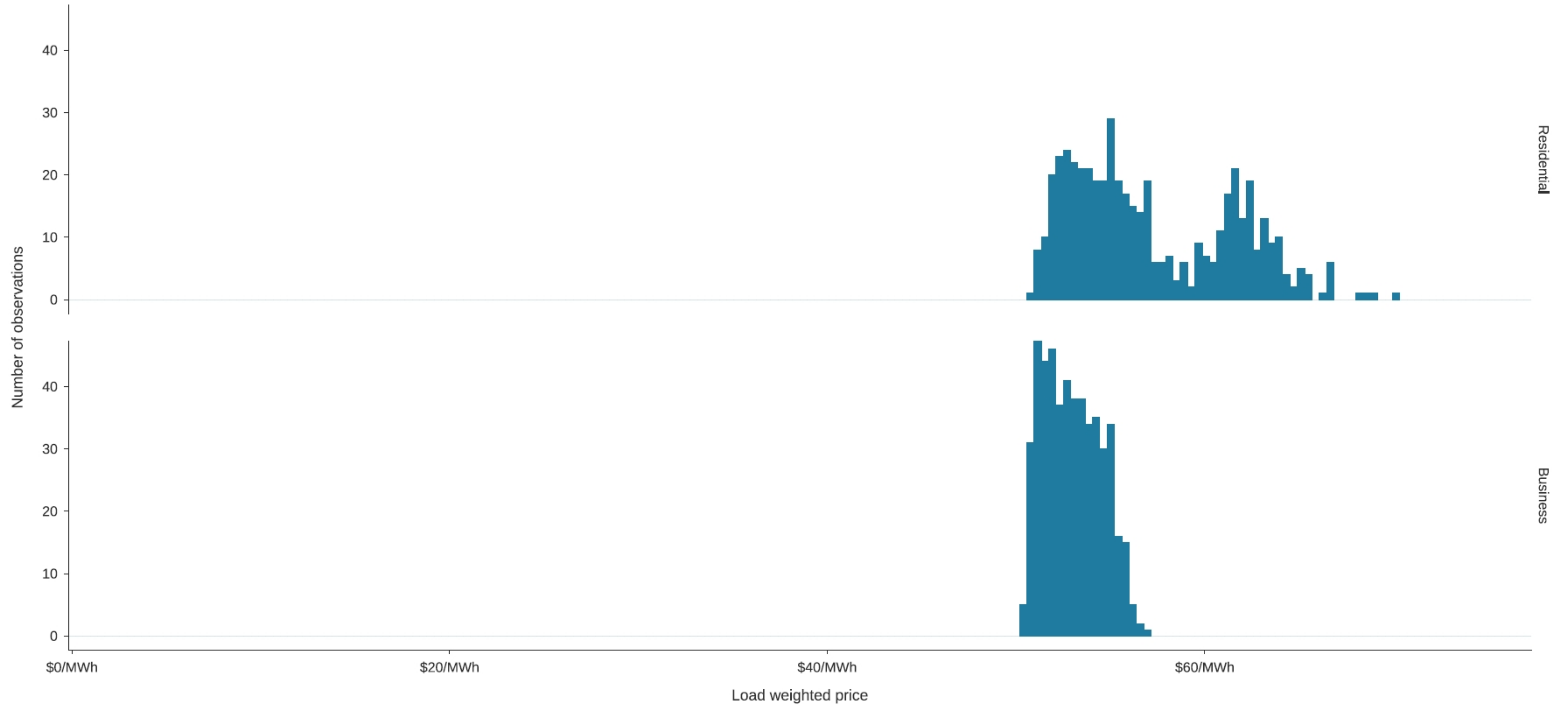
Source: Frontier Economics

Figure 11: Distribution of load-weighted price for simulated years for residential and business load – Powercor



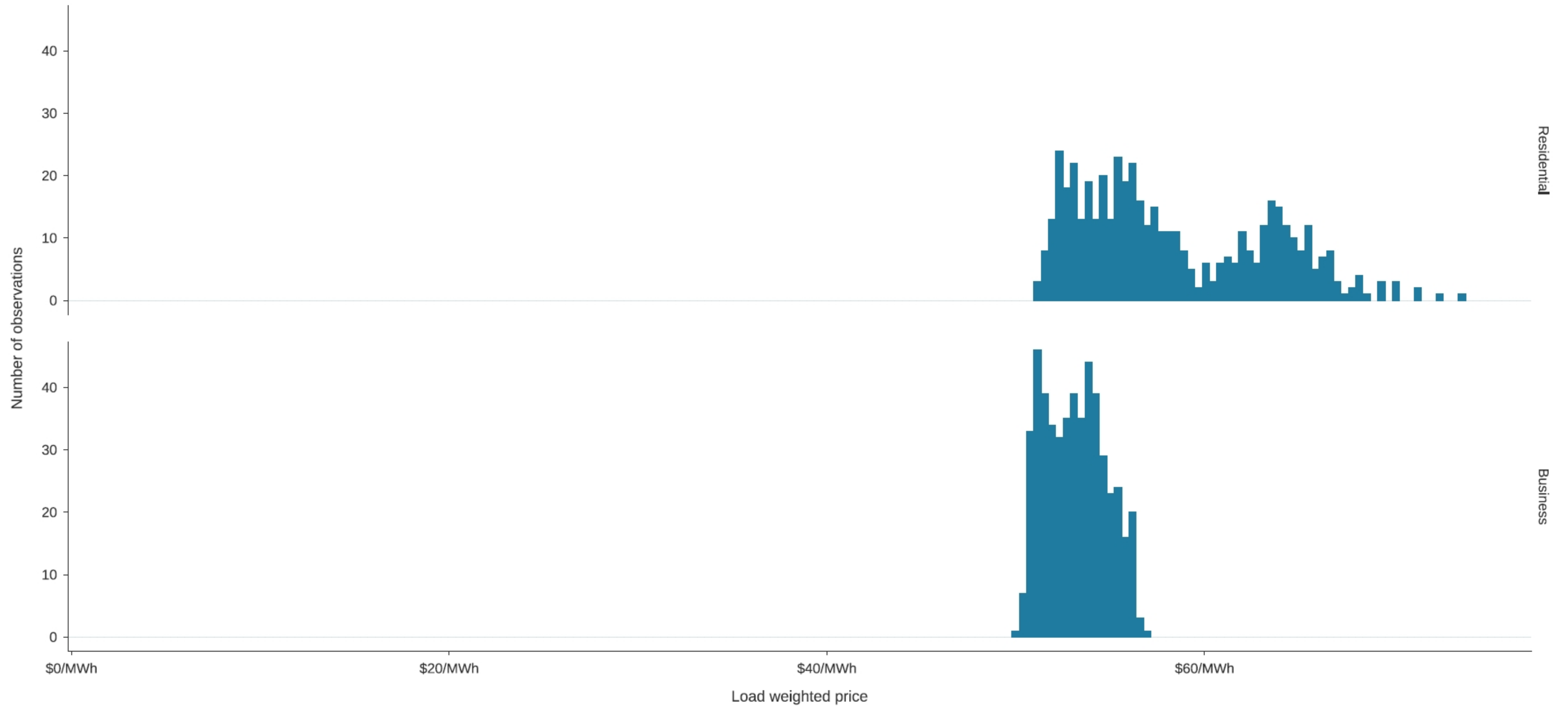
Source: Frontier Economics

Figure 12: Distribution of load-weighted price for simulated years for residential and business load – AusNet



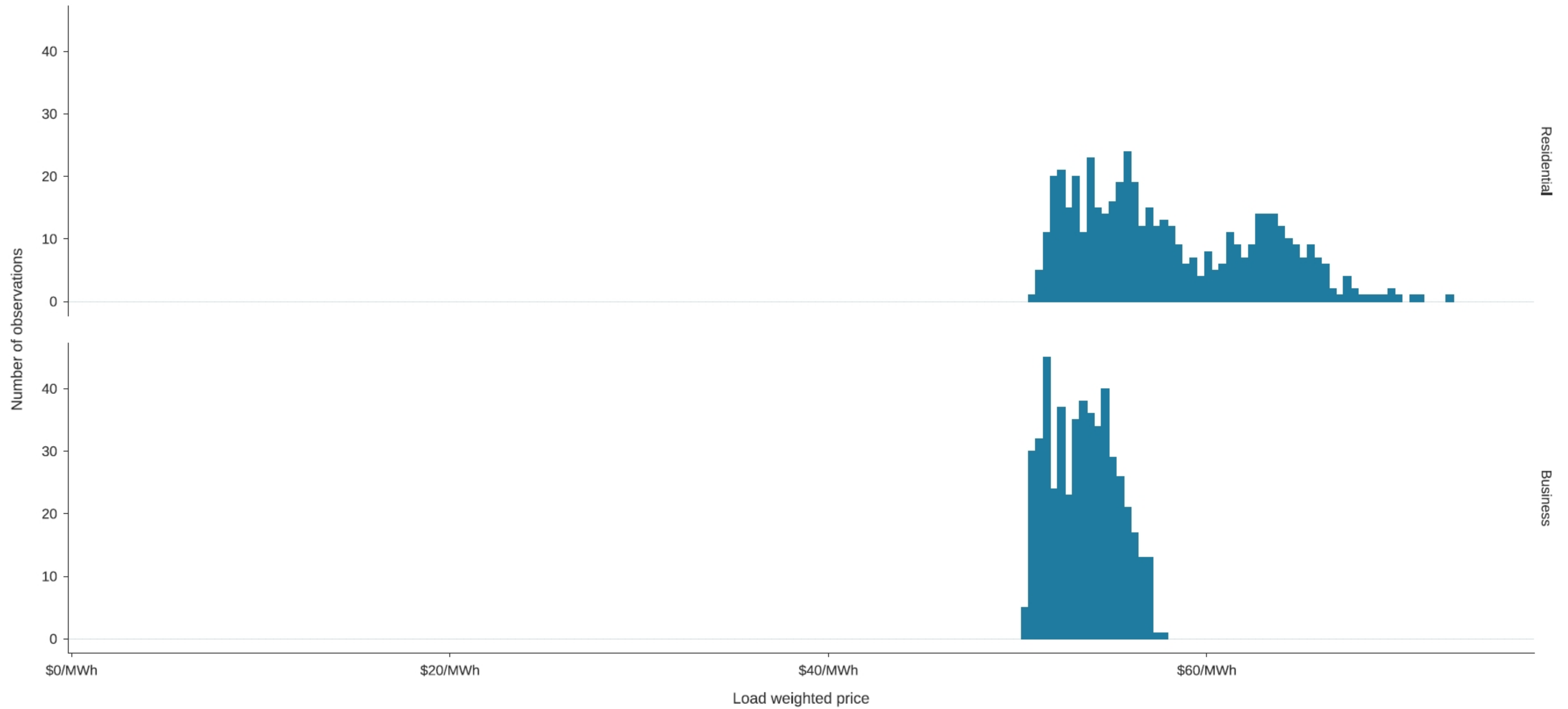
Source: Frontier Economics

Figure 13: Distribution of load-weighted price for simulated years for residential and business load – Jemena



Source: Frontier Economics

Figure 14: Distribution of load-weighted price for simulated years for residential and business load – United



Source: Frontier Economics

4 Contract prices

This section addresses the third question we need to answer to estimate the WEC:

- What is the cost of financial hedging contracts?

As discussed, our approach to assessing the WEC that retailers face is based on an estimate of the cost that a prudent retailer would face in supplying electricity to their customers, having regard to the hedging contracts that a prudent retailer is likely to enter into. The hedging contracts that we base this analysis on are ASXEnergy contracts. There are three main types of electricity contracts that are traded on ASXEnergy:

- Base swaps for each quarter.
- Peak swaps for each quarter.
- Base $300 caps for each quarter.

These contracts trade for a number of years in advance. Prices are published by ASXEnergy for each contract for each trading day.

Contract price data

Figure 15 through **Figure 17** set out the relevant trading data for each of these three contract types, for each quarterly product. The trading data that is presented is open interest (which measures the total volume of contracts in the market), the settlement price and the trading volume.

We can see from **Figure 15** through **Figure 17** that base swap contracts for calendar year 2022 are currently trading regularly. Indeed, we can see that trade in these contracts is occurring on most trading days. This suggests that the daily prices for base swaps does provide a genuine indication of the market's view of future prices.

However, trade in peak swaps and in caps is a lot lower, which raises the prospect that the available prices for peak swaps for calendar year 2022 and for caps may not represent the market's current view of likely price outcomes for 2022. While there is some risk to this, we would note that the relative level of peak swap prices, compared to base swap prices, is consistent with what we would generally expect.

Our view is that economic decisions in competitive markets will be based on the market value of contracts (and we consider 40-day average prices a good proxy for this market value), regardless of when those contracts are purchased. If a retailer has purchased contracts in the past at prices above the current market price, we would expect that competition from existing or new entrant retailers would force the retailer to make retail price offers based on the current cost of purchasing contracts; to do otherwise would be to risk losing customers to competitors able to enter or expand by purchasing contracts at the current cost and making retail price offers based on those current costs. Similarly, if a retailer has purchased contracts in the past at prices below the current market price, we would expect that maximising shareholder value would require them to make retail price offers based on the current cost of purchasing contracts; making retail price offers based on lower historical contract costs would result in less profit than simply selling the contracts again at the current contract price.

However, there may be good reasons that a regulator will choose to base regulated prices on something other than 40-day average contract prices. For instance, a longer averaging period, such as 12 months or 24 months, would be expected to provide regulated prices that are more stable over time and would also likely result in regulated prices that are more reflective of incumbent retailers' actual historical costs (since most retailers will buy contracts over a period of time leading up to the settlement year). The ESC has asked us to use 12-month trade weighted contract prices in estimating the WEC. We calculate the 12-month trade weighted contract price for each contract by taking an average of the daily settlement price for that contract over the last 12 months, but weighting each daily settlement price by the share of the total volume of trade over the last 12 months that happened on that day. This means that the settlement price on a day on which no trade occurred is given a weighting of zero in calculating the 12-month trade weighted contract price, while the settlement price on the day on which the most trades occurred in the last 12 months is given the highest weighting.

ASXEnergy contract prices are shown in **Table 1**, for the 12-month trade weighted average price, up to 8 October 2021. It is clear from **Figure 15** through **Figure 17** that contract prices for calendar year 2022 have generally trended lower during 2021. These recent reductions bring down the 12-month trade weighted average prices shown in **Table 1**.

The recent reductions in contract prices for 2022 have been occurring at the same time that spot electricity prices have been falling. These reductions in spot prices are typically attributed to increased investment in renewable generation (and, to a lesser extent, storage), including increased investment in rooftop PV by customers, as well as lower demand and lower fuel prices. The expectation that these drivers of prices will persist would account for the generally lower contract prices seen in **Figure 15** through **Figure 17**.

Table 1: 12-month trade weighted average ASXEnergy derivative prices for Victoria (2022 dollars)

	Product	Status	Calendar year	Quarter			
				Q1	Q2	Q3	Q4
TRADE WEIGHTED	$300 Caps	Base	2022	$23.95	$3.22	$3.45	$5.42
	Swaps	Base	2022	$58.33	$40.61	$41.99	$36.01
	Swaps	Peak	2022	$113.60	$53.36	$52.10	$51.96

Source: Frontier Economics analysis of ASXEnergy data

Note: Caps for 2022 have only been trading since the 22nd of March 2021 and so the price is not a 12-month average, but is still trade-weighted.

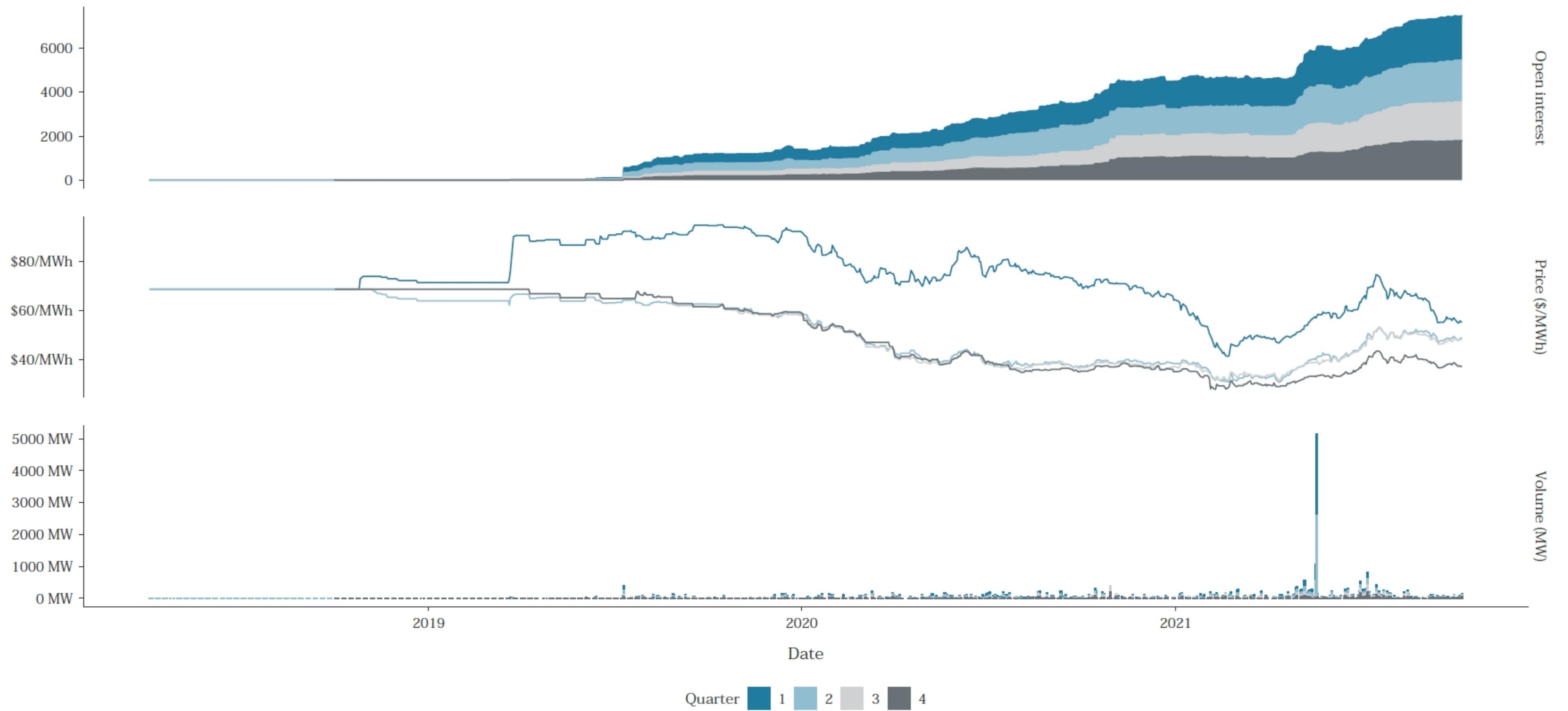
Response to submissions

In its response to our draft report, Powershop noted that a significant proportion of trade in ASXEnergy contracts often occurs on the date of option expiry. This means that the price of contracts on this date will have a larger impact on the 12-month trade weighted average price than the price on other days with fewer trades. Powershop submitted that it would prefer the 12-month trade-weighted average price is calculated *after* the date of option expiry.

The ASXEnergy data that we used to calculate the 12-month trade-weighted contract price certainly reflects that there is generally a significantly higher volume of trade on the date of option expiry. And this does mean that these days have a larger impact on the 12-month trade weighted average price than other days.

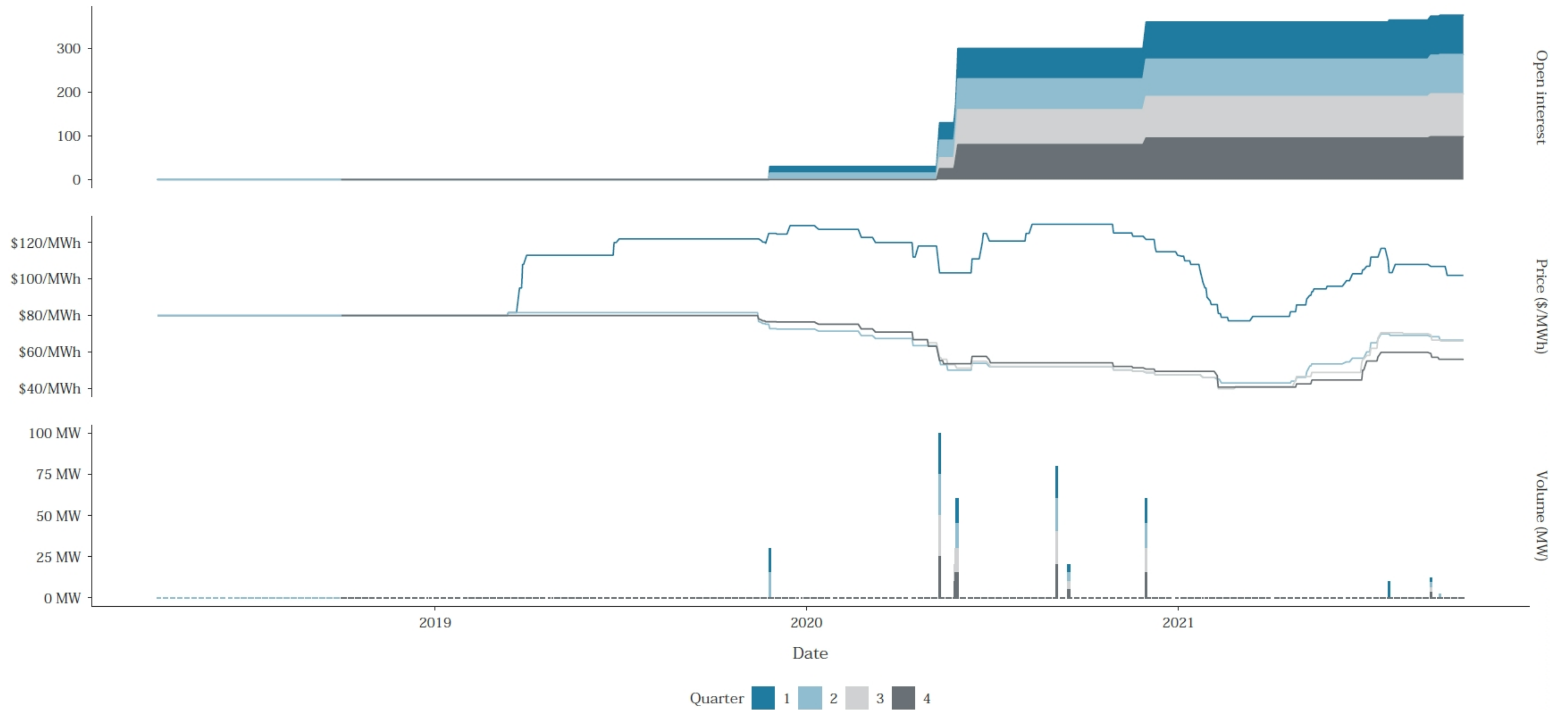
The relevant date for option expiry for the calculation of the VDO for 2022 is 19 November 2021. Given the that the ESC's final decision will be released on 25 November 2021, unfortunately there is not sufficient time to include trading data up to and including 19 November in the calculation of the 12-month trade weighted average price.

Figure 15: Victorian base swaps – open interest, prices and volumes for calendar year 2022



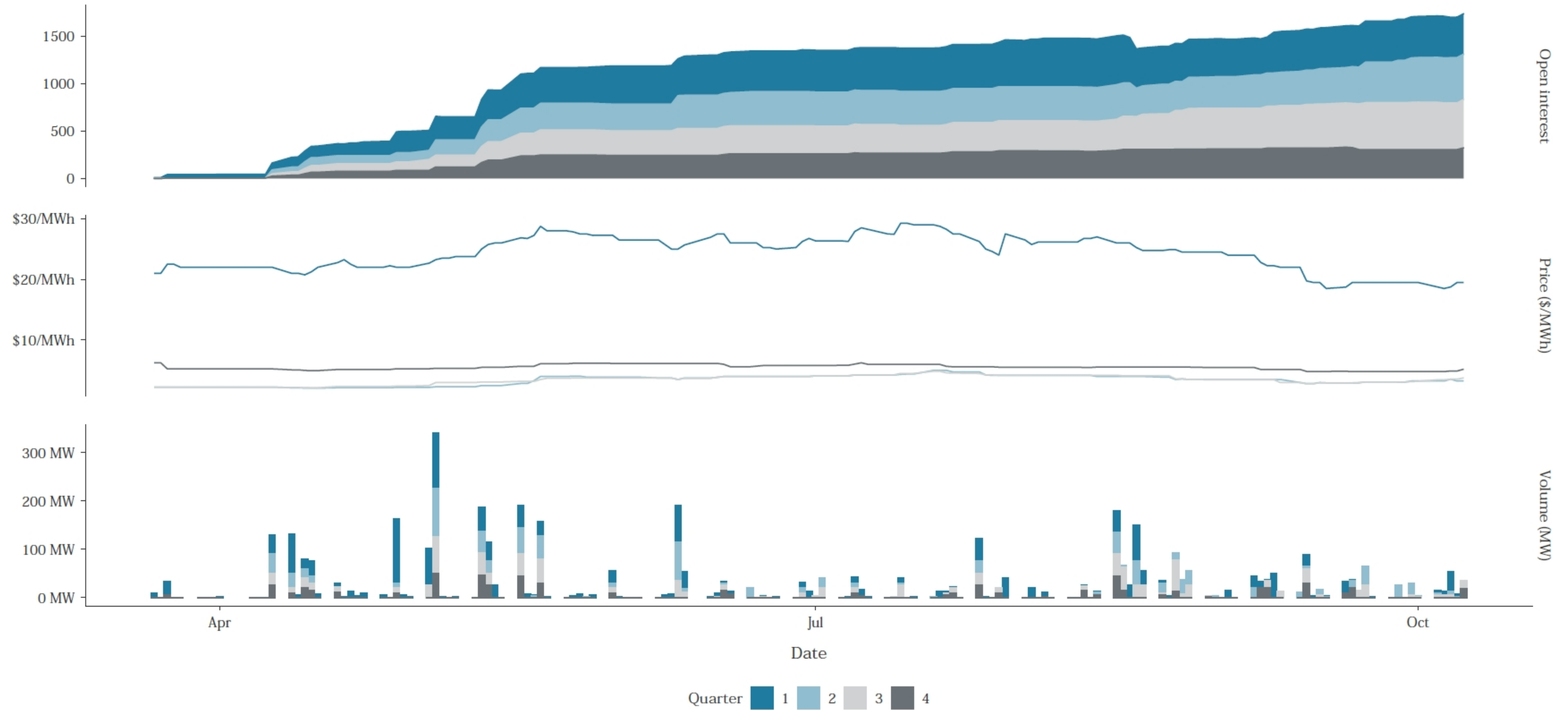
Source: Frontier Economics analysis of ASX data

Figure 16: Victorian peak swaps – open interest, prices and volumes for calendar year 2022



Source: Frontier Economics analysis of ASX data

Figure 17: Victorian base $300 caps – open interest, prices and volumes for calendar year 2022



Source: Frontier Economics analysis of ASX data

5 Contract position

This section addresses the final question we need to answer to estimate WEC:

- What kind of hedging position is a prudent retailer likely to adopt?

We use our portfolio optimisation model – *STRIKE* – to determine the efficient mix of hedging products that a prudent retailer would likely adopt. *STRIKE* calculates an efficient frontier, which represents the contracting positions that provide the lowest energy purchase cost for a given level of risk (as measured by standard deviation).

STRIKE applies a Minimum Variance Portfolio (MVP) approach to the task of hedging a retailer's exposure to wholesale spot prices. *STRIKE* incorporates an estimate of a retailer's exposure to the wholesale spot market, which is determined by the retailer's load and wholesale spot prices. There is an expected return and a variance associated with this. *STRIKE* also incorporates the types of hedging products that are typical in the electricity industry. These contracts – swaps and caps – generate cashflows that also have an expected return and a variance. Instead of assessing the expected return and associated risk for each asset in isolation, *STRIKE* applies the concepts of portfolio theory to evaluate the contribution of each asset to the risk of the portfolio as a whole. Based on this approach, *STRIKE* calculates efficient hedging strategies.

In order to determine a hedging position for the purposes of estimating the WEC for each customer type in each distribution area in Victoria, we make use of the following inputs in *STRIKE*:

- Forecast spot prices and load, as discussed in Section 3. As we discussed, we have developed 500 simulated years of half-hourly spot prices and load for 2022. There is a distribution of outcomes within these 500 simulated years. Our view is that an efficient retailer's hedging position should have regard to the uncertainty associated with what kind of year 2022 will be; will 2022 be a year with high prices and high load corresponding, so that the load-weighted price is high, or will 2022 be a year with low prices and high load corresponding, so that the load-weighted price is low? To account for this uncertainty, we input 7 simulated years into *STRIKE*, representing those simulated years that represent the 99th, 95th, 75th, 50th, 25th, 5th and 1st percentile when the 500 simulated years are ranked according to load-weighted price.
- Contract prices, as discussed in Section 4. We present results for 12-month trade weighted contract prices.

As discussed, *STRIKE* calculates an efficient frontier, which represents the contracting positions that provide the lowest energy purchase cost for a given level of risk. The contract position that we use to calculate the WEC is based on the most conservative contracting position on the efficient frontier, which is the point on the efficient frontier with the lowest risk (but highest cost).

Outlined in **Figure 18** to **Figure 27** are the resulting contract positions at the conservative point for 2022, for each load profile and for each distribution area. For each quarter (the vertical panels) and each peak/off-peak period (the horizontal panels), the charts show the following:

- The distribution of half-hourly load for the 48 half-hours of the day (shown by the box plots, including the dots representing outliers, in the 'Load' panel).
- The distribution of half-hourly spot prices for the 48 half-hours of the day (shown by the box plots, including the dots representing outliers, in the 'Spot price' panel). The price chart is truncated at a spot price of $300/MWh to aid visibility of price outcomes.

- The quantity of swaps and caps at the conservative point of the efficient frontier (shown by the coloured areas in the 'Load' panel).

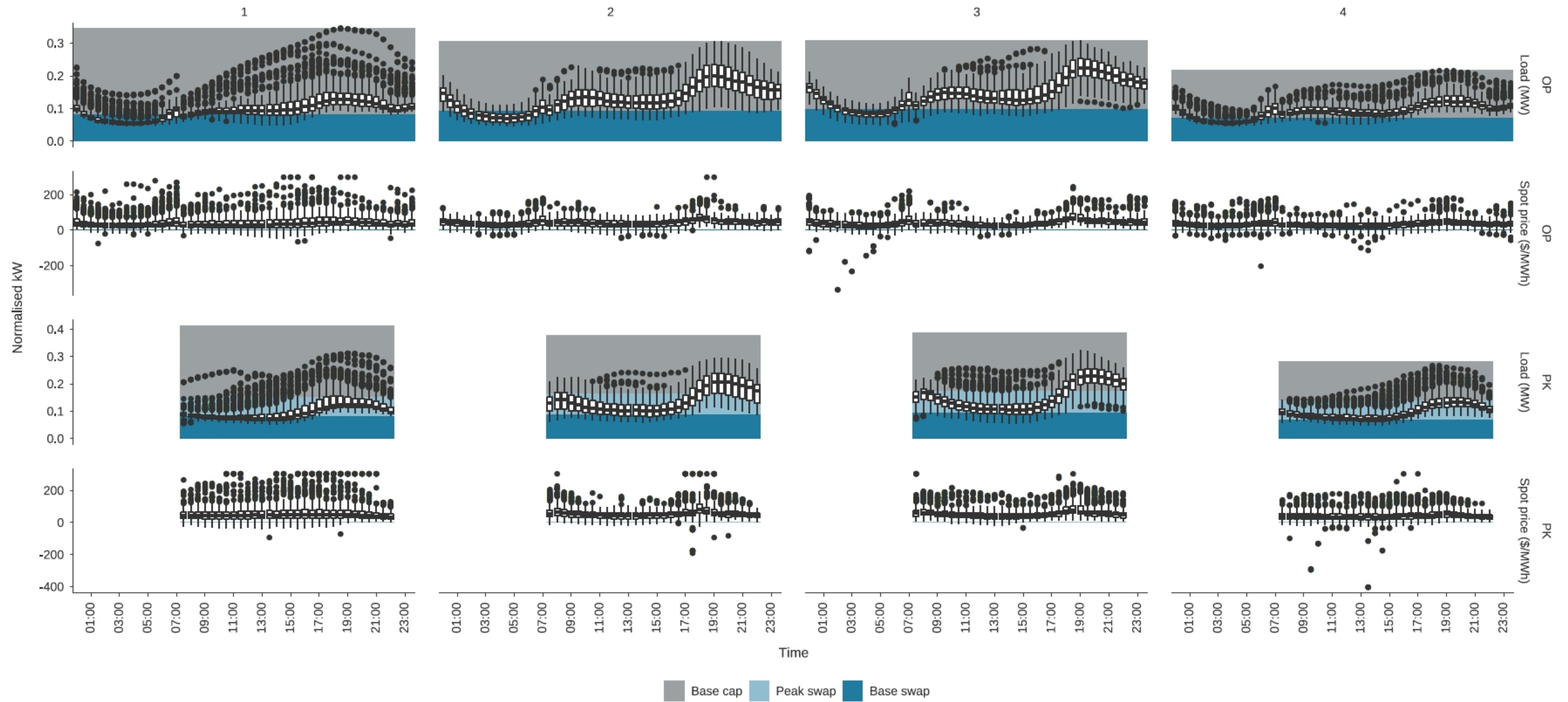
In general, the contract position at the conservative point involves:

- purchasing swaps to cover (approximately) average demand (or slightly lower in off-peak periods)
- purchasing caps, on top of that, to cover (approximately) to peak demand
- in some cases, incurring a small amount of pool exposure at absolute peak demand times.

As seen in **Figure 18** to **Figure 27**, the contract position at the conservative point generally results in complete coverage of the highest demand half hours, but does not always do so. The reason that there can remain some residual pool exposure even at the conservative point is that *STRIKE* balances the costs and risks of remaining exposed to the spot price at these highest demand half hours against the costs and risks associated with being over-contracted. Signing additional contracts is neither costless nor riskless, and while being exposed to the spot price during a small number of high demand half-hours can result in large payments, being over-contracted for a large number of lower demand half-hours can also result in large payments. Some retailers may have a preference for additional contract cover to meet forecast peak demand in all cases, but we note that the volatility allowance (discussed in Section 6.2) is intended to reflect the residual risk at the conservative point and could be used to purchase additional cap cover.

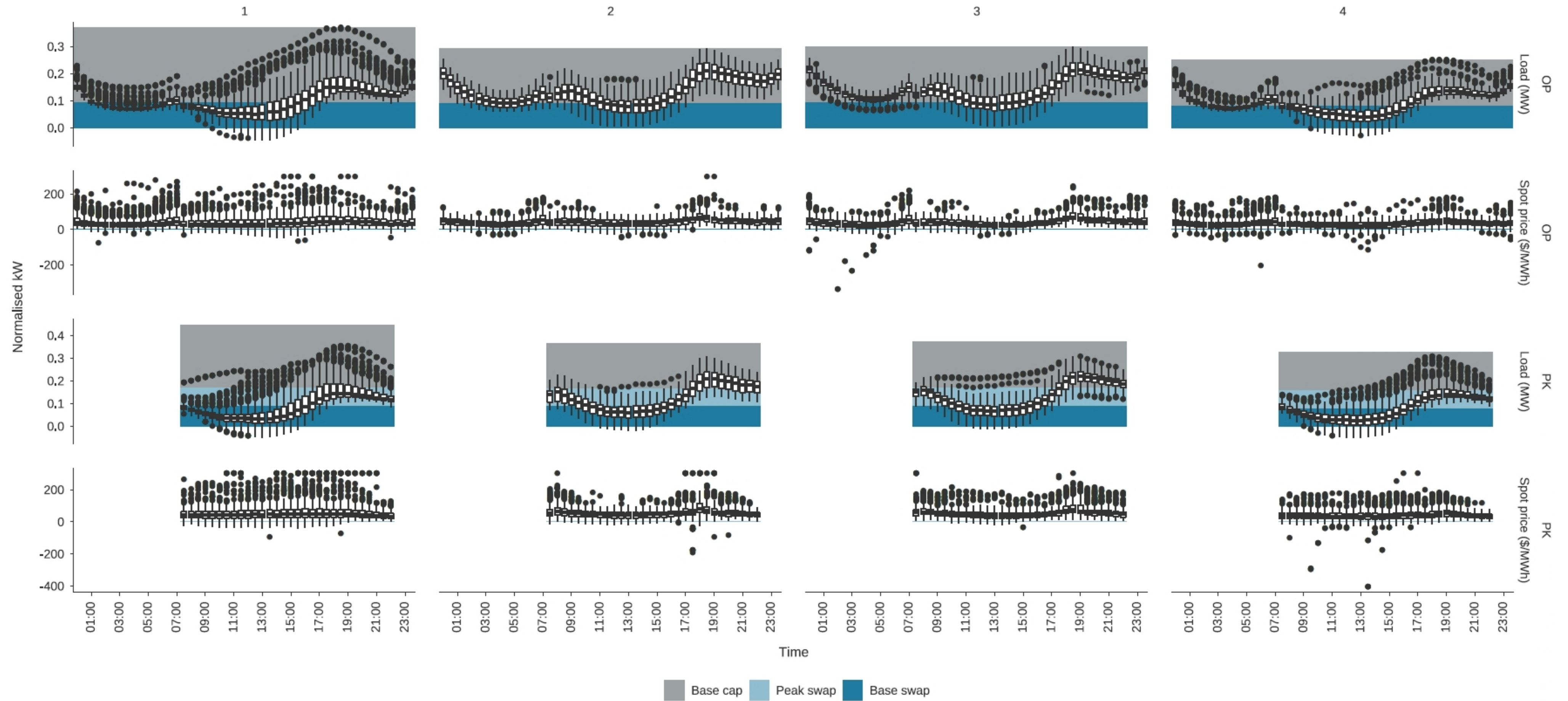
It should also be noted that the conservative point on the efficient frontier reflects the contract position that achieves the lowest risk given the projected state of the world that is input into *STRIKE*. In the event that different states of the world were input into *STRIKE*, the model would find a different contract position that achieves the lowest risk. In particular, if it were assumed, for instance, that next year will have an unusually large number of very high price events that coincided with high load, then the model would certainly find a different contract position that achieves the lowest risk. That load forecasts and price forecasts (and their correlation) are important to the costs that retailers face in supplying regulated customers is why we use the best available information to develop load forecasts and price forecasts that are consistent with the observed peakiness of historic load and historic prices (and the observed correlation between them).

Figure 18: Contract position for CitiPower residential load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



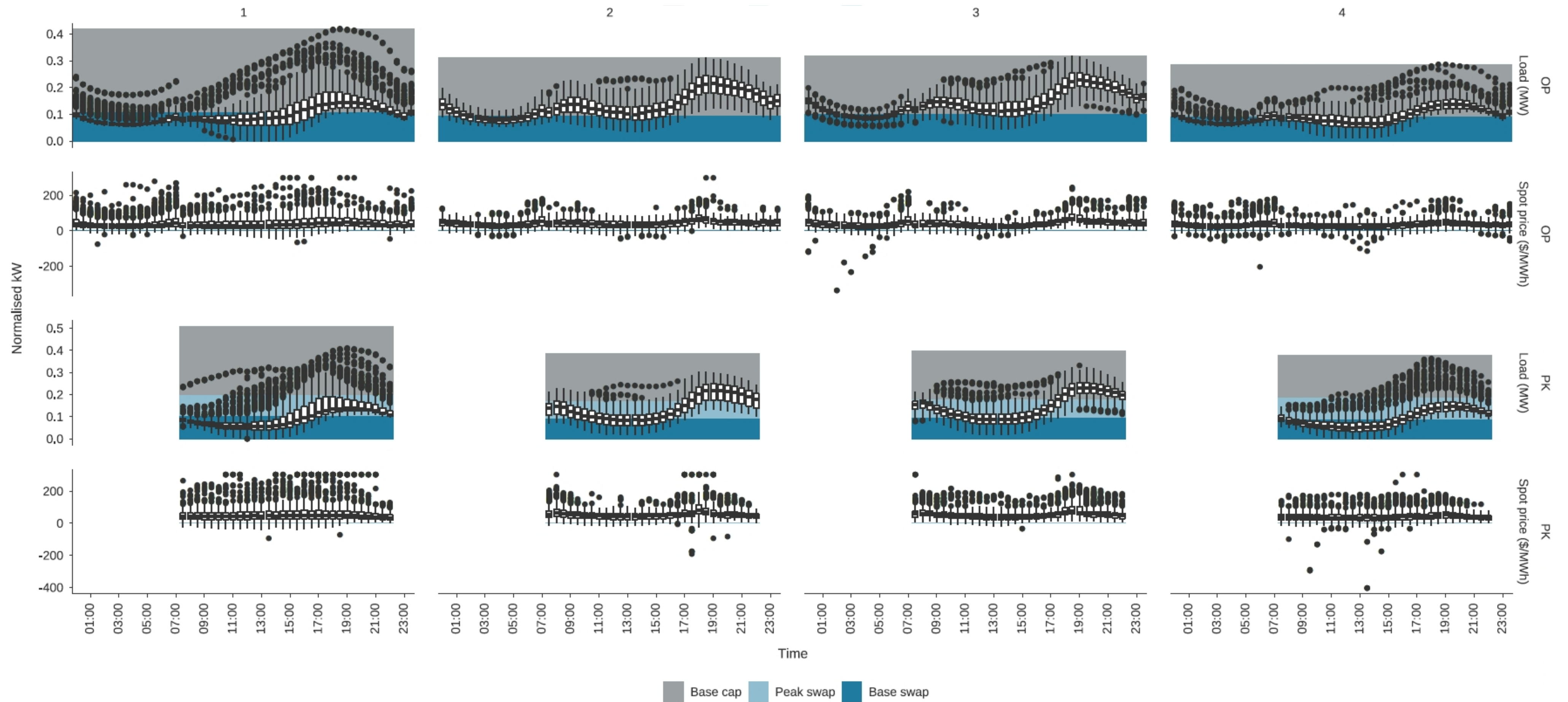
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 19: Contract position for Powercor residential load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



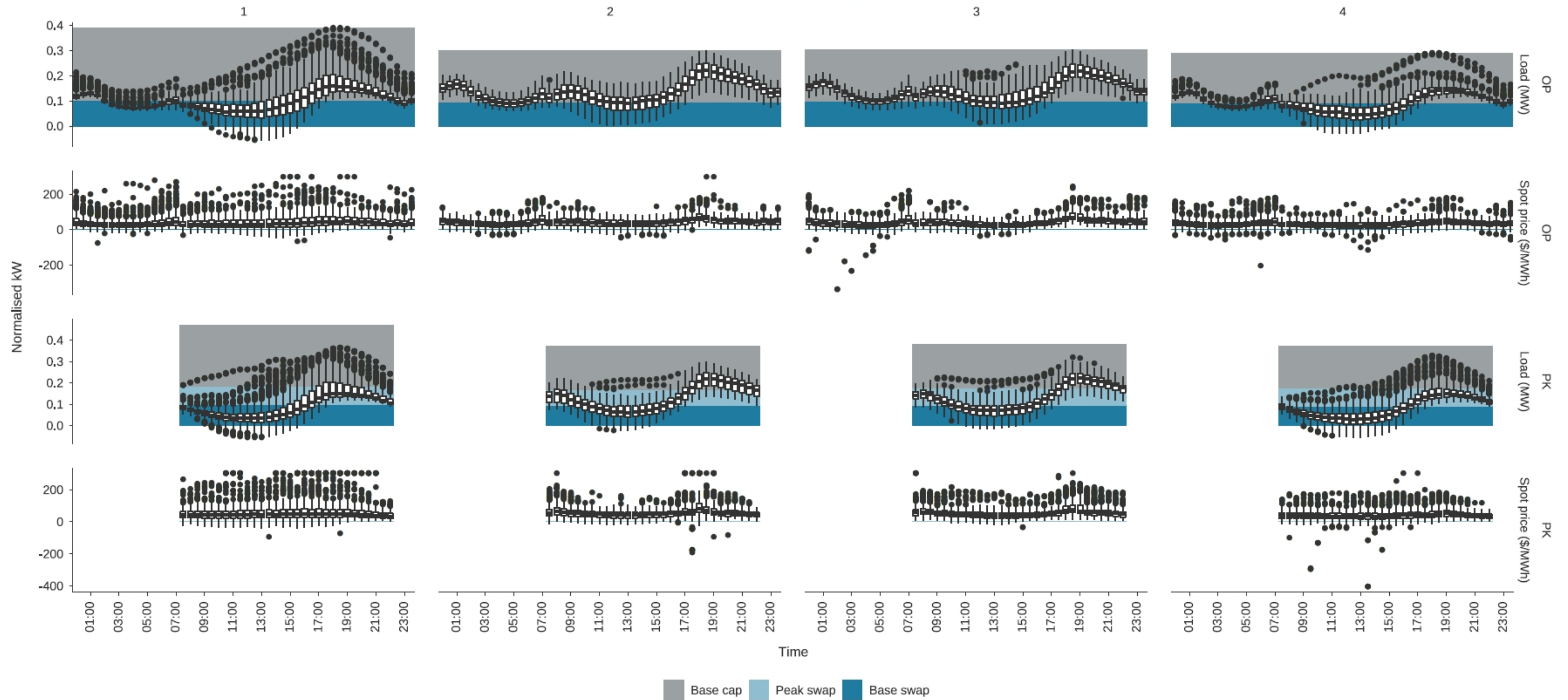
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 20: Contract position for Jemena residential load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



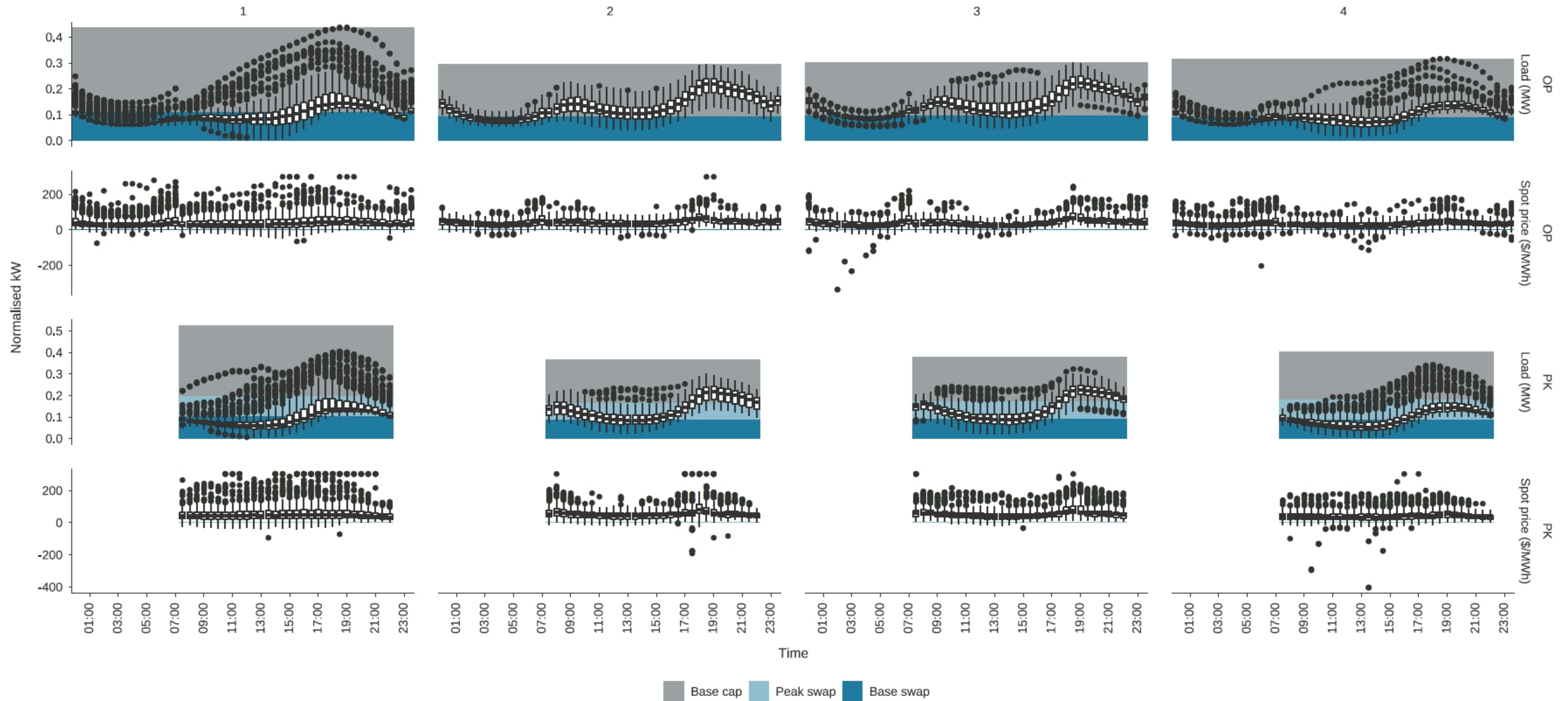
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 21: Contract position for AusNet residential load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



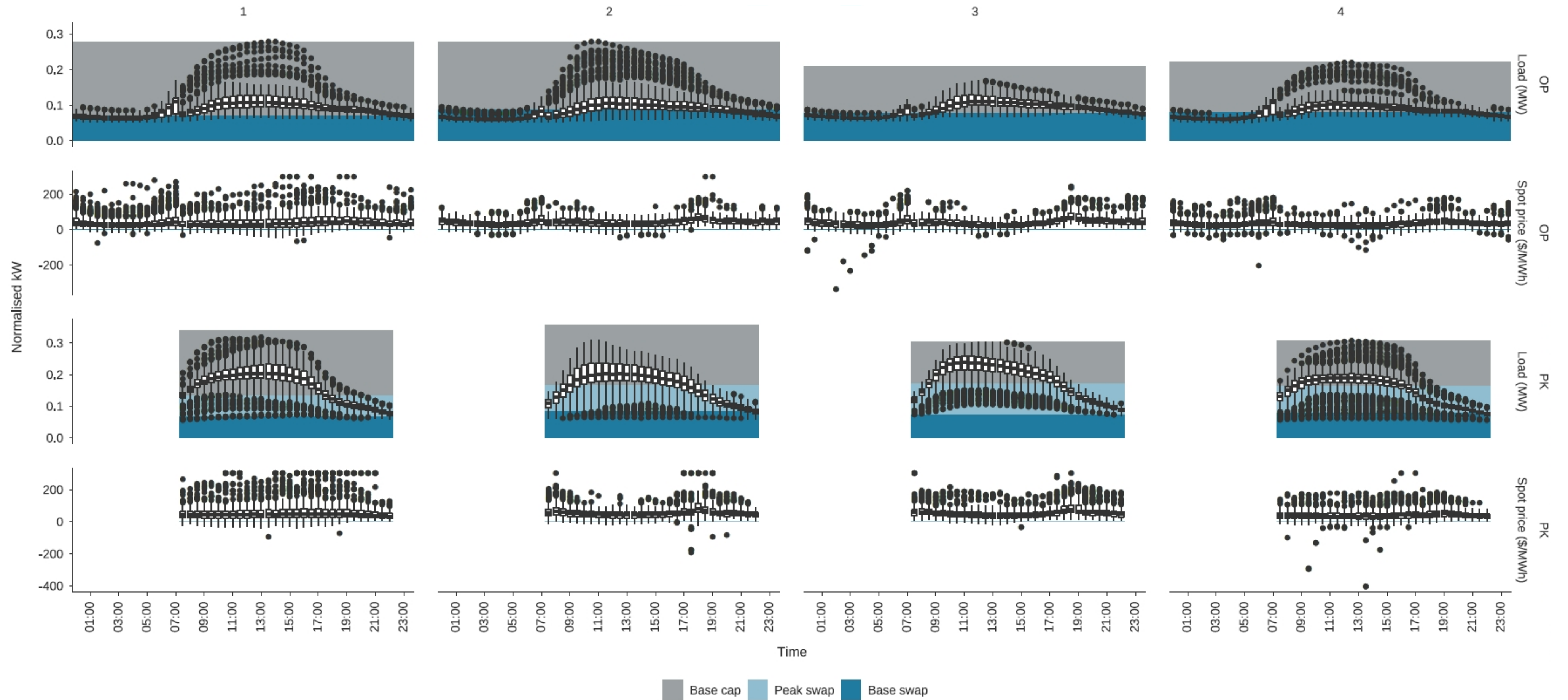
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 22: Contract position for United residential load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



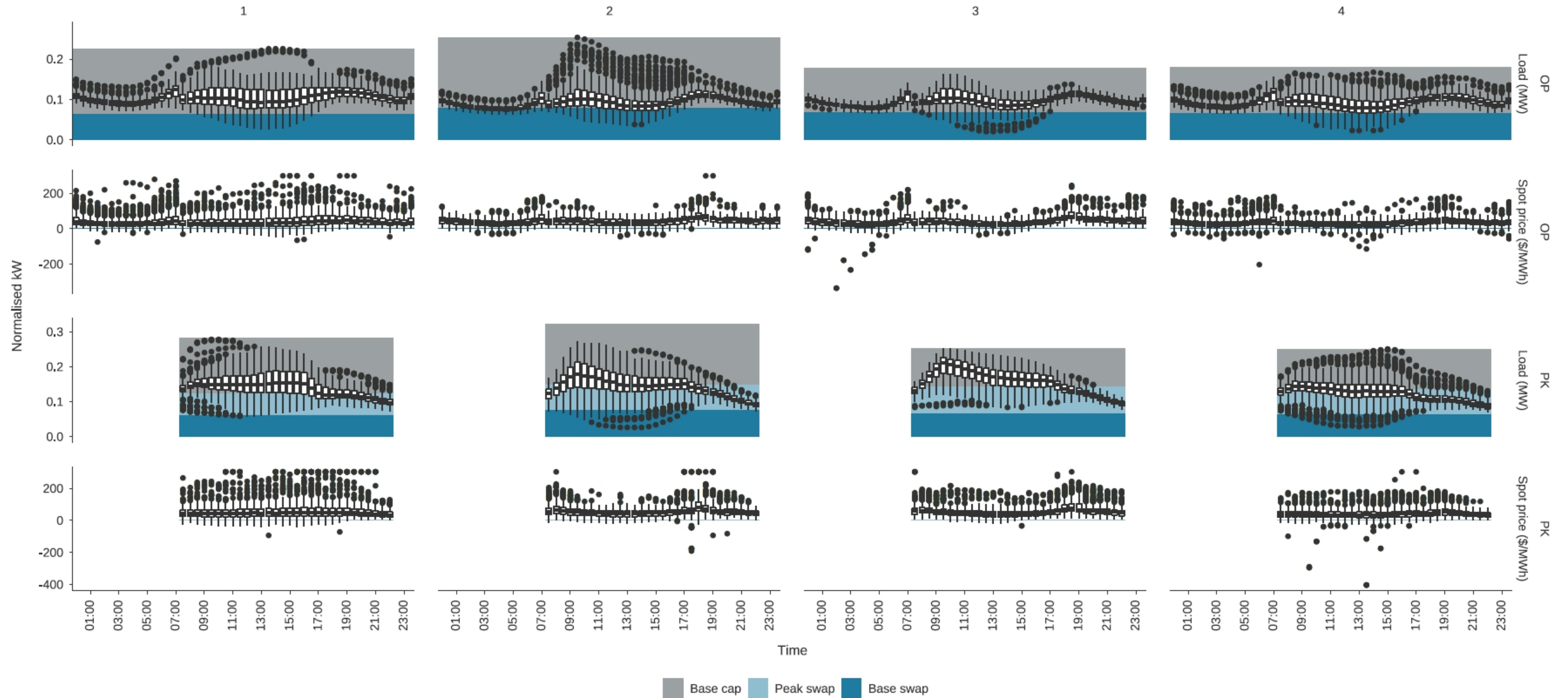
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 23: Contract position for CitiPower business load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



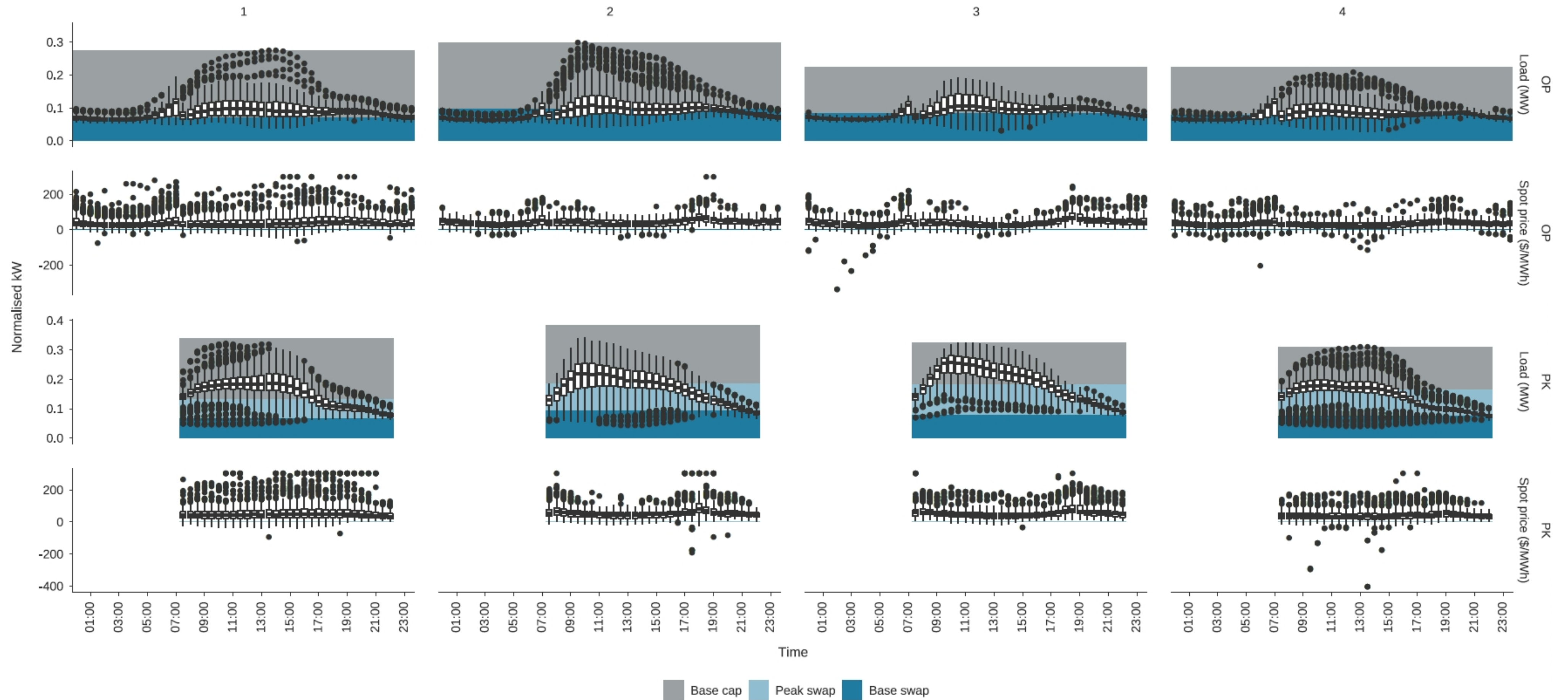
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 24: Contract position for Powercor business load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



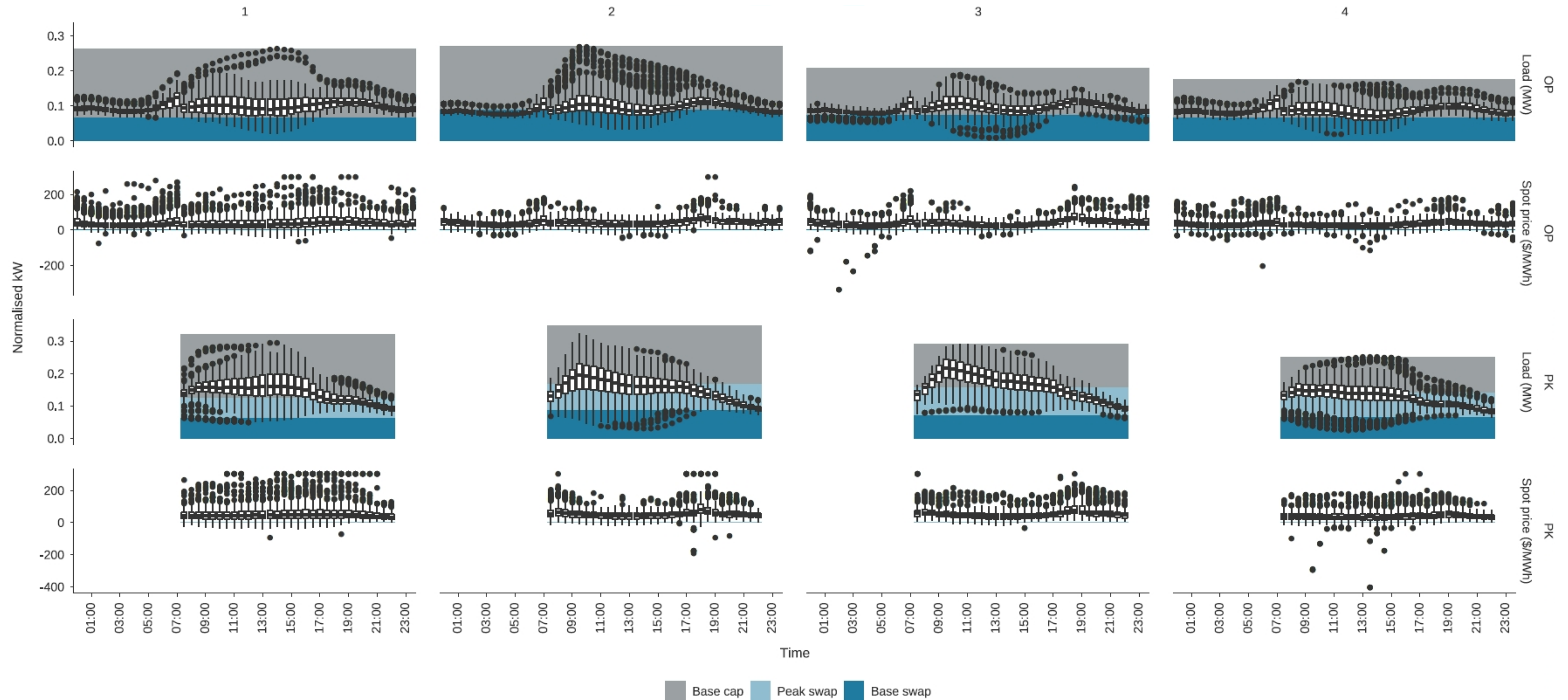
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 25: Contract position for Jemena business load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



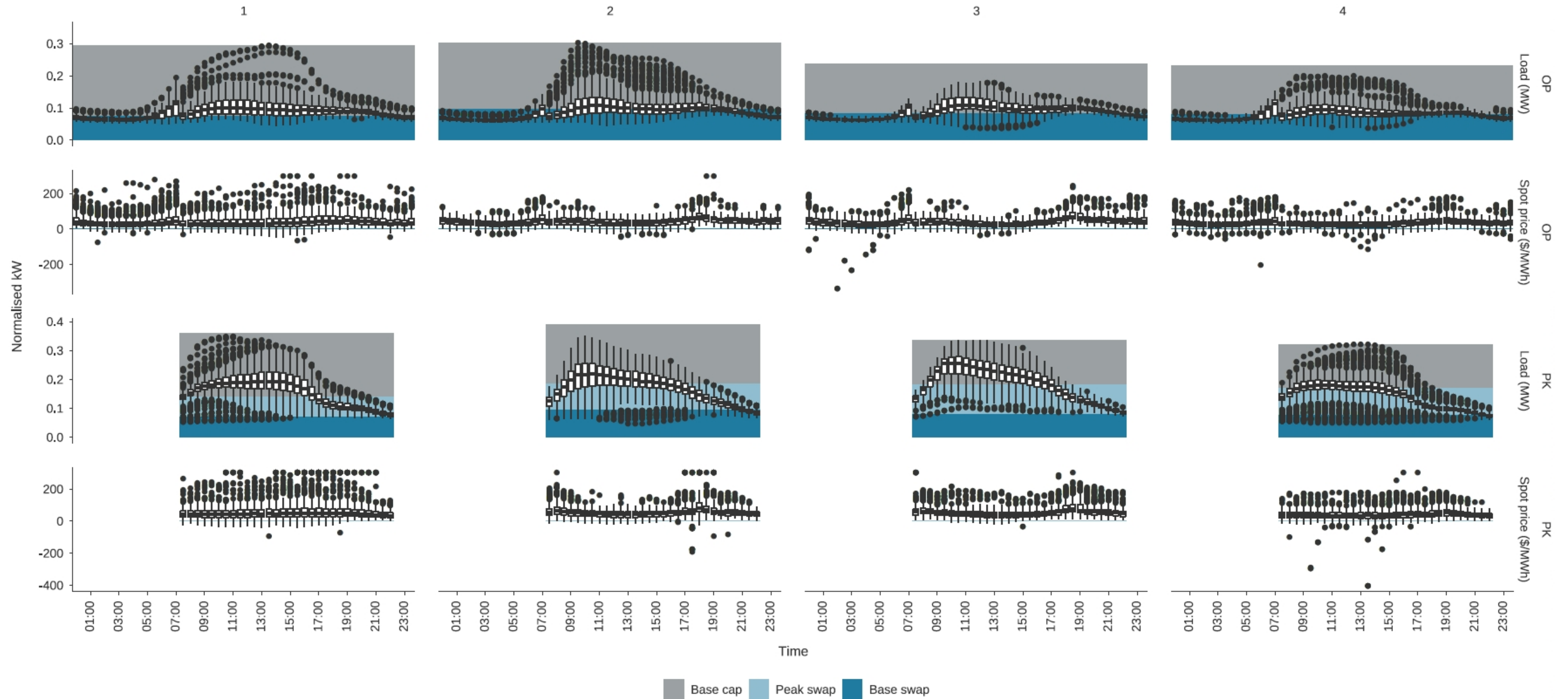
Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 26: Contract position for AusNet business load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



Note: Spot price chart truncated at a spot price of $300/MWh.

Figure 27: Contract position for United business load, ASXEnergy contract prices, calendar year 2022 (2022 dollars)



Note: Spot price chart truncated at a spot price of $300/MWh.

6 Wholesale electricity costs

Based on the data discussed in Section 3 through Section 5, this section reports the WEC that we have estimated.

6.1 Wholesale electricity costs

We estimate the WEC by calculating settlement payments and differences payments resulting from the half-hourly spot prices and load, contract prices and contract position that we have developed.

Results

The WECs that we have estimated are based on half-hourly spot prices and load from the median simulated year (when these years are ranked according to WEC). The WECs that we have estimated are based on 12-month trade weighted average ASXEnergy contract prices up to 8 October 2021. The WECs that we have estimated are based on the contract position from the conservative point on the efficient frontier for each DNSP.

These WECs are set out in **Table 2**.

Table 2: Modelled market-based wholesale electricity cost result

Entity	Wholesale electricity costs ($/MWh, real $2022)	
	Residential	Business
AusNet	$71.42	$62.76
CitiPower	$67.80	$63.89
Jemena	$73.68	$63.96
Powercor	$69.78	$61.05
United	$74.19	$65.22

Source: Frontier Economics

Figure 28 through **Figure 32** show the distribution of WEC for each customer type and for each DNSP area across the full set of 500 simulated years from our Monte Carlo analysis. For each of these 500 simulated years we use the same contract prices and the same contract position; all that changes between these 500 simulated years is the half-hourly profile of prices and the half-hourly load profile. Since each of these WECs is based on a hedged position, they are more concentrated than the load weighted prices. The average difference between the minimum and

maximum WEC for both customer types and DNSP area is $10.03/MWh while the average difference for the load weighted price is $13.21/MWh.

We note that these distributions do not reflect the distribution of all possible outcomes that retailers could face. If patterns of spot prices or load are materially different from the historical period on which we based our Monte Carlo analysis, or if average spot prices were too much different from suggested by current ASXEnergy contract prices, the wholesale energy cost could fall outside the range implied by these distributions.

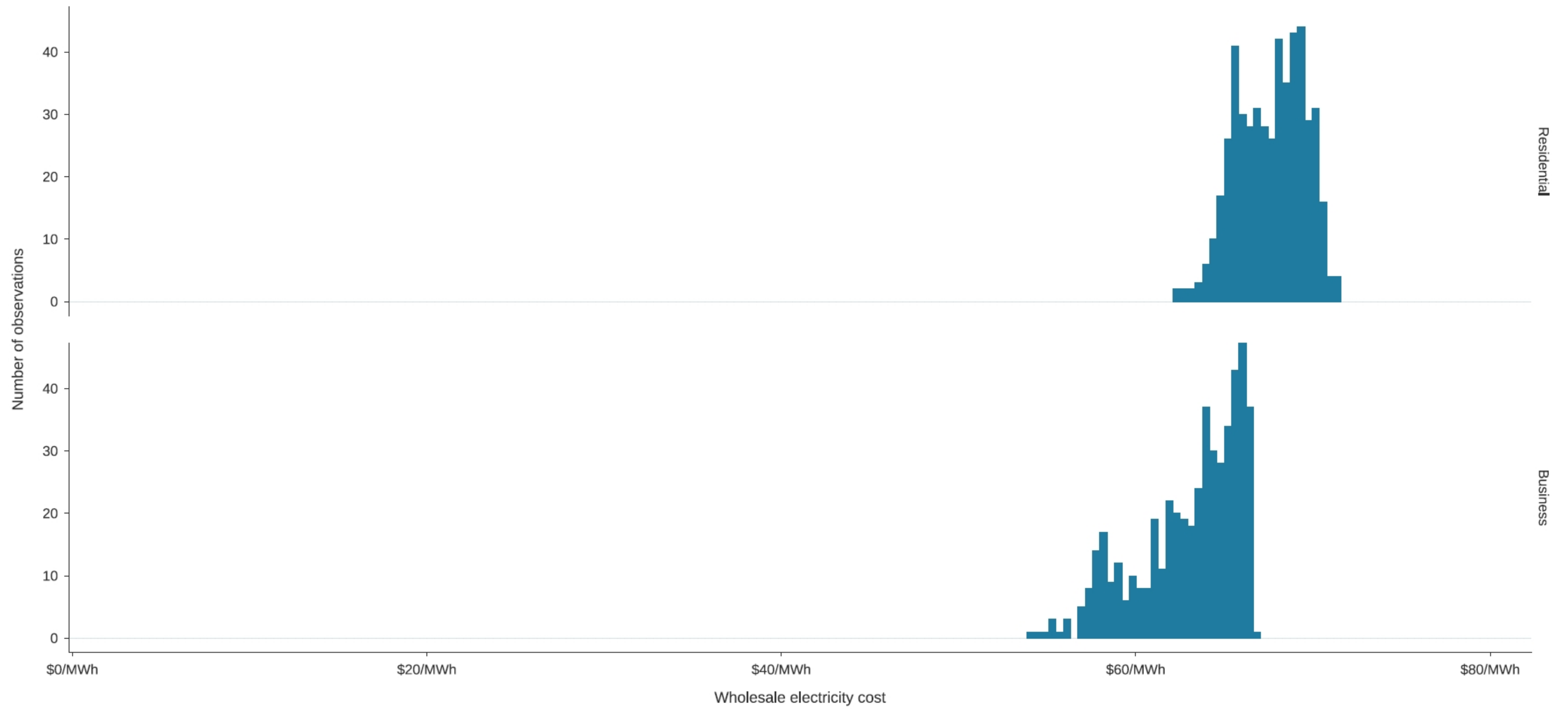
Changes since the draft report

Since the draft report, our estimates of WEC have changed slightly as a result of more recent ASXEnergy prices:

- For residential customers, our estimate of the WEC has increased since the draft report, by around $0.50/MWh for each network area.
- For business customers, the change since the draft report has been smaller, with the result varying between a very slight decrease in WEC to a slight increase in WEC (the changes for business customers were between -$0.04/MWh and +$0.13/MWh for each network area).

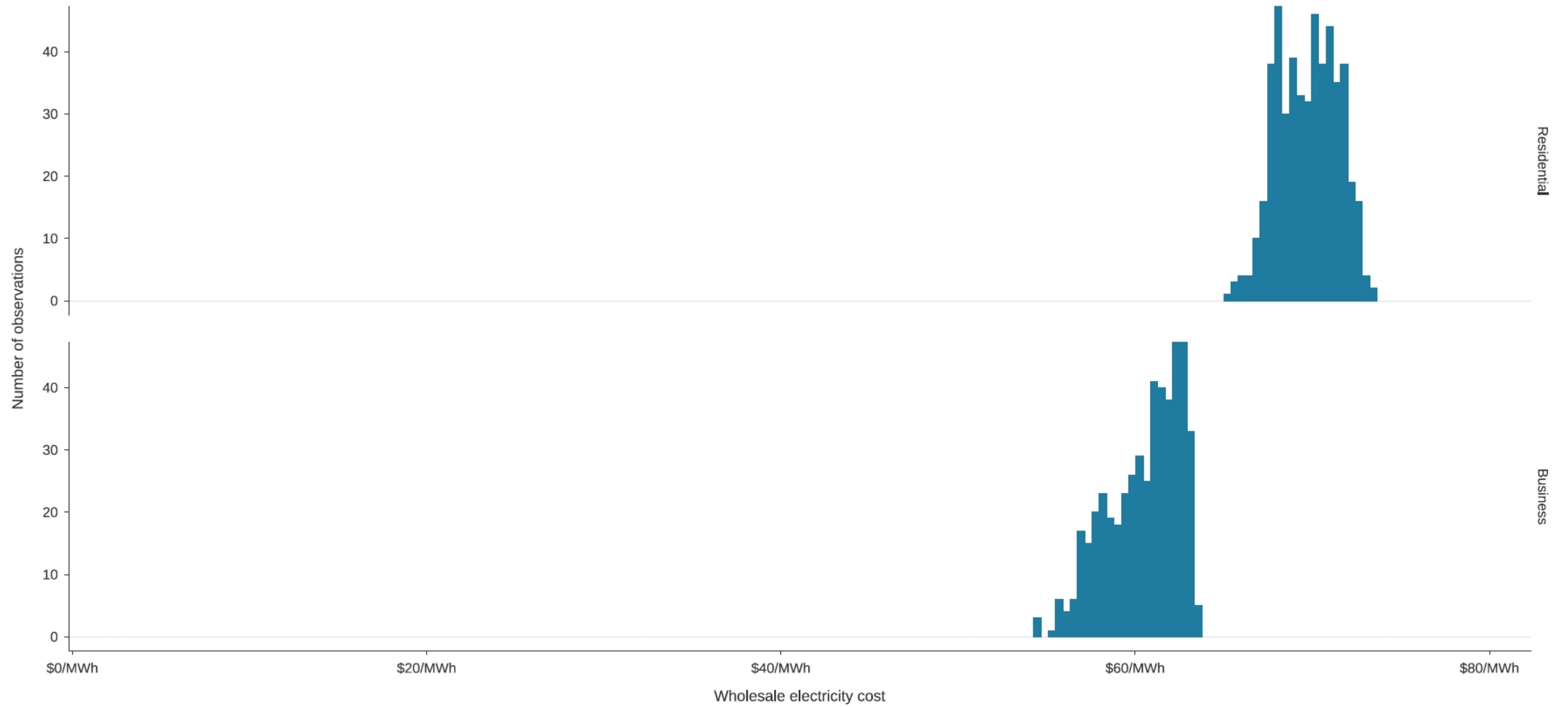
The reason for this difference between the changes for residential customers and the changes for business customers is driven by differences in the load profiles for these customers. For instance, the change in 40-day average ASXEnergy prices (which we use to scale our spot prices) since the draft report varies between quarters: prices increased most in Q2 and Q3, increased a little in Q4 and decreased in Q1. Business customers have similar consumption in each quarter of the year, so they are equally exposed to the changes in each of these quarters. Residential customers, however, have higher consumption in Q2 and Q3 than in Q1 and Q4. As a result, residential customers are relatively more exposed to the higher price increases in Q2 and Q3.

Figure 28: CitiPower load wholesale electricity cost distribution



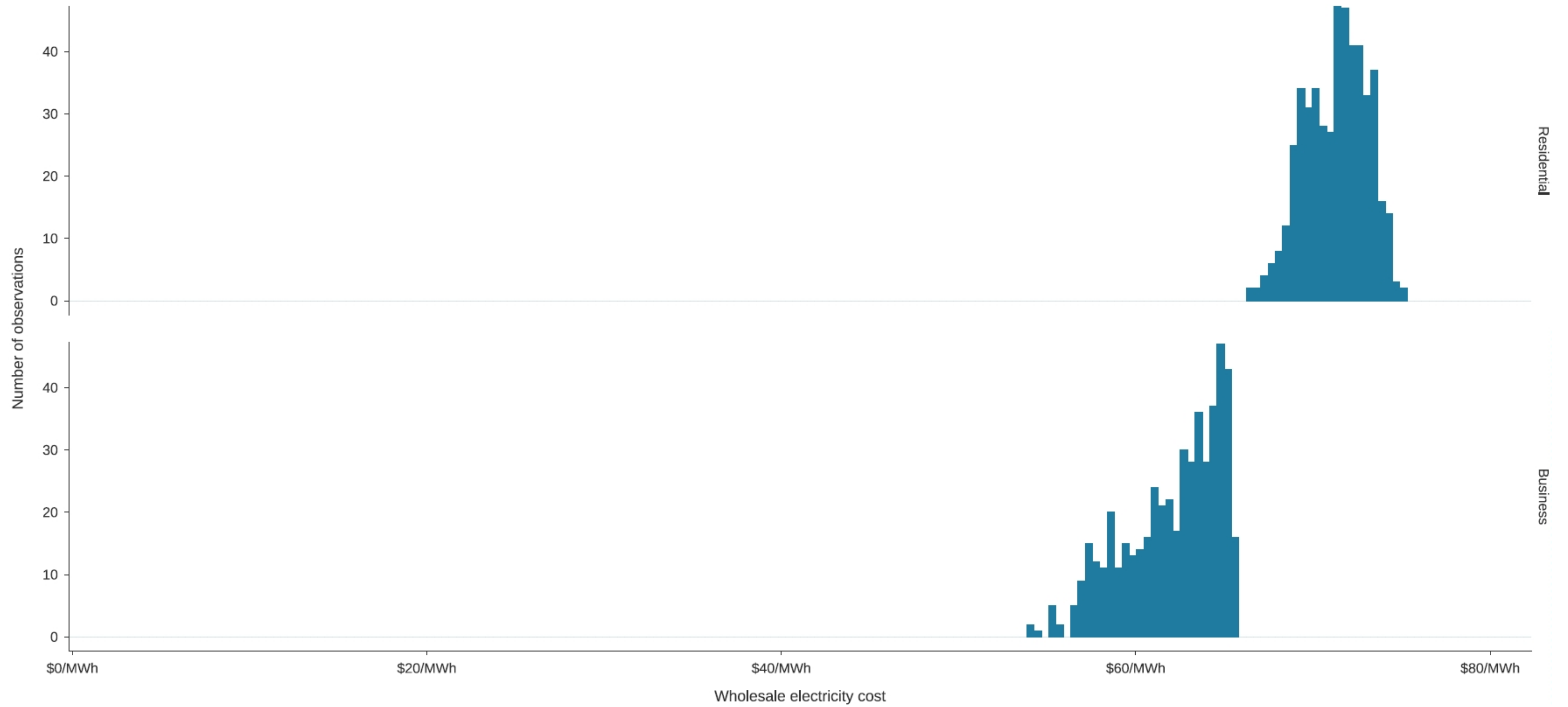
Source: Frontier Economics

Figure 29: Powercor load wholesale electricity cost distribution



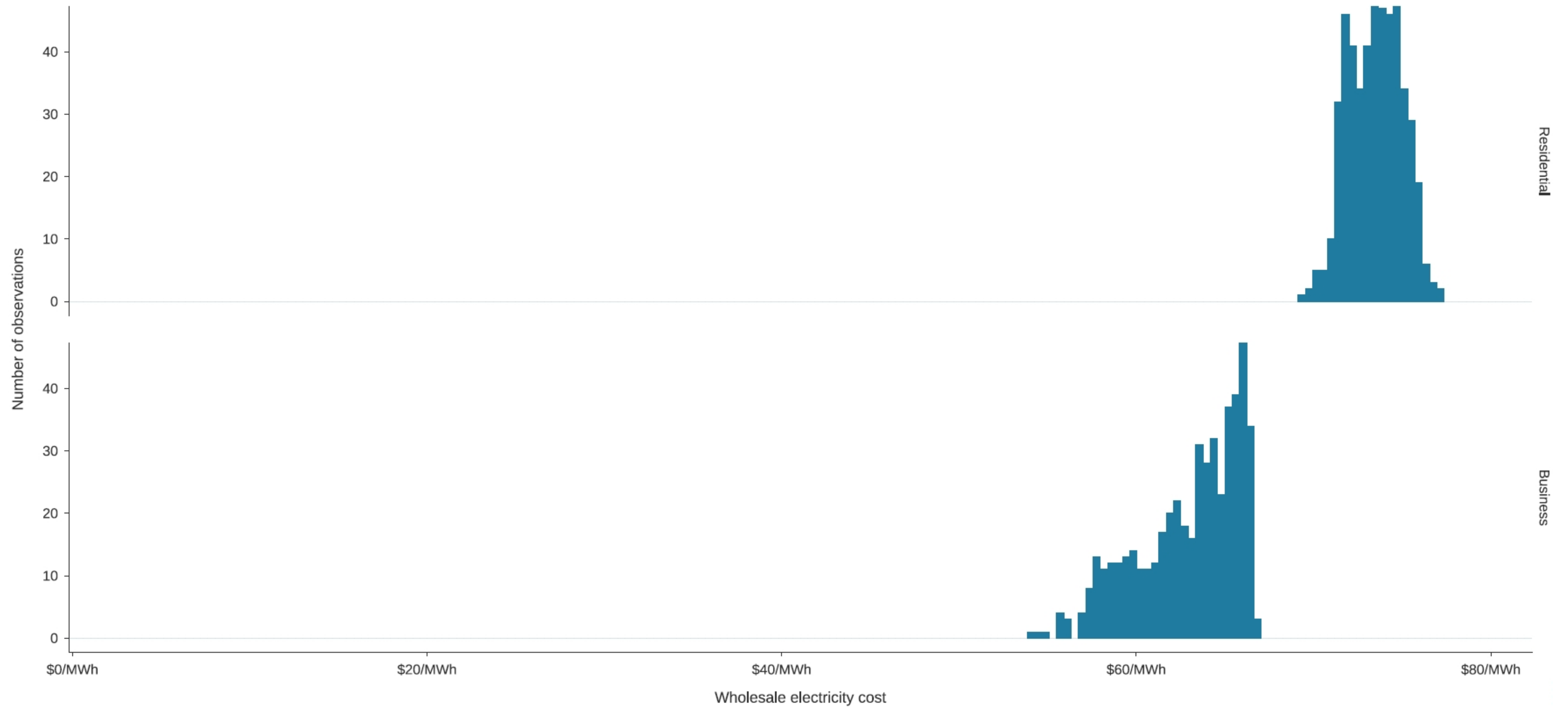
Source: Frontier Economics

Figure 30: AusNet load wholesale electricity cost distribution



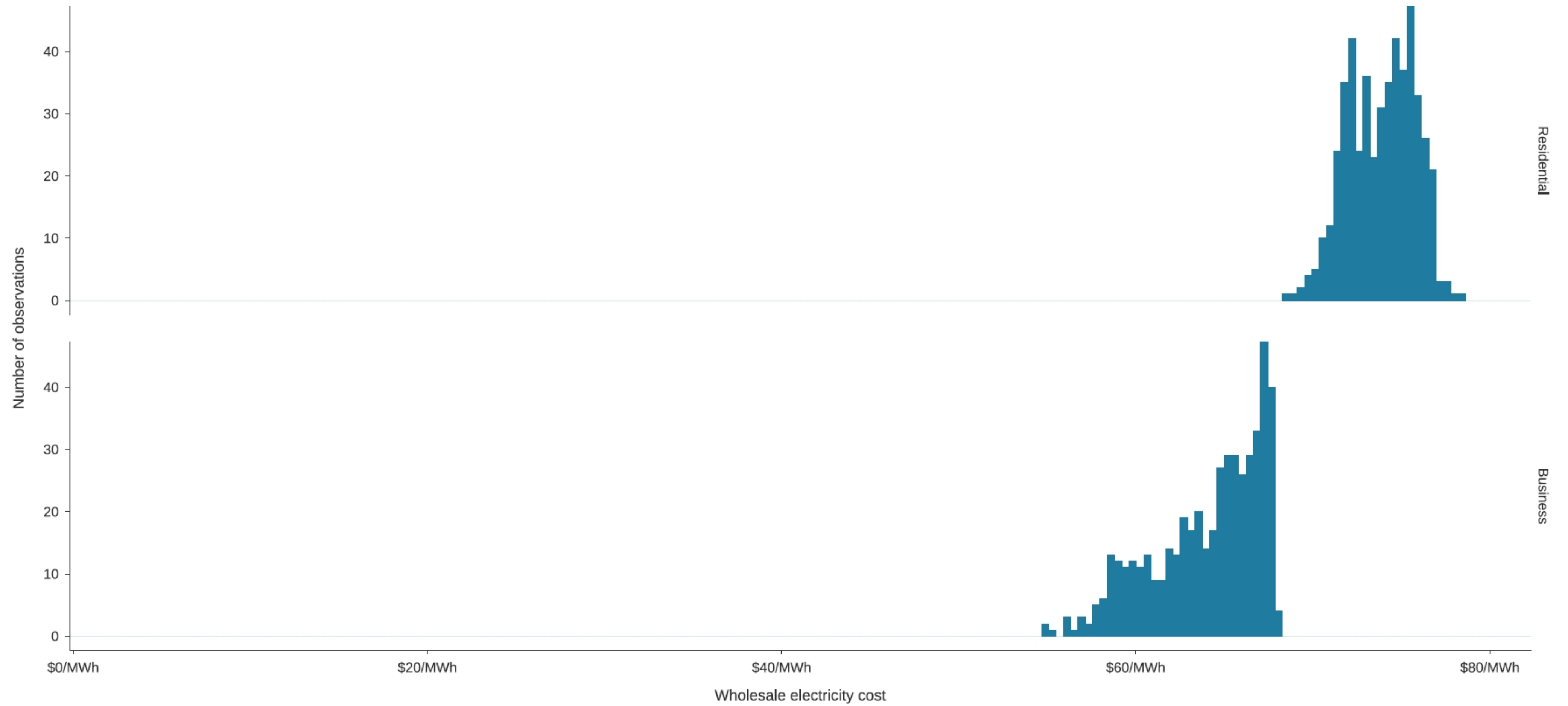
Source: Frontier Economics

Figure 31: Jemena load wholesale electricity cost distribution



Source: Frontier Economics

Figure 32: United load wholesale electricity cost distribution



Source: Frontier Economics

6.2 Volatility allowance

As discussed, the WECs that we have estimated are based on half-hourly spot prices and load from the median simulated year. The volatility allowance is intended to compensate retailers for the residual risk to which they are exposed, even when contracted at the conservative point. The volatility allowance is calculated based on the cost of holding working capital to fund cashflow shortfalls that could arise in years when the actual WEC is higher than we have estimated for the median simulated year. The working capital requirement is based on the difference between the WEC that we have estimated for the median simulated year and the WEC for the most costly simulated year for each distribution area. We then estimate the cost of holding sufficient working capital by applying a WACC of 7.5 per cent.

The volatility allowances calculated using this framework are set out in **Table 3**.

Table 3: Modelled volatility allowance

Entity	Volatility Allowance ($/MWh real $2022)	
	Residential	Business
AusNet	$0.27	$0.23
CitiPower	$0.28	$0.22
Jemena	$0.27	$0.22
Powercor	$0.28	$0.18
United	$0.30	$0.23

Source: Frontier Economics

7 LRET and SRES

In addition to estimating the WEC, our scope of work also includes estimating the costs that a retailer will face as a result of the following schemes:

- the Large-scale Renewable Energy Target (LRET)
- the Small-scale Renewable Energy Scheme (SRES).

This section reports our estimate of these costs.

7.1 LRET

The LRET places a legal liability on wholesale purchasers of electricity to proportionately contribute towards the generation of additional renewable electricity from large-scale generators. Liable entities support additional renewable generation through the purchase of Large-scale Generation Certificates (LGCs). The number of LGCs to be purchased by liable entities each year is determined by the Renewable Power Percentage (RPP), which is set each year by the Clean Energy Regulator. LGCs are created by eligible generation from renewable energy power stations.

In order to calculate the cost to a retailer of complying with the LRET, it is necessary to determine the RPP for the retailer (which determines the number of LGCs that must be purchased) and the cost of obtaining each LGC.

Renewable Power Percentage

The RPP establishes the rate of liability under the LRET and is used by liable entities to determine how many LGCs they need to surrender to discharge their liability each year.

The RPP is set to achieve the renewable energy targets specified in the legislation. The Clean Energy Regulator is responsible for setting the RPP for each year.

The *Renewable Energy (Electricity) Act 2000* states that where the RPP for a year has not been determined it should be calculated as the RPP for the previous year multiplied by the required GWh's of renewable energy for the current year divided by the required GWh's of renewable energy for the previous year. This calculation increases the RPP in line with increases in the renewable energy target but does not decrease the RPP to account for any growth in demand. As a result, this calculation is likely to overestimate the RPP for a given year when energy demand is growing.

The Clean Energy Regulator has published a RPP for 2021 of 18.54%. Using this 2021 RPP, and applying the default calculation, results in an RPP for 2022 of 18.54%.

Cost of obtaining LGCs

The cost to a retailer of obtaining LGCs can be determined either on the basis of the resource costs associated with creating LGCs, or on the basis of the market price at which LGCs are traded.

For this report, we have used a market price for LGCs to determine the cost of complying with the LRET. The market price for LGCs is determined by taking a 12 month trade weighted average of

LGC prices reported by Demand Manager.[6] This 12 month trade weighted average LGC price is $34.44 per certificate ($2022).

Cost of complying with the LRET

Based on the RPP and the LGC price discussed above, the cost of complying with the LRET is $6.39/MWh ($2022).

7.2 SRES

The SRES places a legal liability on wholesale purchasers of electricity to proportionately contribute towards the costs of creating small-scale technology certificates (STCs). The number of STCs to be purchased by liable entities each year is determined by the Small-scale Technology Percentage (STP), which is set each year by the Clean Energy Regulator. STCs are created by eligible small-scale installations based on the amount of renewable electricity produced or non-renewable energy displaced by the installation.

Liable entities can purchase STCs on the open market or through the STC Clearing House. There is a guaranteed price of $40/STC through the Clearing House, but certificates may take some time to clear, delaying payment to sellers of STCs.

In order to calculate the cost to a retailer of complying with the SRES, it is necessary to determine the STP for the retailers (which determines the number of STCs that must be purchased) and the cost of obtaining each STC.

Small-scale Technology Percentage

The STP establishes the rate of liability under the SRES and is used to determine the number of STCs that liable entities are required to surrender each year. The STP is determined by the Clean Energy Regulator.

The STP is calculated in advance based on:

- the estimated number of STCs that will be created for the year[7]
- the estimated amount of electricity that will be acquired for the year
- the estimated number of all partial exemptions expected to be claimed for the year

The STP is to be published for each compliance year by March 31 of that year. The Clean Energy Regulator is also required to publish a non-binding estimate of the STP for the two subsequent compliance years by March 31. The STPs set out by the Clean Energy Regulator in March 2021 are given in **Table 4**.

6 Available at: http://www.demandmanager.com.au/. Accessed 8th October 2021

7 This is determined by the Clean Energy Regulator. In recent years it has estimated it based on the simple average of STC forecasts made by consultants to the Clean Energy Regulator.

Table 4: STPs published by the Clean Energy Regulator in 2021

Binding/Non-binding	Estimate/Forecast year	STP
Binding	2021	28.80%
Non-binding	2022	22.40%
Non-binding	2023	21.15%

Source: Clean Energy Regulator

In our view, based on the Clean Energy Regulator's estimates, the non-binding estimate of the STP for 2022 is the appropriate STP to calculate costs of complying with the SRES for 2022.

However, in previous determinations, the ESC has favoured using an average of the most recent binding estimate and non-binding forecast in previous determinations i.e., for this 2022 VDO, this would be the average of the 2021 binding and 2022 non-binding STP. Our understanding is that the ESC's methodology is motivated by the fact next year's non-binding STP has typically understated next year's binding STP.

We have analysed historical STP publications and found that:

- since 2019, the previous year's binding STP would have been a better forecast for next year's binding STP
- prior to 2019, next year's non-binding STP forecast would have typically been better forecast for next year's binding STP

Therefore, it is not obvious whether using the 2021 binding STP would provide a better forecast for the 2022 liability compared with the 2022 non-binding estimate. Given this uncertainty and the ESC's historical preference to use the average of the binding and non-binding STP, we have provided an estimate of the costs of complying with the SRES in 2022 based on both:

- the binding STP for 2021 and
- the non-binding STP for 2022.

Cost of obtaining STCs

For the purposes of this report, we assume that the cost of STCs is equal to this STC Clearing House price of $40/STC ($2022).

Historically, the reported spot price of STCs has typically been at, or close to, this price of $40/STC.

Cost of complying with the SRES

Based on the STC price discussed above, the cost of complying with the SRES in 2022 is:

- $11.52/MWh ($2022) based on the binding STP for 2021
- $8.96/MWh ($2022) based on the non-binding STP for 2022

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