WHOLESALE PRICE FORECASTS FOR CALCULATING MINIMUM FEED-IN TARIFF

A REPORT FOR THE ESSENTIAL SERVICES COMMISSION

4 FEBRUARY 2019

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1 INTRODUCTION

Frontier Economics has been engaged to advise the Essential Services Commission (ESC) on wholesale price forecasts for the purpose of calculating a Feed-in Tariff (FiT).

1.1 Background

The ESC is required under the *Electricity Industry Act 2000 (Vic)* to determine one or more rates to be paid by electricity retailers to customers who feed-in surplus renewable energy generation into the grid. The ESC has published two minimum FiT rates used for financial year 2018/19:

- A single flat-rate FiT
- A time-varying FiT (with peak, shoulder and off-peak rates).

The ESC has engaged Frontier Economics to project Victorian wholesale prices for 2019/20 to inform its determination of the FiT rates for 2019/20. This report details our approach, considerations, methodology and results.

1.2 Our approach

The value of small scale renewable energy fed into the grid is a function of wholesale spot prices at the times of those exports. It is therefore necessary to develop a set of half-hourly prices that can be appropriately correlated to a set of half-hourly solar PV export or generation data for the relevant period. We do this by making use of forward prices for 2019/20 from ASXEnergy, and scaling these forward prices to a recent historical year of half-hourly prices.

We begin by analysing the historical half-hourly Victorian system demand and prices over the past five years, to identify the effects of embedded solar generation on system demand and prices. This analysis informs the selection of the series of historical half-hourly wholesale prices which provide the half-hourly profile used for projection of 2019/20 wholesale prices. Importantly, the half-hourly prices selected as the 'starting point' for this projection must be taken from the same time period as the embedded solar generation data (export data) used to compute the FiT in order to preserve the correlation between the two sets of data.

We then scale the selected historical half-hourly Victorian spot prices to an estimate of the average spot price for 2019/20. The price at which a quarterly base swap for Victoria trades on ASXEnergy is generally taken to reflect the market's expectation of the average electricity spot price for Victoria for the relevant quarter (after adjusting for the implied contract premium). In our analysis we make use of forward contract prices for the FiT period (2019/20) from ASXEnergy. We adjust these forward prices to remove an assumed contract premium and scale the selected historical half-hourly spot price profile to achieve these target average prices.

1.3 Best practice

The approach used in this paper is consistent with what we consider to be best practice, and reflects the approach that we have previously adopted in providing similar advice to other regulators. More specifically:

- The approach allows the correlation between half-hourly solar exports and half-hourly market prices to be maintained, so that the resulting FiT accurately reflects the relationship between the two.
- Price profiles have been scaled to meet future expectations of spot prices. Consistent with other work, we have inferred prices from ASXEnergy contract prices (adjusted for an assumed contract premium).
- In our previous advice to IPART, we accounted for uncertainty in customer load and solar export quantities by using a Monte Carlo simulation of available data. Given our focus on forecasting half-hourly prices for this project there is not the same need to undertake a Monte Carlo simulation to account for uncertainty in load and exports. A Monte Carlo simulation could be used to generate half-hourly price profiles using historical data, but in our view there would be benefit to this only if we were confident that we could use a reasonable number of years of historical price data.

Overall, we consider the approach outlined in this report to be consistent with regulatory best practice. We also consider that the approach outlined in this report has the benefit of being relatively simple and transparent: it relies largely on publicly available data and, in principle, could be replicated by interested stakeholders (subject to the availability of reasonable data on half-hourly solar exports).

1.4 About this paper

This report is structured as follows:

- Section 2 discusses our analysis of historical system demand and prices in Victoria.
- Section 3 outlines the methodology used to produce a wholesale price profile for 2019/20.
- Section 4 presents our results.

2 HISTORICAL SYSTEM DEMAND AND PRICES

In order to elect a series of historical half-hourly wholesale prices to provide the half-hourly profile used for projection of 2019/20 wholesale prices, we analysed recent historical years to pick a representative year. This is done by comparing historical half-hourly system demand (since demand is a key determinant of prices) and historical half-hourly prices. We undertook this analysis of historical data on a quarterly basis because this helps preserve seasonal differences and also lines up with the quarterly contracts traded on ASXEnergy (which we use to determine average prices for 2019/20).

Analysing the past 5 years of data also allows trends to be seen, which is particularly important when the uptake of rooftop solar PV has been extremely fast and can have a material effect on load shape. By comparing the load shapes on a yearly and quarterly basis we can determine which years are most relevant to use as the forecast year for load.

We considered five years of historical half-hourly data on system demand and prices from Q1 2014 to Q3 2018 for this analysis. We excluded older data given the changes in the market dynamics, owing to changes in both supply and demand conditions.

We discuss the observations and key findings for historical Victorian system demand (Section 2.1) and historical Victorian prices (Section 2.2), before setting out our recommendations (Section 2.3).

2.1 Historical Victorian system demand

Our analysis of historical half-hourly system demand for Victoria considered:

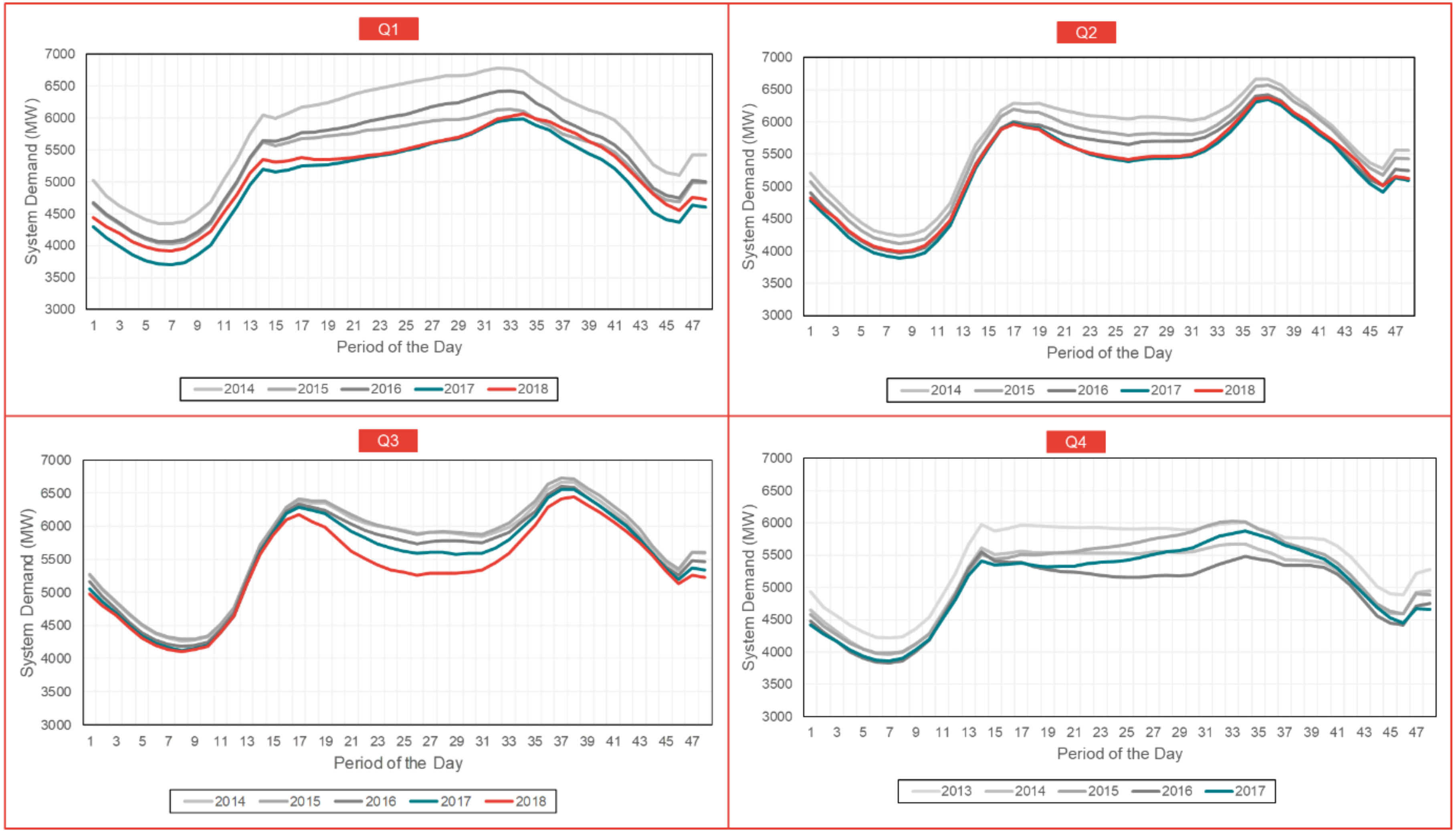
- the overall level of system demand
- the effects of embedded generation on the system demand profile.

We analysed half-hourly historical Victorian system demand data from Q1 2014 to Q3 2018. This data represents the total Victorian daily energy demand profile in megawatts (MW), less the embedded generation profile in MW (which is mostly solar generation).

For each quarter, and for each of working days and non-working days (i.e. weekends and public holidays), we average the system demand for each half-hourly interval to derive an average daily profile (consisting of each of the 48 half-hours that make up a day). We did not average across quarters to ensure the different demand levels and characteristics between quarters, for example the summer and winter quarters, remain distinct. We also ensure that working days and non-working days are averaged separately for the same reason.

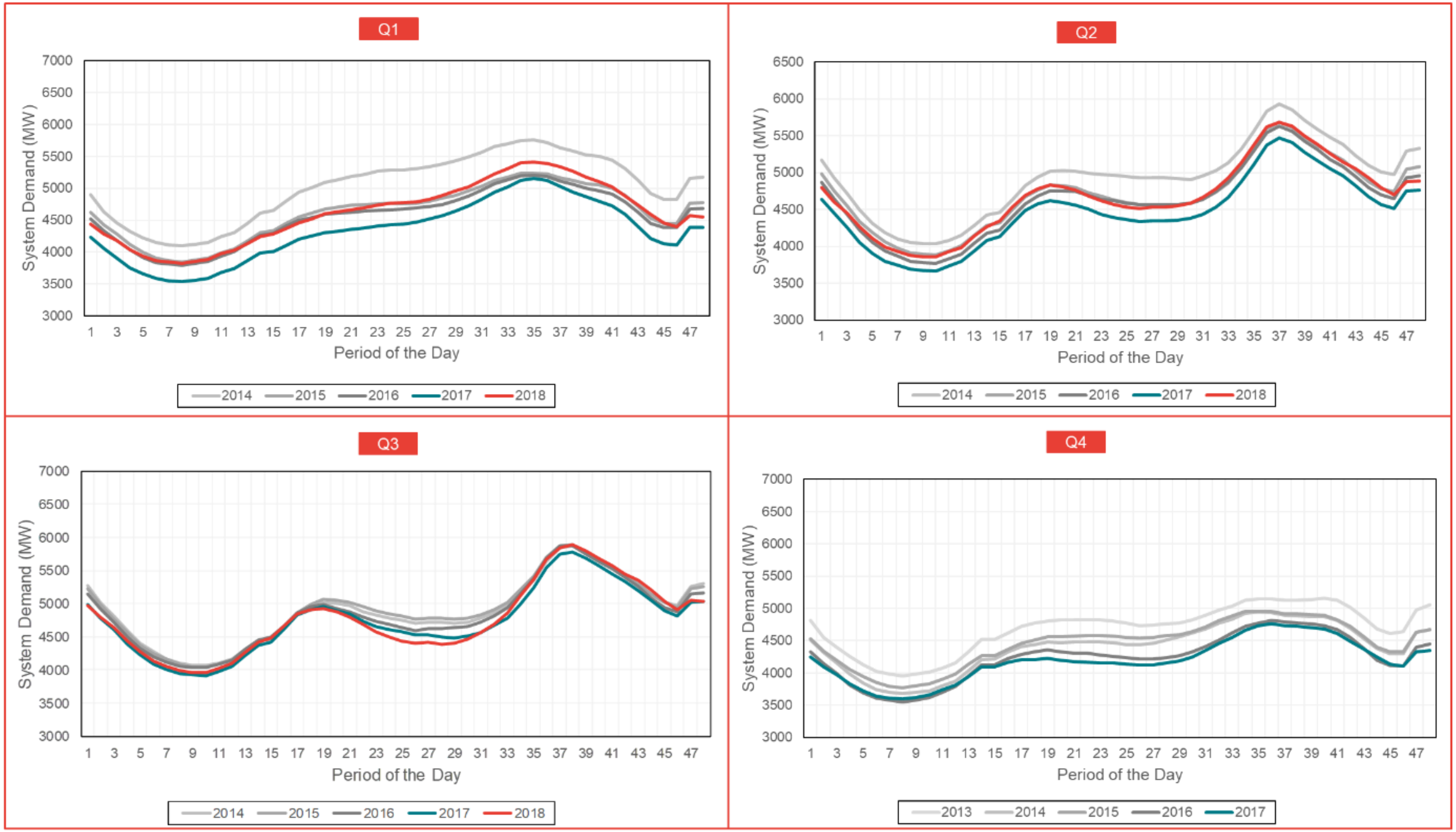
Figure 1 and **Figure 2** present the results for working days and non-working days respectively.

Figure 1: Working day profiles for Victorian system demand for the past five years (by quarters)



Source: National Electricity Market data from AEMO, analysis by Frontier Economics

Figure 2: Non-working day profiles for Victorian system demand for the past five years (by quarters)



Source: National Electricity Market data from AEMO, analysis by Frontier Economics

Our analysis of historical half-hourly system demand, net of solar exports, highlights a number of observations:

- Across the system demand profiles the effects of embedded generation on system demand in Victoria are characterised by a reduction in demand in trading intervals that occur when solar PV is generating. In more recent years this effect has been more apparent, with demand during the middle of the day in 2017 and 2018 tending to be relatively lower (compared with demand overnight and during the morning and evening) than it was in earlier years.
- System demand peaks occur at the same trading interval (or in adjacent trading intervals) over the period. The reason is that even in 2014 system demand peaks were occurring sufficiently late in the afternoon (or in the evening) that increased solar PV has not shifted the time of peak demand later.

Overall, there is some evidence that solar PV has continued to change the shape of the system demand profile over the historical period we have examined, although the time of absolute peak demand has not been significantly affected.

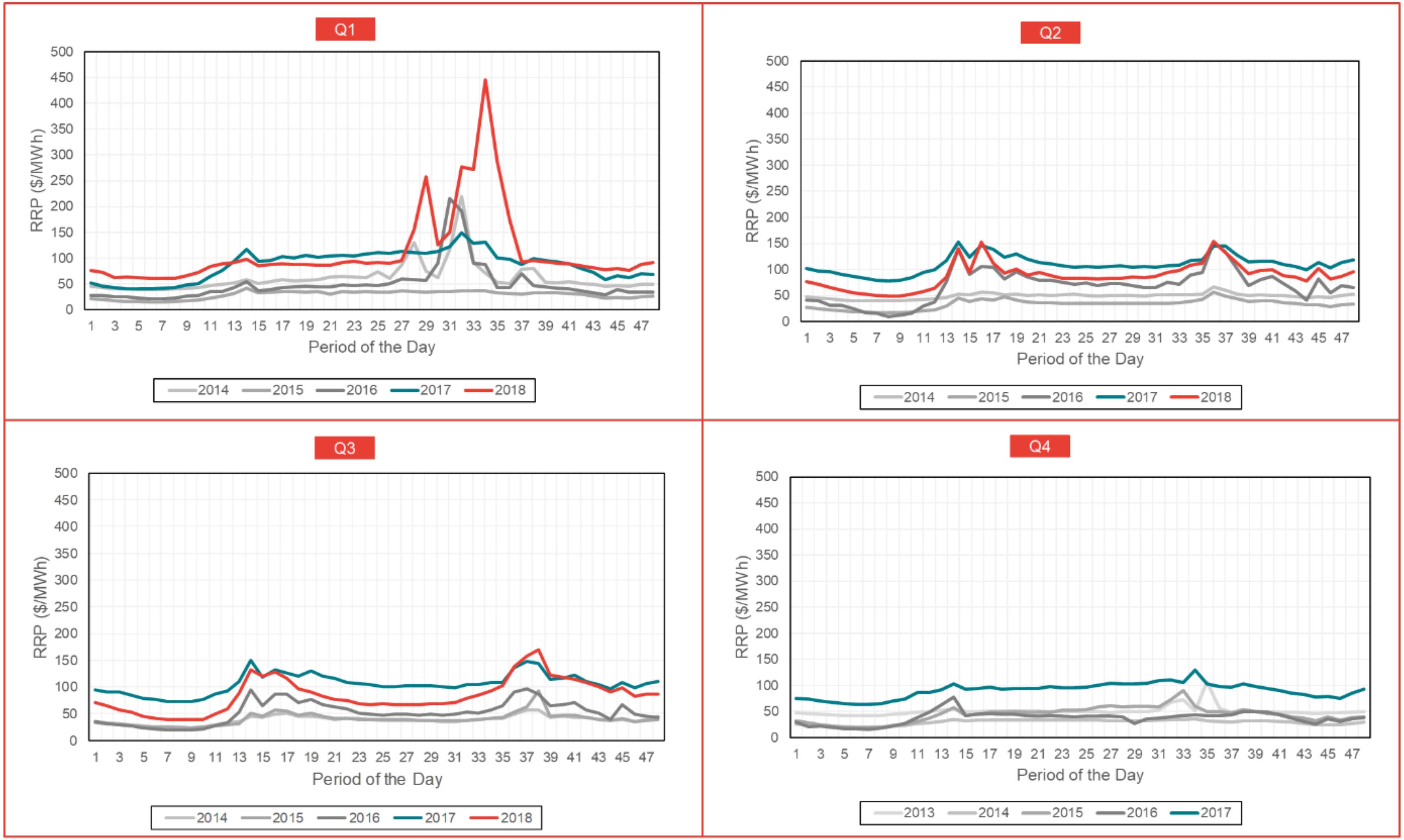
2.2 Historical Victorian prices

Like the analysis of historical half-hourly system demand, we considered historical half-hourly spot prices for Victoria across the past five years in terms of:

- the overall price level
- the effects of embedded generation on the behaviour of peak prices.

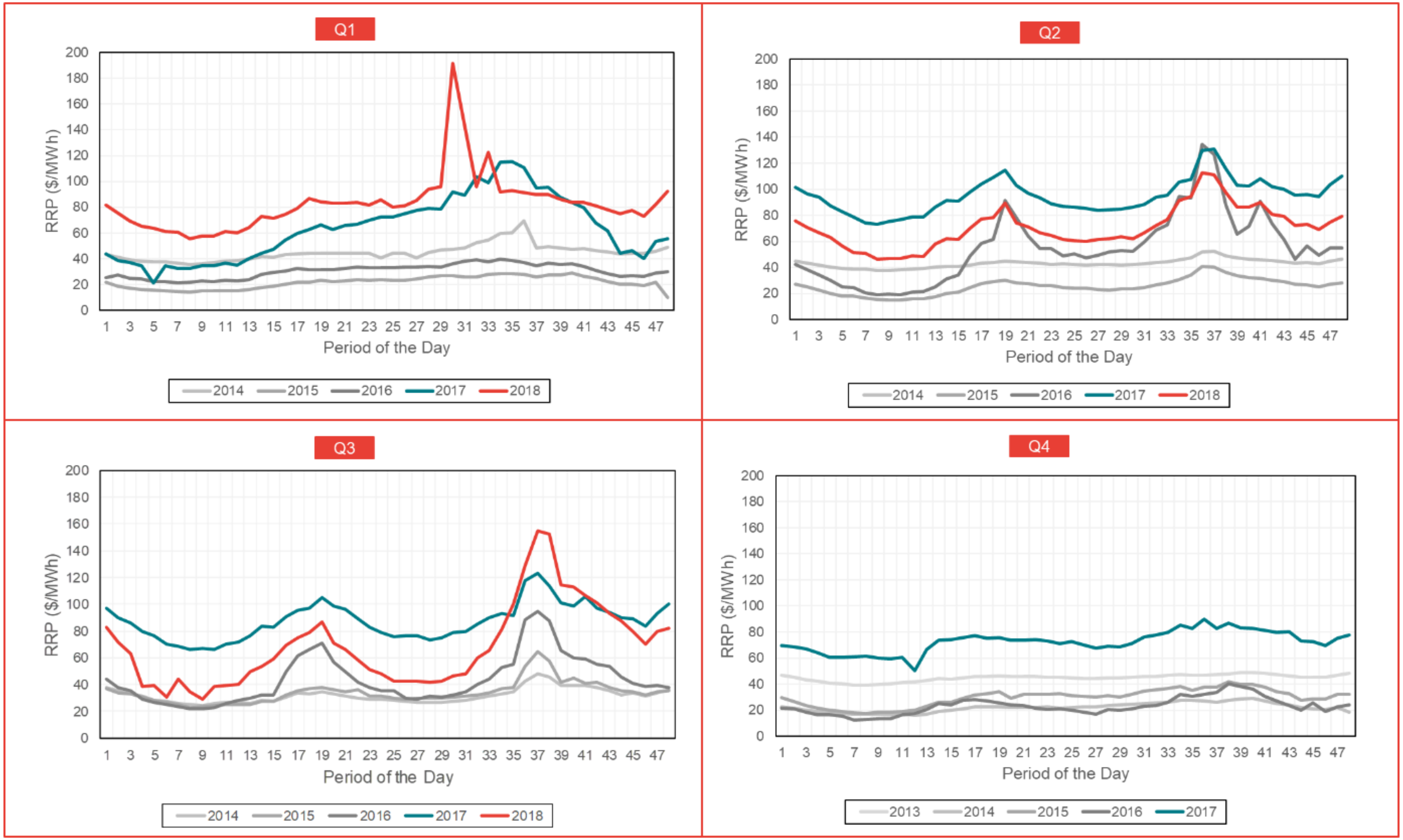
We analysed the historical half-hourly spot price data in the same manner as the historical system demand data and plotted the average Victorian price day profile. **Figure 3** and **Figure 4** present the corresponding charts for prices in working days and non-working days respectively.

Figure 3: Working day profiles for Victorian wholesale prices for the past five years (by quarters)



Source: National Electricity Market data from AEMO, analysis by Frontier Economics

Figure 4: Non-working day profiles for Victorian wholesale prices for the past five years (by quarters)



Source: National Electricity Market data from AEMO, analysis by Frontier Economics

Our analysis of historical half-hourly spot prices highlighted several observations:

- Generally, across the years, we found the price profiles had similar shapes albeit at differing levels, reflecting changing market dynamics, including the supply-demand balance.
- For three out of four quarters (except for Q1), prices have been peaking in the same or relatively close trading intervals. In the summer, peak prices occur in the evening (between trading intervals 33 – 37, save for an anomaly in Q1 non-working day). In winter, prices peak once in the morning (trading intervals 13 – 15 on working days and trading intervals 17 – 19 on non-working days) and once in the evening (between trading intervals 36 – 38). This indicates that embedded generation has not had a substantial time-shifting effect on peak prices over the historical period we have examined (i.e. it is no longer pushing peak prices later into the evening). Even though the peak intervals for Q1 do not consistently fall in the same trading interval across the years, no time-shifting trend was observed.

Overall, we conclude there is no observable peak shifting as a result of embedded solar generation in recent years, and that pricing patterns are quite comparable. Based on this, our view is that any of the historical price data from 2014 to 2018 could be used to provide the half-hourly profile used for projecting the wholesale prices for 2019/20 (subject to the availability of export data, which we will discuss in our recommendation below).

2.3 Our recommendation

We understand that the ESC has requested solar export data from the regional distributors for Q3 2016 to Q3 2018. Given the importance of ensuring the consistency between export profiles and solar prices, in our view this determines the range of reference quarters that could be used to project 2019/20 prices. We strongly recommend against taking prices from time periods outside this range, because doing so would break the correlation between price and export data which will result in inaccurate estimates for the weighted-average FiT.

Given that our analysis of historical half-hourly system demand and prices suggested that any of the historical years that we investigated could be used to project 2019/20 prices, but that solar export data is only expected to be available for Q3 2016 to Q3 2018, this suggests that any historical data within the period Q3 2016 to Q3 2018 could reasonably be used. We recommend using historical prices for the most recent four quarters for which both historical prices and solar export data are available simply because this most recent period is likely to have demand and supply conditions in the electricity market that are most like those in 2019/20, and therefore most likely to be consistent with pricing patterns in 2019/20.

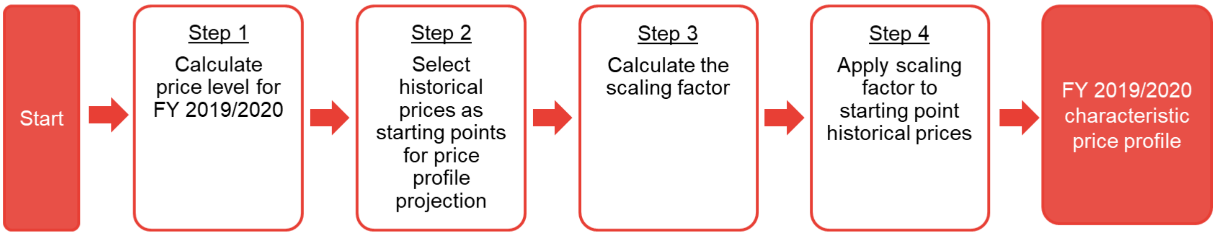
We would note that this decision reflects our assessment of historical pricing patterns and the availability of relevant solar export data. It may be that different circumstances in future would suggest an alternative approach. For instance, a longer time series of solar export data may warrant a Monte Carlo analysis to generate a profile for solar exports and prices that is made up of outcomes over a number of historical years, although this would also depend on the extent to which patterns of system demand and prices may change in future.

We would also note that there could be reasons for different approaches to the use of historical data to determine a FiT and to determine the wholesale energy cost component of the Victorian Default Offer (VDO) for electricity supply. In particular, as we have discussed, an important determinant of how historical data is used is the availability of historical data on solar exports (or retail load); differences in the availability of historical data could feasibly lead to difference decisions about the use of historical data.

3 METHODOLOGY

In this section, we set out our methodology for estimating the wholesale price profile for 2019/20, which is summarised in **Figure 5**:

Figure 5: Summary of methodology



Source: Frontier Economics

- **Step 1: Calculate price level for 2019/20**

  The price level for 2019/20 is represented by the average prices of 2019/20 quarterly base swaps (after adjusting for an assumed contract premium). In our calculations, we assume a contract premium of 5 per cent.

  Quarterly base swaps trade for a number of years in advance of maturity, meaning there is a time series of prices for these contracts. We calculate the average prices of quarterly base swaps across 40-day, 12-month and 24-month window periods. We also calculate average prices based on a time-weighted approach (giving equal weight to each daily price) and using a trade-weighted approach (weighting the daily prices according to the number of trades on the day).

  Our view is that the 40-day average price provides the best indicator of the market's view of prices for 2019/20. Averaging prices over a longer period would mean giving weight to views of prices for 2019/20 that have since changed, likely as a result of updated information about likely market conditions in 2019/20. In the context of retail tariff regulation, retailers have argued in the past, and some regulators have accepted, that average prices over a longer period should be used. The justification given for this is that retailers will actually buy contracts over a longer period when hedging a retail load. While we do not dispute that retailers will likely buy contracts over a number of years leading up to the commencement of 2019/20 to hedge their retail load, we would still view the current market price as the best reflection of the economic value of those contracts and consider that decisions should be made on the basis of that economic value. The rationale for taking a 40-day average price is to avoid the possibility of gaming the regulatory arrangement. The 40-day average approach is consistent with the approach that a number of regulators take to setting cost of capital parameters.

  Our view is that a time-weighted approach would generally provide the best indicator of prices for 2019/20. A trade-weighted approach will give greater weight to a daily price on a day with many trades, but we don't think this necessarily provides a better measure of the average price over, for instance, a 40-day period. However, one advantage of a trade-weighted approach is that it will naturally exclude prices on those days on which no trade occurred, and on those days the published price is a less reliable indicator of the market's view of prices.

  We have provided trade-weighted average quarterly base swap prices (as requested by ESC) in **Table 1**, and the results presented in Section 4 are based on these trade-weighted prices. For reference we have also presented time-weighted average quarterly base swap prices, and results based on these time-weighted prices, in Appendix A. For all of these reported prices we have averaged prices for the relevant period up to and including January 18, 2019. The prices in **Table 1** are higher than the equivalent prices from our draft report. These increases in prices since the draft report are due solely to the increases in ASXEnergy contract prices over the period since we undertook the analysis for the draft report. The increases are most notably for the 40 day average prices, since these are most affected by recent increases in ASXEnergy contract prices.

Table 1: Trade-weighted average price levels for 2019/20 (after removing 5 per cent contract premium)

CALENDAR QUARTER	40 DAY AVERAGE ($/MWH)	12 MONTH AVERAGE ($/MWH)	24 MONTH AVERAGE ($/MWH)
Q3 2019	86.14	78.27	78.46
Q4 2019	75.80	68.83	69.07
Q1 2020	98.80	91.11	90.58
Q2 2020	76.66	66.26	66.61

Source: Base swap price data from ASX Energy and Analysis from Frontier Economics

- **Step 2: Select historical prices as starting points for price profile projection**

  As discussed in Section 2.3, we recommend using historical prices in the most recent four quarters for which both historical prices and solar export data are available. In other words, if solar export data is available up to Q3 2018, we recommend using historical data for Q4 2017 to Q3 2018.

- **Step 3: Calculate the scaling factor**

  For each historical quarter (from Q4 2017 to Q3 2018), we calculate the average price for that quarter by taking a time-weighted average across all half-hourly prices. We then calculate the scaling factor for that quarter by dividing the relevant ASXEnergy price for the equivalent quarter by that time-weighted average price.

  For example, we might find the following:

  - if the average price for the historical quarter Q3 2018 was $80/MWh, and the ASXEnergy price for Q3 2019 was $100/MWh, the scaling factor for Q3 would be 1.25;
  - if the average price for the historical quarter Q4 2017 was $100/MWh, and the ASXEnergy price for Q4 2019 was $110/MWh, the scaling factor for Q4 would be 1.1;
  - and so on, for the other quarters.

- **Step 4: Apply scaling factor to starting point historical prices**

  To each half-hourly price data in the historical quarter, we multiply each half-hourly price by the relevant scaling factor for that quarter. This provides the resulting half-hourly prices for 2019/20. We also performed checks to confirm that these half-hourly prices would not exceed the NEM Market

Price Cap[1] (MPC) and Market Floor Price[2] (MFP). We have also checked that the prices have not exceeded the Cumulative Price Threshold[3] (CPT).

1 We used the latest available MPC of $14,500/MWh (for 2018/19) - https://www.aemc.gov.au/news-centre/media-releases/aemc-publishes-schedule-reliability-settings-2018-19

2 We used the MFP of -$1,000/MWh as prescribed in Chapter 3 of the National Electricity Rules Version 113 - https://www.aemc.gov.au/sites/default/files/2018-04/Reliability%20Panel%20Final%20Report.pdf

3 Where the sum of the spot prices 36 consecutive trading intervals exceeds the CPT, the Administered Price Cap (APC)of $300/MWh will be applied for all trading intervals. The CPT for 2018/19 is $216,900 - https://www.aemc.gov.au/news-centre/media-releases/aemc-publishes-schedule-reliability-settings-2018-19

4 RESULTS

Based on the approach described in Section 3 this section summarises the results of our wholesale price analysis.

Table 2 presents averages of the half-hourly price forecasts for 2019/20, both for a flat annual average and for peak, shoulder and off-peak periods of the year. Results in **Table 2** are presented:

- for trade-weighted ASXEnergy prices for 2019/20
- based on a 40 day average of ASXEnergy prices
- based on the starting point for the analysis being historical quarters Q4 2017 to Q3 2018.

These half-hourly price forecasts in **Table 2** are not weighted in any way. However, we have also provided the full set of half-hourly price forecasts to the ESC, and these half-hourly price forecasts can be weighted, for instance to reflect the time of solar PV exports. Based on data provided by the ESC, export weighting the half-hourly price forecasts in **Table 2** by typical solar PV exports would provide export-weighted average prices as shown in **Table 3**.

The time periods for peak, shoulder and off-peak periods are based on the existing classification used by the ESC,[4] as summarised in **Table 4**.

The prices in **Table 2** and **Table 3** are higher than the equivalent prices from our draft report. These increases in prices since the draft report are due solely to the increases in ASXEnergy contract prices over the period since we undertook the analysis for the draft report.

The increases in prices in **Table 2** and **Table 3** since our draft report are not uniform for the single rate and the three components of the time-varying rate. The reason is that the prices for the time-varying rates are affected by the fact that half-hourly prices from Q4 2017 to Q3 2018 are scaled to *quarterly* ASXEnergy prices for 2019/20, as discussed in Section 3. These quarterly ASXEnergy prices have increased by different amounts since our draft report. Since the time-varying rates are composed of different quarterly contributions, the time-varying rates are also affected differently by different increases in quarterly ASXEnergy prices. For instance, the peak time-varying rate is more affected by high prices in Q1; since our draft report ASXEnergy prices for Q1 have increased less than prices for other quarters, which means that the peak time-varying rate has increased less than other time-varying rates and the single flat rate.

4 See https://www.esc.vic.gov.au/electricity-and-gas/electricity-and-gas-tariffs-and-benchmarks/minimum-feed-tariff

Table 2: Summary of half-hourly spot prices for 2019/20 (based on historical quarters Q4 2017 to Q3 2018)

RATE TYPE		AVERAGE SPOT PRICE (C/KWH)
Single-flat rate		8.43
Time-varying rate	Peak	11.39
	Shoulder	8.53
	Off-peak	6.91

Table 3: Summary of export-weighted half-hourly spot prices for 2019/20 (based on historical quarters Q4 2017 to Q3 2018)

RATE TYPE		EXPORT-WEIGHTED AVERAGE SPOT PRICE (C/KWH)
Single-flat rate		8.90
Time-varying rate	Peak	13.98
	Shoulder	8.35
	Off-peak	8.17

Table 4: Existing classification entered in the model

PERIOD	WEEKDAY	WEEKEND
Peak	3pm – 9pm	N.A.
Shoulder	7am – 3pm; 9pm – 10pm	7am – 10pm
Off-peak	10pm – 7am	10pm – 7am

Source: Essential Services Commission

A APPENDIX A – TIME-WEIGHTED PRICES

This Appendix presents results for time-weighted average prices, in the same form as the results for trade-weighted average prices that are presented in Section 3 and Section 4.

Table 5 provides time-weighted average quarterly base swap prices from ASXEnergy. It is the equivalent of **Table 1**, although using time-weighted average prices rather than trade-weighted average prices. As with the prices in **Table 1**, the increases since the draft report reflect increases in the prices of ASXEnergy contract prices.

Table 6 presents averages of the half-hourly price forecasts for 2019/20, both for a flat annual average and for peak, shoulder and off-peak periods of the year. It is the equivalent of **Table 2**, although using time-weighted average prices rather than trade-weighted average prices.

Table 7 presents export-weighted average prices based on typical solar PV exports. It is the equivalent of **Table 3**, although using time-weighted average prices rather than trade-weighted average prices.

Table 5: Time-weighted average price levels for 2019/20 (after removing 5 per cent contract premium)

CALENDAR QUARTER	40 DAY AVERAGE ($/MWH)	12 MONTH AVERAGE ($/MWH)	24 MONTH AVERAGE ($/MWH)
Q3 2019	85.60	74.71	76.59
Q4 2019	75.89	65.58	67.31
Q1 2020	97.97	88.84	84.61
Q2 2020	76.15	67.33	69.95

Source: Base swap price data from ASX Energy and Analysis from Frontier Economics

Table 6: Summary of half-hourly spot prices for 2019/20 (based on historical quarters Q4 2017 to Q3 2018)

RATE TYPE		AVERAGE SPOT PRICE (C/KWH)
Single-flat rate		8.39
Time-varying rate	Peak	11.32
	Shoulder	8.48
	Off-peak	6.87

Table 7: Summary of export-weighted half-hourly spot prices for 2019/20 (based on historical quarters Q4 2017 to Q3 2018)

RATE TYPE		EXPORT-WEIGHTED AVERAGE SPOT PRICE (C/KWH)
Single-flat rate		8.86
Time-varying rate	Peak	13.90
	Shoulder	8.31
	Off-peak	8.16

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