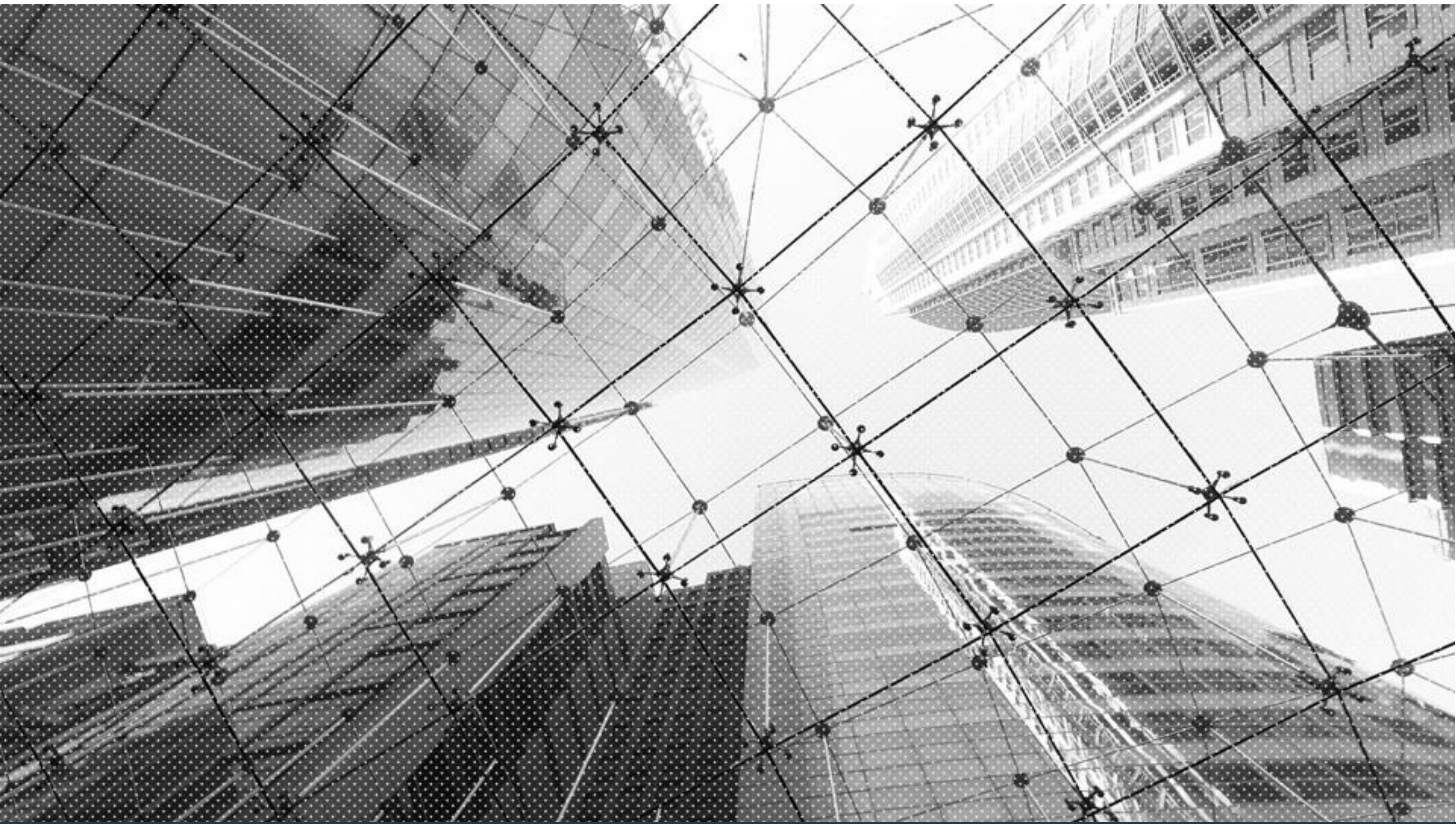

Wholesale Price Forecasts for Calculating Minimum Feed-In Tariff

Final Report for the Essential Services Commission | 4 February 2021

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Executive Summary

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 is currently determining these rates for 2021/22.

As part of its determination of the FiT rates for 2021/22, the ESC has engaged Frontier Economics to project Victorian wholesale prices for 2021/22.

We have produced half-hourly forecasts over 2021/22 based on historical wholesale prices and ASXEnergy prices (which reflect future expectations of wholesale prices), and present averages of these forecasts over:

- The entire annual forecast period
- Over peak, shoulder and off-peak time during the forecast period

We also calculate solar export-weighted averages of our half hourly forecasts over the same periods.

These averages will be used to inform the ESC's 2021/22 determination of the minimum flat-rate and time-varying FiT rates.

Summary of results

We have summarised the results of our wholesale electricity price forecasts below. Two sets of results are presented:

- Projected *quarterly* average spot prices for 2021/22. These are based on ASXEnergy contract prices (adjusted to remove a 5 per cent contract premium)[1] using trade-weighted averaging over 12 months.
- Projected *annual* average spot prices, and peak, shoulder and off-peak average spot prices, for 2021/22. These averages are presented both unweighted and weighted by solar PV exports.

Projected quarterly average spot prices for 2021/22

To produce our forecasts, we first calculate the quarterly projected average price level for each quarter in the forecast period. These are based on the 12-month trade-weighted price of quarterly ASXEnergy base swaps (less a contract premium).

[1] The price of ASXEnergy contracts is the price at which the future price of electricity can be 'locked in' today. So, for instance, a price for a Q1 2022 contract of $50/MWh would enable a market participant to 'lock in' that electricity price of $50/MWh for Q1 2022. The price of ASXEnergy contracts is related to expectations of what spot electricity prices will be in Q1 2022: if the market expects higher spot electricity prices in Q1 2022 we would expect that the price of a futures contract for Q1 2022 to increase; if the market expects lower spot electricity prices in Q1 2022 we would expect that the price of a futures contract for Q1 2022 will fall. However, because the futures contract provides certainty (that is, it enables the future price to be 'locked in') retailers are generally prepared to pay a premium for the futures contract. What this means is that the ASXEnergy contract price will trade at a premium to the expected spot price. While this contract premium cannot be directly observed, our econometric analysis suggests that the contract premium is 5 per cent. What this means is that if market participants expect that the spot price will by $50/MWh for Q1 2022, market participants would be prepared to pay $52.50 for a contract to 'lock in' a price for Q1 2022 today. Therefore, to infer expectations of future spot prices from ASXEnergy contract prices we remove a 5 per cent contract premium from contract prices.

These projected quarterly average spot prices are presented **Table 1**.

Table 1: Projected average prices for 2021/22, using **trade-weighted** ASXEnergy contract prices (after removing 5 per cent contract premium) ($ 2021/22)

Calendar quarter	12 month average ($/MWh)
Q3 2021	43.29
Q4 2021	40.58
Q1 2022	68.79
Q2 2022	37.99

Average half-hourly prices in 2021/22

We use the projected quarterly average spot prices for 2021/22 presented in **Table 1**, and historical half-hourly prices for 2019/20, to developed forecasts of half-hourly spot prices for 2021/22.

The average of these half-hourly price forecasts for 2021/22 is presented in **Table 2** and **Table 3**, providing a flat annual average price and average prices during peak, shoulder and off-peak periods of the year.

The results in **Table 2** and **Table 3** are both based on:

- trade-weighted ASXEnergy prices for 2021/22 (as presented in **Table 1**)
- a **12 month** trade-weighted average of ASXEnergy prices
- historical half-hourly prices for 2019/20.

Table 2 provides average half-hourly prices that do not take into account solar export data (that is, the half-hourly prices are time-weighted averages, or simple averages).

Table 2: Summary of half-hourly spot prices for 2020/21 (based on historical quarters Q3 2019 to Q2 2020), unweighted by solar exports ($ 2021/22)

Rate type		Average spot price (c/kWh)
Single-flat rate		4.76
Time-varying rate	Peak	9.26
	Shoulder	4.00
	Off-peak	3.50

In contrast, **Table 3** provides average half-hourly prices that are weighted by solar exports in each half hour interval. These solar export-weighted prices are based on solar export data for 2019/20 for each distribution network service provider (DNSP), which was provided by the ESC.[2]

Table 3: Summary of half-hourly spot prices for 2021/22 (based on historical quarters Q3 2019 to Q2 2020), solar export-weighted ($ 2021/22)

Rate type		Export-weighted average spot price (c/kWh)
Single-flat rate		3.92
Time-varying rate	Peak	7.91
	Shoulder	3.39
	Off-peak	3.87

Changes in wholesale price forecasts since the draft report

While our methodology has remained unchanged from our draft report, we have updated our inputs in light of the most recent market expectations with respect to wholesale electricity prices in 2021/22. These expectations are reflected in the latest ASXEnergy contract prices.[3]

The average ASXEnergy prices used in this report have declined relative to our draft report. These lower average ASXEnergy prices reflect the fact that the market's expectations of average prices across 2021/22 are lower now than they were that at the time of the draft report.[4]

The contract prices in the draft report and final report are compared in **Table 4**.

2 Solar-weighting adjusts the unweighted wholesale price forecast to reflect the average value of electricity at exporting times rather than the average value of electricity at all times. Given the minimum FiT applies to exported electricity (which is predominantly solar), in our view solar-weighted wholesale price forecasts are more appropriate for use in determining minimum FiT rates.

3 Expectations of future spot prices, and hence contract prices, reflect market participants' understanding of future demand and supply conditions in the electricity market and how these will affect prices (e.g. information on generation investment, power plant closures, costs of different fuels etc.). Short-term volatility (e.g. recent high international gas prices in early 2021) is unlikely to affect these contract prices unless it is expected to persist into the future. Factors that participants expect will have a lasting impact on price are likely to flow through to contract prices, however. For example, COVID-19 appears to have impacted market expectations, which we discuss in more detail in Sections 3 and 5.1.

4 For the draft report, we calculated 12-month trade-weighted averages of contract prices from 15 October 2019 to 15 October 2020 for the forecast quarters. We have 'rolled-forward' these averages for the current report to the period from 2 February 2020 to 2 February 2021. Given that contract prices since 15 October 2019 have exhibited a downward trend, by rolling-forward the average, we *lose* relatively high contract prices in the average (over 15 October 2019 to 2 February 2020) and *adds* relatively low contract prices (over 15 October 2020 to 2 February 2021). Together, these bring down the calculated contract price average for the current report relative to the draft report.

Table 4: Comparison of projected average prices based on ASXEnergy contract prices (after removing 5 per cent contract premium)

Period	Average projected price ($/MWh) – 2021/2022 – DRAFT REPORT	Average projected price ($/MWh) – 2021/2022 – FINAL REPORT
Q3 2021	47.40	43.29
Q4 2021	46.41	40.58
Q1 2022	74.16	68.79
Q2 2022	41.17	37.99

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 renewable energy generation into the grid. In financial years 2018/19, 2019/20 and 2020/21 the ESC has published two minimum FiT rates:

- 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 electricity prices for 2021/22, to inform its determination of the FiT rates for 2021/22. This report details our approach, considerations, methodology and results.

Frontier Economics previously advised the ESC on Victorian wholesale electricity prices for 2019/20 and 2020/21 to inform the ESC's determination of FiT rates for those years.[5] The methodology that we have adopted for this final report is the same as we used previously advising on wholesale prices.

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. Therefore, it is necessary to develop a forecast of half-hourly prices that are appropriately correlated to data on half-hourly solar PV exports in the relevant period. We achieve this by using historical half-hourly prices as the starting point for forecasting prices, and ensuring we select half-hourly prices from the same time period as that for which we have solar export data.

Preferably, we select for our starting point historical half-hourly prices that are from the same period as the *most recent* solar export data. Our view is that, generally speaking, more recent prices would be expected to better reflect future demand and supply conditions. However, as a precautionary measure, we analyse historical half-hourly prices to assess whether the half-hourly prices coinciding with the most recent solar export data seem to reflect any 'abnormal' outcomes that would not be expected to recur.

We then scale the selected historical half-hourly Victorian spot prices to an estimate of the average spot price for 2021/22. 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 (2021/22) from ASXEnergy. This scaling shifts the average of the historical half-hourly spot prices to reflect the contract price, without altering the underlying pattern of half-hourly spot prices. In this way, the relationship between exports and price is maintained.

5 See, for example: Frontier Economics, *Wholesale Price Forecasts for Calculating Minimum Feed-in Tariff*, A Report for the Essential Services Commission, 24 February 2020.

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 future price levels 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.[6] Given that we have two financial years of export data from all 5 DNSPs, and corresponding wholesale electricity price data, Monte Carlo simulation is possible. However we do not recommend the approach in this case. In recent years it is clear that solar premiums[7] have fallen significantly (which is likely to be driven in part by increased solar PV penetration). Since solar premiums are a key driver of solar-weighted FiT results we think that in these circumstances a Monte Carlo simulation may inappropriately preserve historical correlations between prices and exports.

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 final report

Throughout this final report, we make references to the four quarters of a calendar year (i.e. Q1, Q2, Q3 and Q4). The months associated with these quarters are:

- January to March for Q1.
- April to June for Q2.
- July to September for Q3.
- October to December for Q4.

For the most part, references to quarters are coupled with a year e.g. ‘Q1 2020’. However, in sections of the paper which deal with quarterly analysis over multiple years, we may refer to a quarter in general (without specifying a year). In these cases, ‘Q2’ for example, refers to the months April to June across all years under analysis.

This remainder of this report is structured as follows:

6 Other aspects of our approach are similar to our previous advice to IPART: using historical data for exports and spot prices as a starting point; scaling prices to a forecast of future spot prices; weighting the forecast spot prices by exports; calculating an annual average (or peak, shoulder and off peak) FiTs based on this.

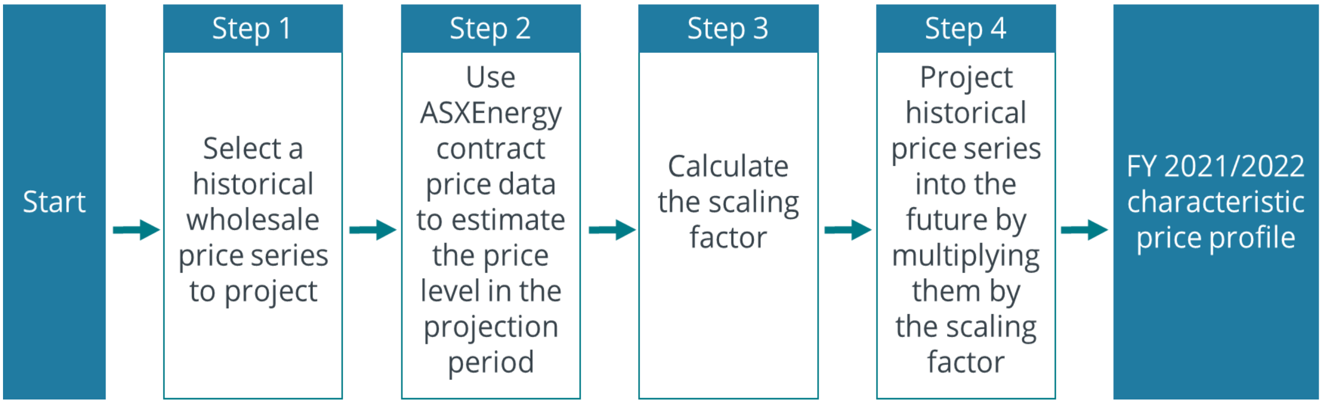
7 The solar premium is the solar-weighted wholesale price divided by the time-weighted wholesale price. A solar premium below one indicates that prices tend to be lower at times when solar exports occur. A solar premium above one indicates that prices tend to be higher at times when solar exports occur.

- Section 2 outlines the methodology used to produce a wholesale price profile for 2021/22.
- Section 3 discusses our analysis of historical prices in Victoria.
- Section 4 presents our results.
- Section 5 compares the current report to results from our previous final report as well as the wholesale electricity component of the VDO.

2 Methodology for projecting price

In this section, we set out our methodology for estimating the wholesale price profile for 2021/22, which is summarised in **Figure 1**:

Figure 1: Summary of methodology



Source: Frontier Economics

Our methodology consists of four steps:

- **Step 1: Select an historical wholesale price series to use as the basis for forecasts**

  Preferably, we select for our starting point historical half-hourly prices that are from the same period as the *most recent* solar export data. Our view is that, generally speaking, more recent prices would be expected to better reflect future demand and supply conditions. In other words, if the ESC has access to solar export data up to Q2 2020, we recommend using historical price data for Q3 2019 to Q2 2020.

  In some cases, there may be sufficient reason to believe this most recent wholesale price data series will not reflect future supply and demand conditions and another set of spot prices should be used as the basis for forecasts. This is why we assess historical price patterns to check whether recent prices exhibit abnormal 'shape' that is likely to be unreflective of future conditions.

  We note that this process of selection is informed by 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 more unpredictable trend in the correlation between solar exports and prices 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, though we do not consider this appropriate in this case for reasons discussed in Section 1.3.

- **Step 2: Calculate price level for 2021/22**

  The average price level for 2021/22 is represented by the average prices of 2021/22 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 contracts using a 12-month trade-weighted average of base swap prices.

  Our view is that the 40-day average price provides the best indicator of the market's view of prices for 2021/22. Averaging prices over a longer period would mean giving weight to views of prices for 2021/22 that have since changed, likely as a result of updated information about market conditions in 2021/22.

  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 generally 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 2021/22 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, rather than the current market price on a single day, 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.

  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 of 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 costs (since most retailers will buy contracts over a number of years leading up to the year).

  Regarding the type of average to use, our view is that a time-weighted approach would generally provide the best indicator of prices for 2021/22. A trade-weighted[8] approach will give greater weight to a daily price on a day with many trades than on a day with fewer trades; but, in our view, a larger number of trades occurring on a day does not necessarily mean that the closing price conveys more reliable information about the market's view of future electricity prices. 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.

  In our results we have provided trade-weighted, 12-month average quarterly base swap prices, as requested by ESC, and results based on these trade-weighted average quarterly prices. We have averaged prices for the relevant period up to and including 8 January 2021.

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

  For each historical quarter (from Q3 2019 to Q2 2020), we calculate the average price for that quarter by taking a time-weighted average across all half-hourly prices. We then calculate the

8 Trade-weighted contract prices are calculated by multiplying the number of trades by the closing price on each day over the averaging period (i.e. 40 days, 12-months or 24 months) then dividing by the total number of trades over the averaging period.

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 2019 was $80/MWh, and the ASXEnergy price for Q3 2021 was $100/MWh, the scaling factor for Q3 would be 1.25;
- if the average price for the historical quarter Q4 2019 was $100/MWh, and the ASXEnergy price for Q4 2021 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 develop a forecast of half-hourly prices**

  For each half-hourly price in the historical quarter, we multiply the half-hourly price by the relevant scaling factor for that quarter. This provides the resulting half-hourly prices for 2021/22.[9] We also perform checks to confirm that these half-hourly prices do not exceed the NEM Market Price Cap[10] (MPC) or Market Floor Price[11] (MFP). We also check that the prices do not exceed the Cumulative Price Threshold[12] (CPT).

  Once we have developed a forecast of half-hourly prices for 2021/22, we are able to calculate the *weighted average* of these prices by solar PV exports, and/or *average* these half-hourly prices in different ways in order to inform the ESC's determination of a FiT.

  For instance, we can average the half-hourly prices over the whole year to inform the ESC's determination of a single flat-rate FiT. Or, we can average the half-hourly prices in peak, shoulder and off-peak periods to inform the ESC's determination of a time-varying FiT. When averaging for peak, shoulder and off-peak periods we use the definitions of these periods presented in **Table 5**. Formulae used to take average and weighted-average half-hourly prices are provided in **Table 6**.

9 The NEM is scheduled to adopt 5 minute settlement on 1 October 2021. In principle, from this date for the purposes of determining the FiT prices should be forecast for each 5 minute period, rather than for each 30 minute period. However, in practice, with no existing historical data on prices under 5 minute settlement, it is extremely difficult to forecast patterns of prices under 5 minute settlement. For this reason, we have chosen to continue with forecasting patterns of prices under 30 minute settlement.

10 AEMC 2020, *Schedule of Reliability Settings for 2020*-21, MPC for 2020/21, accessed 2 November 2020, <https://www.aemc.gov.au/news-centre/media-releases/schedule-reliability-settings-2020-2021>

11 AEMC 2020, *National Electricity Rules Version 153*, Chapter 3, Section 9.6, pg. 159. Accessed 2 November 2020, <https://www.aemc.gov.au/sites/default/files/2018-04/Reliability%20Panel%20Final%20Report.pdf>

12 AEMC 2020, *Schedule of Reliability Settings for 2020*-21, CPT for 2020/21, accessed 2 November 2020. <https://www.aemc.gov.au/news-centre/media-releases/schedule-reliability-settings-2020-2021>.

Table 5: Time of use classifications

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

Table 6: Simple (time-weighted) average and weighted average formulae

	Simple average	Weighted average formula
Whole period	$\frac{\sum \text{wholesale\_prices}}{time\_periods}$	$\frac{\sum \text{wholesale\_prices} * \text{solar\_weights}}{\sum \text{solar\_weights}}$
Peak	$\frac{\sum \text{wholesale\_prices}_{\text{peak}}}{time\_periods_{peak}}$	$\frac{\sum \text{wholesale\_prices}_{\text{peak}} * \text{solar\_weights}_{\text{peak}}}{\sum \text{solar\_weights}_{\text{peak}}}$
Shoulder	$\frac{\sum \text{wholesale\_prices}_{shoulder}}{t\_periods_{shoulder}}$	$\frac{\sum \text{wholesale\_prices}_{\text{shoulder}} * \text{solar\_weights}_{\text{shoulder}}}{\sum \text{solar\_weights}_{\text{shoulder}}}$
Off-peak	$\frac{\sum \text{wholesale\_prices}_{\text{off-peak}}}{t\_periods_{off-peak}}$	$\frac{\sum \text{wholesale\_prices}_{\text{off-peak}} * \text{solar\_weights}_{\text{off-peak}}}{\sum \text{solar\_weights}_{\text{off-peak}}}$

Source: Frontier Economics

Note that in **Table 6**:

- **wholesale_prices** refer to half-hourly Victorian spot prices from 1/07/2019 to 30/06/2020
- **solar_weights** refer to half-hourly exports
- products of **wholesale_prices** and **solar_weights** that are taken in the weighted average formula are between corresponding half-hours (i.e. prices and exports of the same date and half-hour are multiplied)

3 Selecting an historical price series

In this section we select an historical price series to use as the basis for forecasts. As discussed in the methodology section, we prefer to use the most recent series of prices for which we have solar export data (Q3 2019 to the end of Q2 2020) but may not if there is sufficient reason to believe this most recent wholesale price data series will not reflect future supply and demand conditions.

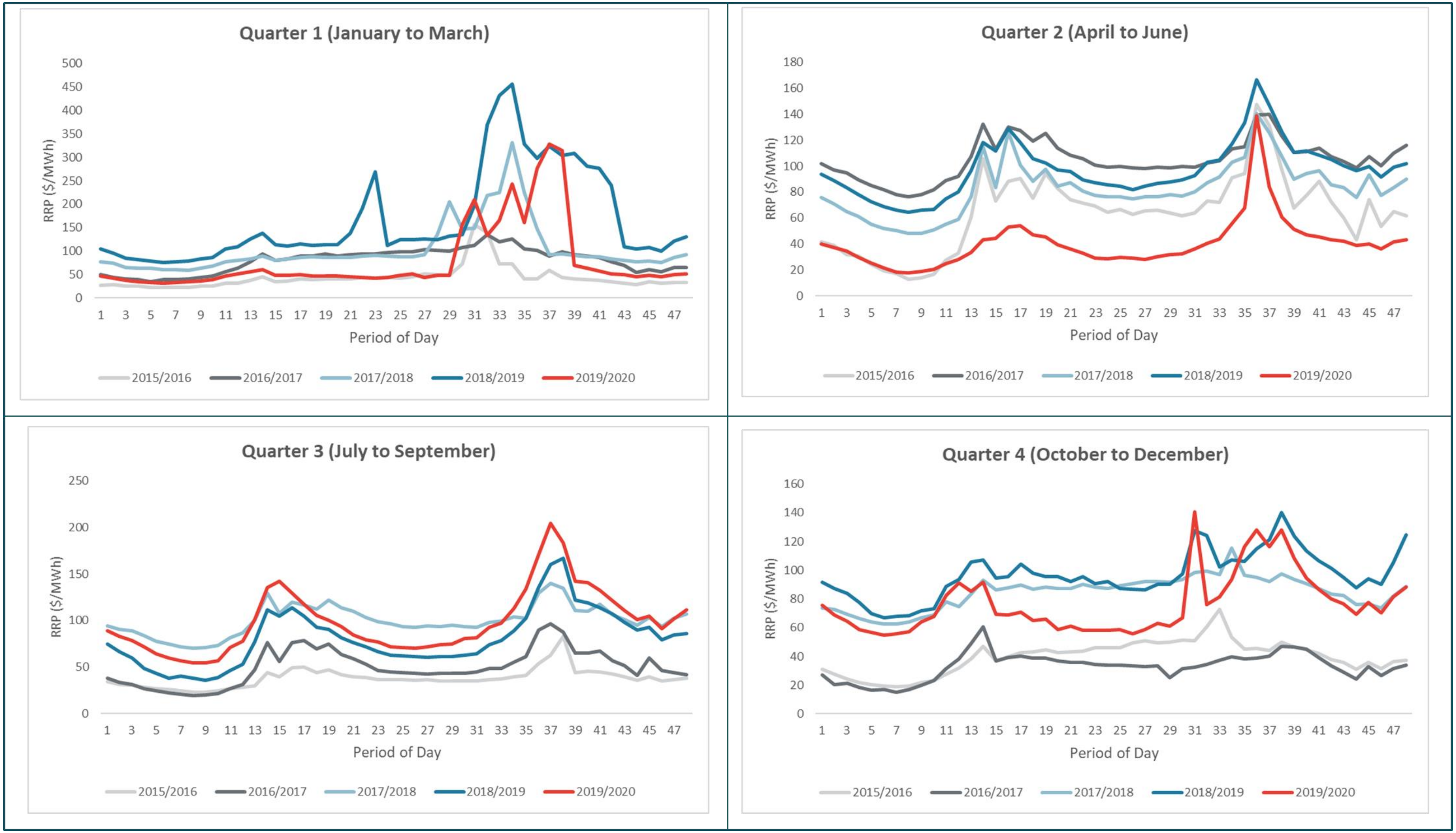
Importantly, we are primarily concerned with the shape of the historical half-hourly prices, not the absolute level of these prices since the average level of the prices is ultimately determined by ASXEnergy contract prices.

We analyse patterns of historical prices for Q3 2019 to Q2 2020 by comparing historical prices over a number of recent years. The analysis is conducted:

- On five years of historical half-hourly data on prices from Q3 2015 to Q2 2020.
- On a quarterly basis:
  - to understand seasonal differences in prices, and
  - to ensure analysis lines up with the quarterly contracts traded on ASXEnergy (which we use to determine average prices for 2021/22).

Figure 2 presents the average daily pattern of Victorian spot prices, for each quarter, over the period Q3 2015 to Q2 2020 (i.e. the last 5 financial years).

Figure 2: Price profiles of Victorian wholesale electricity prices for the last 5 financial years



Source: Frontier Economics analysis of AEMO spot price data

Our analysis of these historical half-hourly prices highlighted several observations. We find that, for the most part:

- Across the years, the daily price profiles were similar within each quarter
- Prices have tended to peak in similar trading intervals, or adjacent trading intervals. This is particularly the case in winter – Q2 and Q3 – where 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 is less apparent in summer – Q4 and Q1 – when outcomes are more volatile; but nevertheless, we see prices peaking in the late afternoon or early evening. Particularly in Q1 2019 we see high prices extending well into the night.
- Prices have tended to be at their lowest in similar trading intervals. Specifically, we tend to see prices at their lowest overnight and during the middle of the day.

While, on the whole, we see similar pricing patterns over the years, suggesting that outcomes in 2019/20 were not 'abnormal', we do note that:

1. Q2 2020 prices have been substantially lower than in previous years. These reductions in spot prices are attributable, at least in part, to the effects of COVID-19. COVID-19 is generally considered one of the drivers of lower international prices for oil, gas and coal, which contributes to lower fuel prices for some power stations in the NEM.[13] COVID-19 is also generally considered to cause lower aggregate electricity demand in the NEM. The combination of lower fuel prices and lower demand results in lower spot electricity prices in Victoria and across the NEM. However, this should not require any change to approach, since expectations of lower electricity prices due to any prolonged impacts of COVID-19 in 2021-22 will already be reflected in forward prices for 2021-22. As it happens the ASXEnergy forward market suggests that lower prices for Q2 are expected again in 2021.
2. The ratio of evening prices (intervals 35 to 41) to midday prices (intervals 21 to 31) has tended to increase over each financial year, especially over the last three financial years. This is most noticeable over Q3 where the difference between the lowest midday price and evening peak, around $120/MWh, is substantially higher in 2019/20 relative to any other financial years. We would expect this general result where there has been an increase in solar PV penetration over time, as has been the case in Victoria. This means that more cheap electricity is produced in the middle of the day, depressing midday prices and followed by a spike in evening demand as the sun goes down and people return home from work.

Based on this, we recommend using the historical prices for the most recent four quarters for which both historical prices and solar export data are available (the preferred series). These prices will be used to project prices for 2021/22.

[13] Generators reliant on domestic fuel suppliers not connected to an accessible port (e.g. brown coal power stations in Victoria, and black coal power stations in Queensland) are not exposed to these fluctuations in international fuel prices. In general, other plants with any reliance on non-domestic supplies of fuel are likely to be affected by international prices.

4 Results on wholesale price projections

In this section we present the results on wholesale price projections for 2021/22 based on the methodology described in Section 2.[14] These modelling results are used by the ESC for the determination of the minimum FiT rates and are presented as follows:

- Projected quarterly average spot prices for 2021/22 (based on ASXEnergy contract prices adjusted to remove a 5 per cent contract premium) using trade-weighted averaging over 12 months. These prices are presented in Section 4.1.
- Projected annual average spot prices, and peak, shoulder and off-peak average spot prices, for 2021/22. These averages are presented both unweighted and weighted by solar PV exports. These prices are presented in Section 4.2.

4.1 Projected quarterly average spot prices for 2021/22

Table 7 presents trade-weighted quarterly average spot prices for 2021/22. These are the results of Step 2 of our analysis, and are used to determine scaling factors and, ultimately, to forecast half-hourly prices for 2021/22.

Table 7: Projected average prices for 2021/22, using **trade-weighted** ASXEnergy contract prices (after removing 5 per cent contract premium) ($ 2021/22)

Calendar quarter	12 month average ($/MWh)
Q3 2021	43.29
Q4 2021	40.58
Q1 2022	68.79
Q2 2022	37.99

Source: Base swap price data from ASXEnergy and Analysis from Frontier Economics

14 As discussed in Section 2, our view is that the 40-day time-weighted average contract price provides the best indicator of the market's view of prices for 2021/22. We also provided reasons why longer averaging periods and trade-weighted averages may be valuable in regulatory contexts. Our understanding is that the ESC prefers the use of the 12-month trade-weighted average for the purposes of determining an appropriate minimum FiT, which is what the results presented in this section are based on.

4.2 Average half-hourly prices in 2021/22

Using the projected quarterly average spot prices for 2021/22 presented in Section 4.1, and historical half-hourly prices for 2019/20, we developed forecasts of half-hourly spot prices for 2021/22. These half-hourly spot prices are the results of Step 4 of our analysis.

This section summarises the average of these half-hourly price forecasts for 2021/22, providing a flat annual average and average prices during peak, shoulder and off-peak periods of the year.

The results in **Table 8** and **Table 9** are both based on:

- trade-weighted ASXEnergy prices for 2021/22 (as presented in **Table 7**)
- a **12 month** trade-weighted average of ASXEnergy prices
- historical half-hourly prices for 2019/20.

Table 8 provides average half-hourly prices that do not take into account solar export data (that is, the half-hourly prices are time-weighted averages, or simple averages), while **Table 9** provides average half-hourly prices that are weighted by solar exports in each half hour interval. These solar export-weighted prices are based on solar export data for 2019/20 for each DNSP, which was provided by the ESC.

Table 8: Summary of half-hourly spot prices for 2020/21 (based on historical quarters Q3 2019 to Q2 2020), unweighted by solar exports ($ 2021/22)

Rate type		Average spot price (c/kWh)
Single-flat rate		4.76
Time-varying rate	Peak	9.26
	Shoulder	4.00
	Off-peak	3.50

Table 9: Summary of half-hourly spot prices for 2021/22 (based on historical quarters Q3 2019 to Q2 2020), solar export-weighted ($ 2021/22)

Rate type		Export-weighted average spot price (c/kWh)
Single-flat rate		3.92
Time-varying rate	Peak	7.91
	Shoulder	3.39
	Off-peak	3.87

It is important to note that since **Table 9** presents prices that are based on solar export-weighted average prices, the relationship between these prices in different periods (peak, should and off-peak) does not necessarily correspond with the relationship between unweighted wholesale electricity prices during those same periods.

For example, wholesale electricity prices are generally *higher* in shoulder periods than in off-peak periods, as we can see in **Table 8**. However, once we weight these wholesale electricity prices by solar exports, we see in **Table 9** that prices in shoulder periods are *lower* than prices in off-peak periods. One reason for this is that off-peak periods occur daily from 10 PM to 7 AM. Most of this period tends to have very low prices, with higher prices only beginning to occur between around 6 AM and 7 AM (as we can see in **Figure 2**). When we take an average of all prices in off-peak periods (as in **Table 8**), the average is dominated by the very low prices over night. However, when we take a solar-weighted average of prices in off-peak periods (as in **Table 9**) the only prices that receive any weight are those between around 6 AM and 7 AM, when solar exports begin. This means that export-weighted off-peak prices are based on these higher prices that occur between 6 AM and 7 AM, and give no weight to the lower overnight prices when no exports occur.

5 Comparison with 2020/21 FiT and VDO

This section briefly compares the results of our flat-rate FiT for 2021/22 with the equivalent result for 2020/21 and considers how these changes relate to changes in the wholesale electricity component of the Victorian Default Offer (VDO) over a similar time period.

5.1 Comparison with 2020/21 FiT

Frontier Economics previously advised the ESC on the forecast of wholesale electricity prices for the purpose of calculating a FiT for 2020/21.[15] As discussed, we used the same methodology for this final report that we previously used for the 2020/21 FiT. In this section we explore what is driving the differences in results between the two reports.

The value of the FiT depends on both the projected average price in each quarter (based on ASXEnergy base swap prices) and the correlation between projected half-hourly prices and solar export data.

Average ASXEnergy prices

Broadly speaking, average ASXEnergy prices depend on what the market expects future electricity spot prices to be (and the premium participants are prepared to pay to 'lock in' prices). **Table 10** shows that the average ASXEnergy prices in the current report have declined relative to our previous final report that informed the 2020/21 FiT (2020/21 final report).[16] These lower average ASXEnergy prices reflect the fact that the market's expectations of average prices across 2021/22 are far lower than they were for 2020/21. While it is difficult to be certain about what drives the market's expectations of future prices, we observe that ASXEnergy forward prices generally respond to movements in spot prices. This has been the case recently, with lower ASXEnergy forward prices reflecting lower electricity spot prices. As discussed in Section 3, these lower spot prices can be attributed in part to the effects that COVID-19 has had on energy markets. We expect that these same impacts – lower international fuel prices, resulting in lower fuel prices for some generators in the NEM, and lower demand for electricity – are responsible for the fall in ASXEnergy forward prices. Ongoing investment in new generation capacity – particularly renewable generation – would also be expected to result in lower spot and contract prices.

Given lower average ASXEnergy prices, we would expect a lower FiT rate, all else equal.

15 Frontier Economics, *Wholesale Price Forecasts for Calculating Minimum Feed-in Tariff*, A Report for the Essential Services Commission, 24 February 2020.

16 Since projected average prices in both reports are based on ASXEnergy prices and calculated based on 12-month trade weighted average of ASXEnergy prices they therefore are directly comparable accounting for an assumed inflation rate.

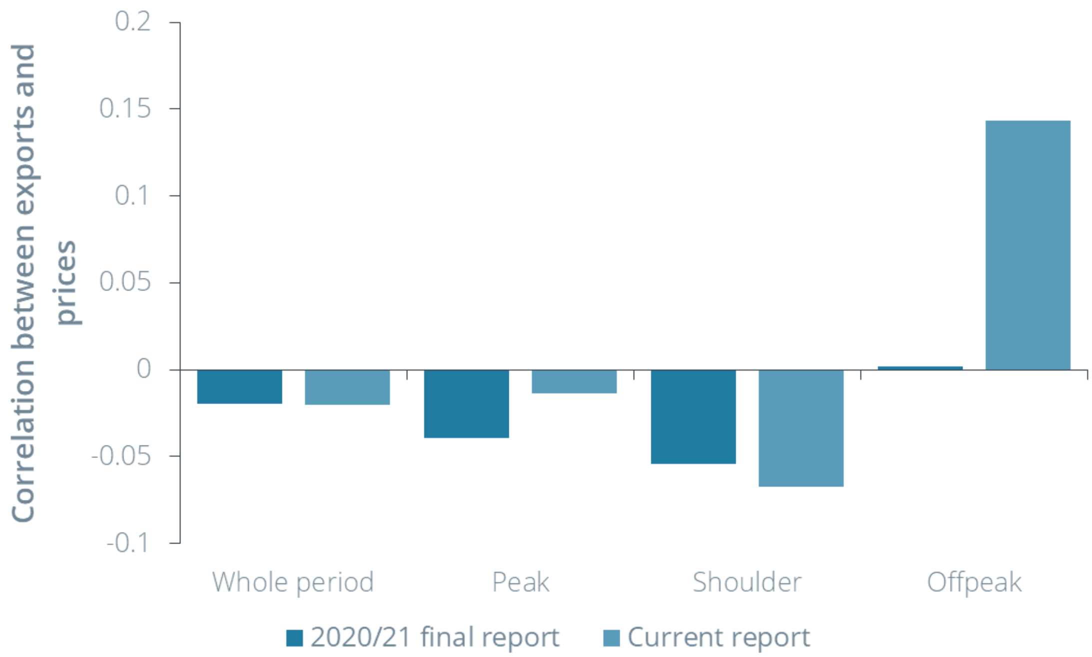
Table 10: Comparison of projected average prices based on ASXEnergy contract prices (after removing 5 per cent contract premium)[17]

Period	Average projected price ($/MWh) – 2020/2021	Average projected price ($/MWh) – 2021/2022
Q3 2021	77.98	43.29
Q4 2021	78.65	40.58
Q1 2022	109.10	68.79
Q2 2022	65.93	37.99

Correlation between projected half-hourly prices and solar export data

The correlation between projected half hourly wholesale electricity prices and solar exports also has an influence on FiT rates that are based on projected prices that are solar weighted. **Figure 3** summarises how the correlation between wholesale electricity prices and solar exports across the year have changed between our 2020/21 final report and the current final report.

Figure 3: Comparison of correlation between wholesale electricity prices and solar exports



Overall relationships between wholesale electricity prices and corresponding solar exports in the current report are the same as in the 2020/21 final report: solar exports are anti-correlated during the whole period, during peak periods and during shoulder periods. This has the effect of lowering solar-weighted FiTs during these times. During off-peak periods wholesale electricity prices and solar

17 Projected 2020/21 prices from previous final report are escalated at an assumed CPI of 2.5% to put into ($ 2021/22)

exports are positively correlated, which has the effect of raising the solar-weighted FiT during this time, as in the 2020/21 final report.

5.2 Comparison with VDO

Our estimate of the wholesale electricity price component of the flat-rate FiT has fallen in this final report for 2021/22 compared with our 2020/21 final report. Similarly, our estimate of the wholesale electricity cost component of the Victorian Default Offer (VDO) for 2021 has fallen relative to our previous estimate of the VDO for 2020, though to a lesser extent.

The reasons for sharper fall in the FiT are:

- The solar weighted FiT is determined, in part, by the correlation between solar exports and prices, while the VDO is determined, in part, by the correlation between retail load and prices. In this case, solar premiums have fallen while load premiums have not.[18] All else equal, these movements have the effect of lowering the solar weighted FiT and raising the wholesale electricity component of the VDO.
- While both the FiT and VDO employ ASXEnergy contract prices to scale historical wholesale prices, the FiT determination is for financial year 2021/22 while the VDO determination is for calendar year 2021. Retailers' expectations of future prices (as reflected in contract prices) are different over these periods and it happens to be the case that contract prices used to determine the FiT have fallen more than contract prices used to determine the VDO.

18 As discussed previously, the solar premium is the solar-weighted wholesale price divided by the time-weighted wholesale price. A solar premium below one indicates that prices tend to be lower at times when solar exports occur. A solar premium above one indicates that prices tend to be higher at times when solar exports occur. In a similar way, the load premium is the customer load-weighted wholesale price divided by the time-weighted wholesale price. A load premium below one indicates that prices tend to be lower at times when customer use electricity. A load premium above one indicates that prices tend to be higher at times when customer use electricity.

6 Response to submissions

Submissions to the ESC on their Draft Decision on the minimum FiT raised a number of issues. This section addresses those issues raised by stakeholders specifically related to our wholesale price modelling.

6.1 The approach to determining FiT does not account for the expected decline in wholesale prices

EnergyAustralia commented on our draft report estimate of the wholesale cost component of the FiT that they "expect further reductions as this analysis is updated for the latest contract price data" for the final determination. This is indeed the case, with lower contract prices since the draft report resulting in a lower estimate of the wholesale cost component of the FiT, as seen in **Table 4**.

EnergyAustralia also commented that "[w]hile not directly flowing through to contract prices for 2021-22, we have noted a material and recent decline in spot prices owing to outages of higher cost thermal units in NSW (i.e. Loy Yang A) and expect prices to be further depressed with the commissioning of new utility scale renewable generation (especially solar in NSW, and wind in VIC) over 2021. New transmission constraints affecting power flows between NSW and Victoria will also be relevant considerations".

We agree that the factors identified by EnergyAustralia – generator outages, new generation capacity and network constraints – could each be expected to have an effect on electricity spot and contract prices. However, our view is that expectations about the effect of these factors on future electricity prices will be reflected in the prices at which contracts trade on ASXEnergy. For instance, we would expect that one of the reasons that the price of contracts for 2021/22 have been falling is the expectation of the commissioning of new utility scale renewable generation. The potential for changes in the electricity market to affect prices is the reason that we use the most recent historical data possible in our approach. By using the most recent historical data we are likely to best capture expectations of the effect of any such changes in price.

One of the implications of using ASXEnergy data as the basis for estimating future electricity prices is that we cannot clearly identify the impact that any single factor has on electricity prices. For instance, we cannot untangle the impact that the commissioning of new utility scale renewable generation has on prices from the other factors that are simultaneously driving expectations of future prices. But we do not think being able to untangle the individual effects of these factors on prices will generally be important to determining the FiT.

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