frontier economics

Wholesale Price Forecasts for Calculating Minimum Feed-In Tariff

Draft Report for the Essential Services Commission | 16 November 2021

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Executive Summary

The ESC is required under the Electricity Industry Act 2000 (Vic) to determine one or more minimum 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 2022/23.

As part of its determination of the FiT rates for 2022/23, the ESC has engaged Frontier Economics to project Victorian wholesale energy prices for 2022/23.

We have produced half-hourly forecasts over 2022/23 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 day, early evening and overnight times 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 2022/23 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 2022/23. 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 day, early evening and overnight average spot prices, for 2022/23. These averages are presented both unweighted and weighted by solar PV exports.

[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 2023 contract of $50/MWh would enable a market participant to 'lock in' that electricity price of $50/MWh for Q1 2023. The price of ASXEnergy contracts is related to expectations of what spot electricity prices will be in Q1 2023: if the market expects higher spot electricity prices in Q1 2023 we would expect the price of a futures contract for Q1 2023 to increase; if the market expects lower spot electricity prices in Q1 2023 we would expect the price of a futures contract for Q1 2023 to decrease. 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 be $50/MWh for Q1 2023, market participants would be prepared to pay $52.50 for a contract to 'lock in' a price for Q1 2023 today. Therefore, to infer expectations of future spot prices from ASXEnergy contract prices we remove a 5 per cent contract premium from contract prices.

Projected quarterly average spot prices for 2022/23

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).

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

Table 1: Projected average prices for 2022/23, using **trade-weighted** ASXEnergy contract prices (after removing 5 per cent contract premium) ($ 2022/23)

Calendar quarter	12 month average ($/MWh)
Q3 2022	39.86
Q4 2022	34.28
Q1 2023	54.92
Q2 2023	37.18

Average half-hourly prices in 2022/23

We use the projected quarterly average spot prices for 2022/23 presented in **Table 1**, and historical half-hourly prices for 2020/21, to develop forecasts of half-hourly spot prices for 2022/23.

The average of these half-hourly price forecasts for 2022/23 is presented in **Table 2** and

In contrast, **Error! Not a valid bookmark self-reference.** 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 2020/21 for each distribution network service provider (DNSP), which was provided by the ESC.

Table 3, providing a flat annual average price and average prices during day, early evening and overnight periods of the year.

The results in **Table 2** and

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Table 3 are both based on:

- trade-weighted ASXEnergy prices for 2022/23 (as presented in **Table 1**)
- a **12 month** trade-weighted average of ASXEnergy prices
- historical half-hourly prices for 2020/21.

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 2022/23 (based on historical quarters Q3 2020 to Q2 2021), unweighted by solar exports ($ 2022/23)

Rate type		Average spot price (c/kWh)
Flat rate		4.15
Time-varying rate	Early evening	6.39
	Day	3.51
	Overnight	3.84

In contrast, **Error! Not a valid bookmark self-reference.** 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 2020/21 for each distribution network service provider (DNSP), which was provided by the ESC.[2]

Table 3: Summary of half-hourly spot prices for 2022/23 (based on historical quarters Q3 2020 to Q2 2021), solar export-weighted ($ 2022/23)

Rate type		Export-weighted average spot price (c/kWh)
Flat rate		2.44
Time-varying rate	Early evening	4.03
	Day	2.23
	Overnight	4.27

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.

Key factors responsible for lower wholesale electricity price forecasts

While our methodology has remained unchanged since we last advised the ESC on the FiT, we have updated our inputs in light of more recent market data (including historical spot prices for 2020/21) and the most recent market expectations with respect to wholesale electricity prices in 2022/23. These expectations are reflected in the latest ASXEnergy contract prices.[3]

The average ASXEnergy prices used in this report have declined relative to our final report published in February (February 2021 report). This reflects the fact that up-to-date ASXEnergy prices for 2022/23 are lower than ASXEnergy prices for 2021/22 at the time of the February 2021 report.

The contract prices in the February 2021 report and current report are compared in **Table 4**.

Table 4: Comparison of projected average prices based on ASXEnergy contract prices (after removing 5 per cent contract premium) ($2022/23)[4]

Period	Average projected price ($/MWh) – 2021/2022	Average projected price ($/MWh) – 2022/2023
Q3	44.16	39.86
Q4	41.39	34.28
Q1	70.17	54.92
Q2	38.75	37.18

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.).

4 Projected 2021/22 prices from previous final report are escalated at an assumed CPI of 2.0% to put into ($ 2022/23)

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, 2020/21 and 2021/2022 the ESC has published two minimum FiT rates:

- A flat-rate FiT
- A time-varying FiT (with day, early evening and overnight rates).

The ESC has engaged Frontier Economics to project Victorian wholesale electricity prices for 2022/23, to inform its determination of the FiT rates for 2022/23. This report details our approach, considerations, methodology and results.

Frontier Economics previously advised the ESC on Victorian wholesale electricity prices for 2019/20, 2020/21 and 2021/22 to inform the ESC's determination of FiT rates for those years.[5] The methodology that we have adopted for this draft 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 for energy 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 for energy to an estimate of the average spot price for 2022/23. 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 (2022/23) from ASXEnergy.

5 See, for example: Frontier Economics, *Wholesale Price Forecasts for Calculating Minimum Feed-in Tariff*, Final Report for the Essential Services Commission, 4 February 2021.

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.

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 a number of financial years of export data from all 5 Distribution Network Service Providers (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 draft report

Throughout this draft 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.

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 day, early evening and overnight) 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.

For the most part, references to quarters are coupled with a year e.g. ‘Q1 2022’. 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.

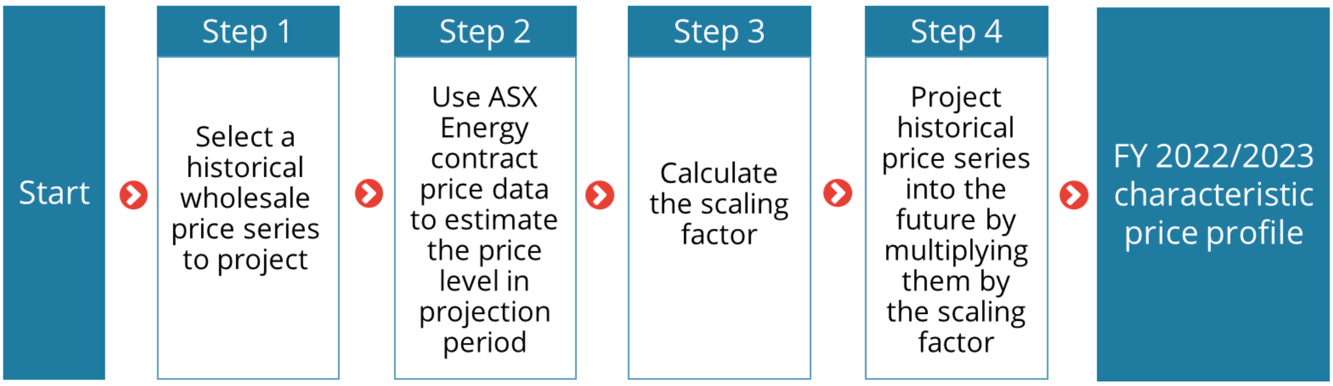
This remainder of this report is structured as follows:

- Section 2 outlines the methodology used to produce a wholesale price profile for 2022/23.
- 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 2022/23, which is summarised in **Figure 1**:

Figure 1: Summary of methodology



Source: Frontier Economics

Our methodology consists of four steps:

- **Step 1: Select a 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 2021, we recommend using historical price data for Q3 2020 to Q2 2021.

  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 the 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 are 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 2022/23**

  The average price level for 2022/23 is represented by the average prices of 2022/23 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 2022/23. Averaging prices over a longer period would mean giving weight to views of prices for 2022/23 that have since changed, likely as a result of updated information about market conditions in 2022/23.

  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 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 2022/23 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 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 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 2022/23. 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 1 October 2021.

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

  For each historical quarter (from Q3 2020 to Q2 2021), 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 2020 was $80/MWh, and the ASXEnergy price for Q3 2022 was $100/MWh, the scaling factor for Q3 would be 1.25;
- if the average price for the historical quarter Q4 2020 was $100/MWh, and the ASXEnergy price for Q4 2022 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 2022/23.[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 2022/23, 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 flat-rate FiT. Or, we can average the half-hourly prices in day, early evening and overnight periods to inform the ESC's determination of a time-varying FiT. When averaging for day, early evening and overnight 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 adopted 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 2021, *Schedule of Reliability Settings for 2020-21*, MPC for 2021/22, accessed 13 October 2021, < https://www.aemc.gov.au/news-centre/media-releases/aemc-publishes-schedule-reliability-settings-2021-22 >

11 AEMC 2021, *National Electricity Rules Version 160*, Chapter 3, Section 9.6, pg. 160. Accessed 13 October 2021, < https://www.aemc.gov.au/sites/default/files/2021-03/NER%20Version%20160%20-%20full.pdf >

12 AEMC 2021, *Schedule of Reliability Settings for 2020-21*, CPT for 2020/21, accessed 13 October 2021. <https://www.aemc.gov.au/news-centre/media-releases/schedule-reliability-settings-2020-2021>.

Table 5: Time of use classifications

Period	Weekday	Weekend
Early evening	3pm – 9pm	N.A.
Day	7am – 3pm; 9pm – 10pm	7am – 10pm
Overnight	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	$\frac{\sum \text{wholesale\_prices}}{\text{time\_periods}}$	$\frac{\sum \text{wholesale\_prices} * \text{solar\_weights}}{\sum \text{solar\_weights}}$
Overnight	$\frac{\sum \text{wholesale\_prices}_{\text{overnight}}}{\text{time\_periods}_{\text{overnight}}}$	$\frac{\sum \text{wholesale\_prices}_{\text{overnight}} * \text{solar\_weights}_{\text{overnight}}}{\sum \text{solar\_weights}_{\text{overnight}}}$
Early evening	$\frac{\sum \text{wholesale\_prices}_{\text{early evening}}}{\text{time\_periods}_{\text{early evening}}}$	$\frac{\sum \text{wholesale}_{\text{prices}_{\text{early evening}}} * \text{solar\_weights}_{\text{early evening}}}{\sum \text{solar\_weights}_{\text{early evening}}}$
Day	$\frac{\sum \text{wholesale\_prices}_{\text{day}}}{\text{time\_periods}_{\text{day}}}$	$\frac{\sum \text{wholesale\_prices}_{\text{day}} * \text{solar\_weights}_{\text{day}}}{\sum \text{solar\_weights}_{\text{day}}}$

Source: Frontier Economics

Note that in **Table 6**:

- **wholesale_prices** refer to half-hourly Victorian spot prices from 1/07/2020 to 30/06/2021
- **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 2020 to the end of Q2 2021) 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.

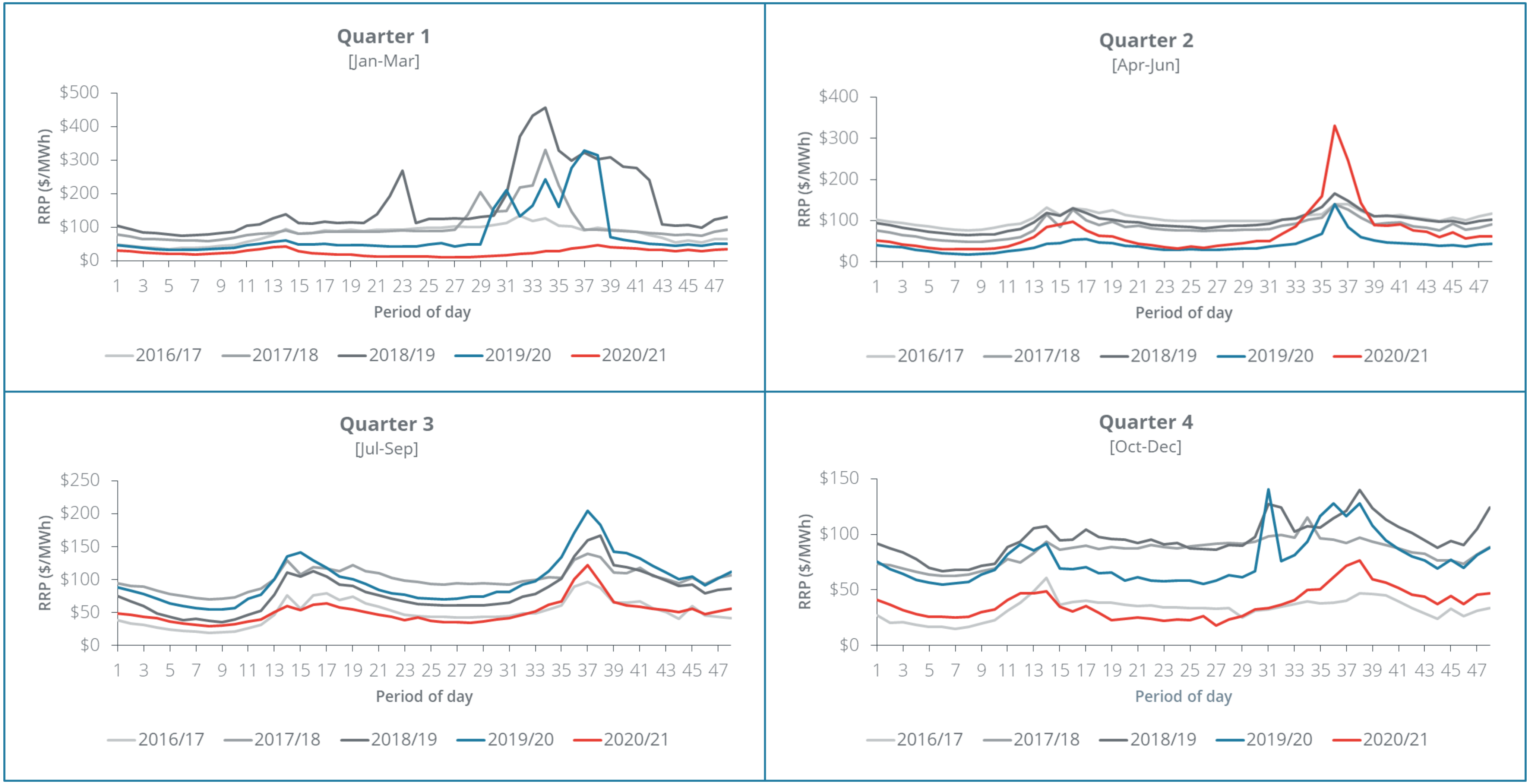
Importantly, we are primarily concerned with the shape of the historical half-hourly prices, not the absolute level of these prices since the average level of the prices is ultimately determined by ASXEnergy contract prices.

We analyse patterns of historical prices for Q3 2020 to Q2 2021 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 2016 to Q2 2021.
- 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 2022/23).

Figure 2 presents the average daily pattern of Victorian spot prices, for each quarter, over the period Q3 2016 to Q2 2021 (i.e. the last 5 financial years).

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



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 2020/21 were not 'abnormal', we do note that:

1. Generally, half hourly prices in 2020/21 have been lower across all four quarters prices than in previous years (except when compared with Q2 2019/20). There are a number of factors to which these reduced prices are attributable, including:
   - Lower demand in the NEM and Victoria, partly due to the lasting effects of COVID-19 during 2020/21 but also driven by ongoing installation of rooftop PV
   - Generally lower gas prices in the NEM and Victoria over 2020/21 relative to previous years
   - Increasing generation investment

   The combination of these factors contributes to lower spot electricity prices in Victoria and across the NEM. However, expectations of lower electricity prices (due to any prolonged impacts of lower demand and gas prices) and increasing generation investment in 2022-23 will already be reflected in forward prices for 2022-23. Therefore, this should not require any change to approach. As it happens the ASXEnergy forward market suggests that lower prices across all 4 quarters over 2022-23 will persist.
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 Q2 where the difference between the average lowest midday price and average evening peak price, around $330/MWh, is substantially higher in 2020/21 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 require energy sourced from the grid.

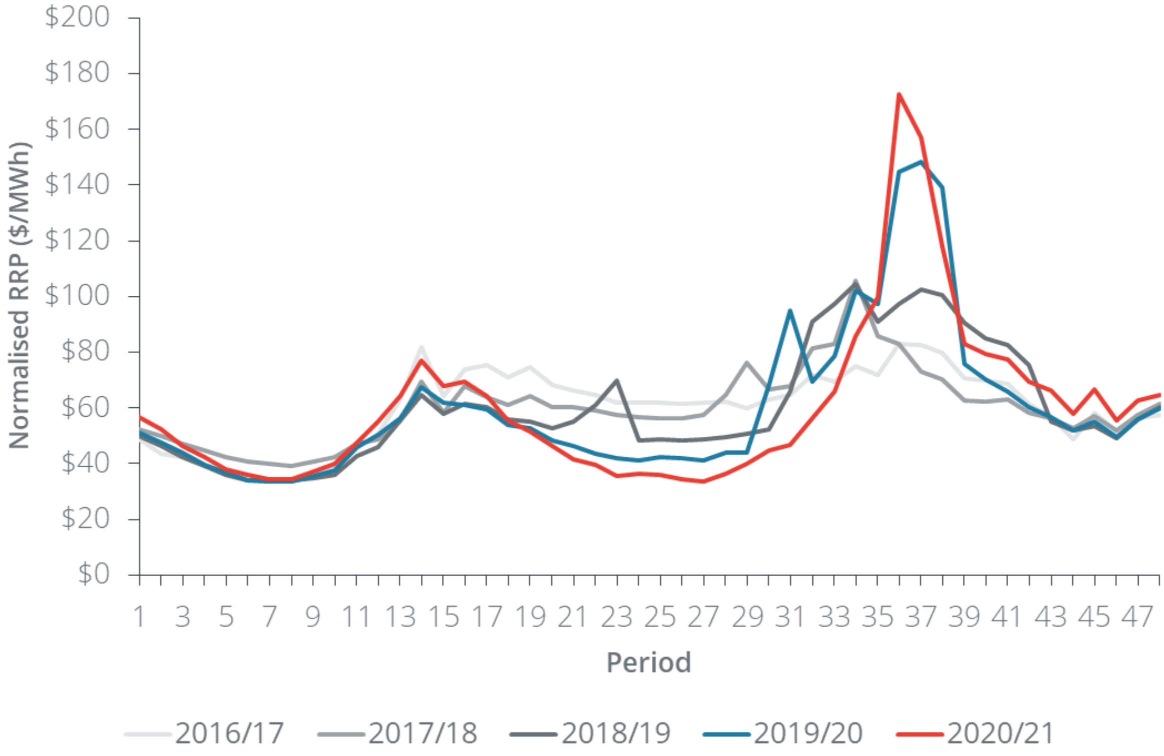
   However, we note that there has been a lack of pronounced evening price spike in Q1 2020/21: while prices in the middle of the day have been lower than evening price, the overall profile is relatively flat compared with other years.[13]

To further our understanding of the overall trend in the ratio of evening to midday prices we can examine yearly price profiles. **Figure 3** plots wholesale prices on average through the day, for

13 A number of factors are likely to have contributed to flatter prices, including greater availability of generation capacity, more PV exports during the late afternoon, as well cooler than average 2020/21 summer.

each year for the last 5 financial years, normalised so that the average price in each year is $60/MWh to highlight changes in the *shape* of wholesale electricity prices.

Figure 3: Normalised profiles of Victorian wholesale electricity prices for the last 5 financial years



Source: Frontier Economics analysis of AEMO spot price data

Note: Price in each year normalised such that the average price is $60/MWh

From inspection of the yearly price profiles, it is clear that the ratio of prices in the middle of the day to evening peak prices has increased over time, including in 2020/21, despite a relatively flat Q1 price profile. Moreover, in 2020/21 we observe a of lack of later afternoon peak prices (between 3pm and 4pm), traditionally driven by high price events in Q1 and Q4. These observations are in line with what we would expect: all else equal, with further entry of rooftop and utility-scale solar over time, we should see lower prices in the middle of the day and less high price events at the times solar is exporting.

In our view, there is no reason to expect that this trend of lower prices in the middle of the day would not continue into the medium term as solar entry persists. As such, the 2021 financial year is likely to be the best starting point for projecting prices.

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 2022/23.

4 Results on wholesale price projections

In this section we present the results on wholesale price projections for 2022/23 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 2022/23 (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 day, early evening and overnight average spot prices, for 2022/23. 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 2022/23

Table 7 presents trade-weighted quarterly average spot prices for 2022/23. 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 2022/23.

Table 7: Projected average prices for 2022/23, using **trade-weighted** ASXEnergy contract prices (after removing 5 per cent contract premium) ($ 2022/23)

Calendar quarter	12 month average ($/MWh)
Q3 2021	39.86
Q4 2021	34.28
Q1 2022	54.92
Q2 2022	37.18

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 2022/23. 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 2022/23

Using the projected quarterly average spot prices for 2022/23 presented in Section 4.1, and historical half-hourly prices for 2020/21, we developed forecasts of half-hourly spot prices for 2022/23. 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 2022/23, providing a flat annual average and average prices during day, early evening and overnight periods of the year.

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

- trade-weighted ASXEnergy prices for 2022/23 (as presented in **Table 7**)
- a **12 month** trade-weighted average of ASXEnergy prices
- historical half-hourly prices for 2020/21.

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 2020/21 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 2020 to Q2 2021), unweighted by solar exports ($ 2022/23)

Rate type		Average spot price (c/kWh)
Flat rate		4.15
Time-varying rate	Early evening	6.39
	Day	3.51
	Overnight	3.84

Table 9: Summary of half-hourly spot prices for 2022/23 (based on historical quarters Q3 2020 to Q2 2021), solar export-weighted ($ 2022/23)

Rate type		Export-weighted average spot price (c/kWh)
Flat rate		2.44
Time-varying rate	Early evening	4.03
	Day	2.23
	Overnight	4.27

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 (day, early evening and overnight) does not necessarily correspond with the relationship between unweighted wholesale electricity prices during those same periods.

For example, average wholesale electricity prices in day periods and overnight periods are similar, 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 day periods are far lower than prices in overnight periods (about half). One reason for this is that overnight 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 overnight periods (as in **Table 8**), the average is dominated by the very low prices during night-time, when no exports occur. However, when we take a solar-weighted average of prices in overnight 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 overnight 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 2021/22 FiT and VDO

This section briefly compares the results of our flat-rate FiT for 2022/23 with the equivalent result for 2021/22 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 2021/22 FiT

Frontier Economics previously advised the ESC on the forecast of wholesale electricity prices for the purpose of calculating minimum FiT rates for 2021/22.[15] As discussed, we used the same methodology for this draft report that we previously used for the 2021/22 minimum 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 February 2021 report.[16] These lower average ASXEnergy prices reflect the fact that the market's expectations of average prices across 2022/23 are lower than they were for 2021/22. 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 over 2020/21 can be attributed to a combination of factors including lower demand and ongoing investment in generation capacity. We expect that these same factors are responsible for the fall in ASXEnergy forward 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.

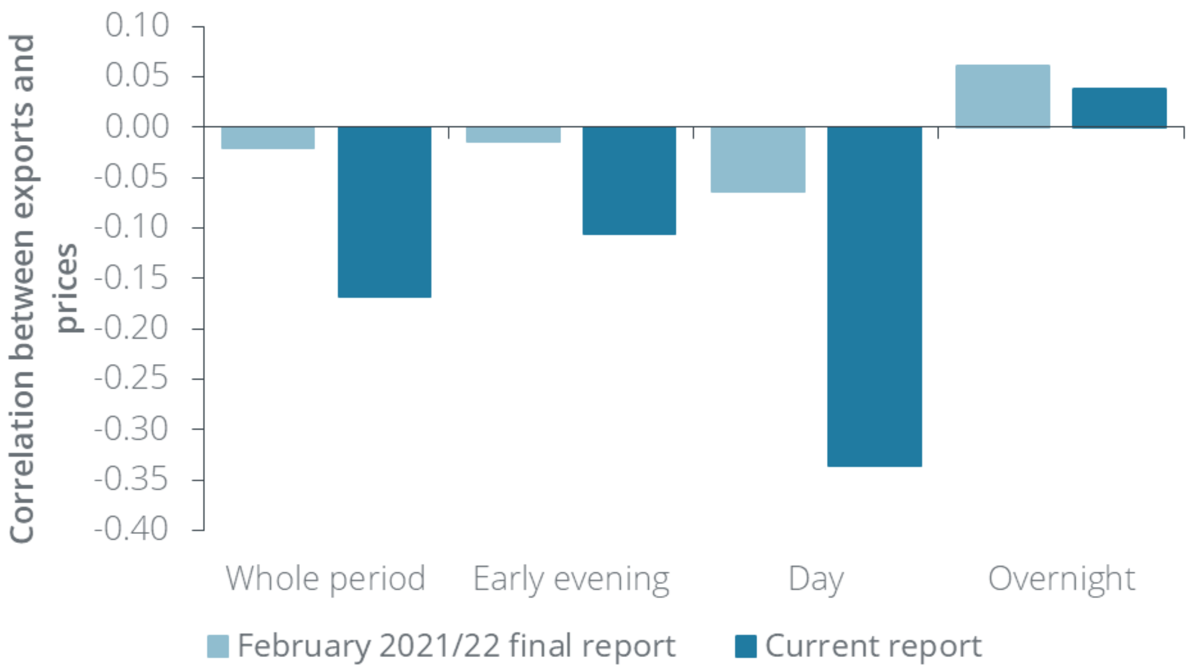
Table 10: Comparison of projected average prices based on ASXEnergy contract prices (after removing 5 per cent contract premium) ($2022/23)[17]

Period	Average projected price ($/MWh) – 2021/2022	Average projected price ($/MWh) – 2022/2023
Q3	44.16	39.86
Q4	41.39	34.28
Q1	70.17	54.92
Q2	38.75	37.18

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 4** summarises how the correlation between wholesale electricity prices and solar exports across the year have changed between our 2021/22 final report and the current draft report.

Figure 4: Comparison of correlation between wholesale electricity prices and solar exports



While the overall relationships between prices and exports relative to the 2021/22 final report are the same, there is now far stronger anti-correlation during the whole, early evening and day periods. This has the effect of lowering the solar-weighted FiTs to a greater extent than previously during these periods. There is small positive correlation between wholesale electricity

17 Projected 2020/21 prices from previous final report are escalated at an assumed CPI of 2% to put into ($ 2022/23)

prices and solar exports during overnight periods, similar to the 2021/22 final report. This has the effect of raising the solar-weighted FiT during this time.

5.2 Comparison with VDO

Our estimate of the wholesale electricity price component of the flat-rate FiT has fallen in this draft report for 2022/23 compared with our 2021/22 final report. Similarly, our estimate of the wholesale electricity cost component of the Victorian Default Offer (VDO) for 2022 has fallen relative to our previous estimate of the VDO for 2021, though to a lesser extent.

The sharper fall in the FiT occurs despite the fact ASXEnergy contract prices used to scale historical wholesale prices for the VDO have fallen more on average than those used for the FiT. The key driver for the sharper fall in the FiT is the effect of weighting prices by exports and load for the FiT and VDO, respectively.

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 stayed relatively constant.[18] All else equal, these movements have the effect of lowering the solar weighted FiT and raising the wholesale electricity component of the VDO.

The effect of this weighting happens to be greater than the effect of contract prices in determining the relative declines in the solar weighted FiT and wholesale electricity component of the VDO, resulting in a sharper fall in the FiT.

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.

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