ENDGAME
ECONOMICS

REVIEW OF THE WHOLESALE VALUE OF SOLAR EXPORTS

IPART

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1. Introduction

Endgame Economics ('Endgame') is pleased to submit this report for the Independent Pricing and Regulatory Tribunal ('IPART') which reviews the methodology for setting the wholesale costs in their annual solar feed-in-tariff benchmark ranges.

Executive Summary

Endgame Economics has been engaged to review IPART's methodology for calculating the wholesale cost of the solar feed-in tariff benchmark range. Endgame reviewed this component of IPART's methodology noting that changing network cost structures may impact the final value of solar exports which IPART will consider separately.

Under the Terms of Reference, IPART's methodology must calculate the solar feed-in tariff benchmark range by considering the costs an electricity retailer can avoid by supplying a customer energy from solar exports.

IPART's methodology, in essence, calculates the solar export weighted average price for the forecast year in question. Our review has found that IPART's methodology is overall economically sound and captures the avoided cost to retailers of rooftop solar exports.

The methodology is made up of 4 steps:

1. **Forecasting wholesale prices** – Use ASX Energy base swaps to determine a range of forecast wholesale prices.
2. **Calculate and apply the solar multiplier** - Calculate the ratio of rooftop solar export captured prices to time-weighted prices and apply it to forecast prices.
3. **Scale by avoided loss factors** - Scale upwards to account for avoided transmission and distribution losses.
4. **Add back the value of NEM fees and charges** - Include further uplift to account for avoidance by retailers of paying NEM fees and charges.

Our review considered alternative methods for estimating steps 1 and 2 of IPART's methodology, as well as a different approach that estimates the wholesale energy costs a retailer faces and is able to avoid due to their customer's rooftop solar exports.

When evaluating IPART's methodology and alternatives, we assessed them against 5 principles:

- **Accuracy** – the methodology should provide an accurate forecast of the avoided cost to a retailer when solar energy is supplied to a customer.
- **Constructive complexity** – complexity should only be added to the methodology if it is essential.
- **Transparency** – the method should be transparent and easy to understand. It shouldn't be a 'black box' and unknown.
- **Ease of implementation** – building from transparency, the method should be reproducible by IPART and retailers.
- **Flexibility** – the method should be fit for purpose in a rapidly changing energy market.

Alternative methods to estimating the value of solar exports, such as wholesale market modelling, may take into account the changing dynamics of the energy market, including the uptake of rooftop solar, electrification, electric vehicles and coal retirement. However, these models are typically non-trivial to keep up-to-date, and IPART may require this to be outsourced. This outsourcing reduces the transparency and ease of implementation and increases the complexity of calculating the solar feed-in tariff benchmark.

Statistical or machine learning approaches could also be used in calculating the feed-in tariff benchmark ranges. These approaches range in complexity and may suffer from reduced transparency and ease of implementation. However, linear regression may provide a straightforward way to forecast the solar multiplier, which may be preferable to IPART's approach of only considering historical data. By considering only historical data, IPART is likely overestimating the solar multiplier. Care should be taken in addressing how these models capture changes in the electricity market, like electrification, electric vehicles and coal retirement.

IPART's methodology calculates two forecasts of wholesale energy prices; the first is calculated by taking the 40-day time weighted average of base swap prices, less a 5 per cent contracting premium, and the second is a volume weighted average of base swap prices. In a competitive market, the feed-in tariff should tend towards the long-run marginal cost of new entry, which is independent of sunk costs faced by incumbent retailers. It is our view that taking the volume weighted average of base swaps over the entire trading period, without accounting for the 5 per cent contracting premium, is not an accurate forecast of average wholesale spot prices. Instead, only the 40-day time weighted average should be used when forecasting the wholesale price.

An error margin can be applied to the forecast wholesale price to determine a range to be used in the benchmark feed-in tariff. IPART has previously applied 10 per cent and -10 per cent to the forecast wholesale price, which favours simplicity and ease of implementation over accuracy. Alternatively, historical analysis can be performed to estimate the forecasting error of base swaps, and this can be applied instead. This approach sacrifices transparency and increases complexity, however, may increase the accuracy of the applied margin.

Upon review of other jurisdictions' methodologies, notably the Queensland Competition Authority, we determined that IPART should consider including Reliability and Emergency Reserve Trader (RERT) and compensation costs in the feed-in tariff benchmark range. Although costs associated with the RERT scheme have only been incurred in recent years, a retailer can avoid this cost for each megawatt hour of rooftop solar exported by their customers. However, these costs are inherently difficult to forecast given their infrequent nature and unknown magnitude. As such, it may be preferable to IPART to exclude these costs if there is not a reliable, publicly available forecast.

In addition, there are international jurisdictions which take a similar avoided cost approach when valuing solar exports produced by distributed energy resources (DER). For example, regulators in California use wholesale market modelling to determine the avoided costs of rooftop solar exports, while New York State estimate a value stack of each cost that a retailer supplying rooftop solar is able to avoid. In both cases, the regulators calculate the energy value of rooftop solar by taking the solar export weighted average price, a methodology similar to IPART's.

Finally, we also considered an avoided cost of hedging approach, where a retailer may be able to avoid purchasing contracts due to their customer's solar exports. A retailer's hedging position is unlikely to be driven by customer exports in the middle of the day when load and prices are both typically low. The uptake of rooftop solar is likely to have changed hedging positions for retailers, however, this is primarily driven by self-consumed solar generation, and the feed-in tariff benchmark is solely valuing solar exports. If this approach were to be used, care would also have to be taken with the contracting position assumed for a retailer, since this would have to be representative of all retailers, and not discriminate by the size or structure of the retailer. In addition, by using this approach, an implicit assumption is being made on a retailer's level of acceptable risk. For these reasons, this approach is likely to be difficult to implement, complex and opaque, and should not yield different results to IPART's methodology in the long run.

1. Introduction

1.1. Context

The Independent Pricing and Regulatory Tribunal (IPART) has engaged Endgame Economics to review the methodology of calculating the wholesale value of solar exports given changing conditions and dynamics in the energy market.

Australia has one of the highest uptake rates of rooftop solar in the world, reducing the reliance customers have on the electricity grid and utility-scale generation. The size of these rooftop solar systems has also rapidly increased, causing many households to generate more than they consume in the middle of the day. This excess electricity is exported to the grid, for which electricity retailers may pay the household - through a solar feed-in tariff (FiT) - since it reduces the amount of electricity a retailer must purchase from the wholesale market on behalf of their other customers.

IPART is required by the New South Wales Government to calculate a benchmark range for an annual all-day solar feed-in tariff and an annual time-varying solar feed-in tariff. These benchmarks allow consumers to be more informed when choosing offers from retailers that include a solar feed-in tariff. However, the methodology to calculate the benchmark has not significantly changed since its inception in 2011, and the rapid and continued uptake of rooftop solar means it is important to review the methodology to assess if it continues to provide a reasonable estimate of the avoided cost of solar exports.

1.2. Nature of the engagement

IPART requires a review of the methodology to calculate the feed-in tariff benchmark range, for both the all-day rate and the time-varying rate. This review and accompanying analysis will consider whether significant changes are needed to ensure that the methodology is fit for purpose and will make any recommendations to ensure that the benchmark achieves its stated objectives. In particular, this investigation focuses on IPART’s method of forecasting the wholesale value of solar exports given the changing dynamics in the energy market. We do not investigate other changes to the market including network charges which may impact the final value of solar.

1.3. Structure of the report

This report is structured as follows:

- **Section 2** provides a summary of our methodology for this review.
- **Section 3** provides an overview of the energy market and changing dynamics.
- **Section 4** documents IPART’s method.
- **Section 5** explores how IPART forecasts wholesale prices.
- **Section 6** investigates how IPART calculates the solar multiplier.
- **Section 7 and Section 8,** explain the scaling by loss factors and accounting for other market fees.
- **Section 9** discusses the methodologies used in other jurisdictions.

- **Section 10** considers various statistical and machine learning approaches.
- **Section 11** assesses the avoided cost of hedging approach.
- **Section 12** summarises and concludes this report.

2. Our assessment method

We take a holistic approach by first developing principles to underpin the review process and then leveraging them to review IPART's methodology.

2.1. Principles

The principles used to assess the methodology include:

Accuracy – the method should yield precise and reliable results ensuring the information is dependable based on economic principles. This is important in determining the validity of the model.

Constructive complexity – this principle relates to simplicity. Complexity should only be added to the methodology if it is essential. The method should be as simple as possible to ensure comprehension, especially by the broader public.

Transparency – the method should be transparent and easy to understand. It shouldn't be a 'black box' and unknown. This will ensure that each step can be tracked, and calculations can be followed through from start to end. A public-facing model can be released to achieve this goal.

Ease of implementation – building from transparency, the method should be reproducible by IPART. This principle also values reproducibility by other stakeholders, especially by retailers who are likely to utilise similar economic principles when setting their own feed-in tariffs.

Flexibility – the method should be fit for purpose in a rapidly changing energy market. This includes adaptability by recognising emerging trends and shifting priorities. The model should also have the functionality for regular and easy updates if needed.

2.2. Process

Our process is outlined in the diagram below, Figure 1.

IPART's methodology will be reviewed and documented first, identifying components, and explaining how they are calculated. Then we will review whether they are fit for purpose or should be updated. Desktop research of benchmark methods in other jurisdictions will also be conducted and considered while reviewing IPART's methodology.

Quantitative analysis will be performed to understand how rooftop solar uptake and generation have evolved over time as well as its consequences for prices. After assessing IPART's method and current emerging trends we will determine findings to ensure that the method is updated for the current energy landscape. We will also evaluate IPART's methodology and any proposed methodologies against historical data to benchmark their ability to forecast actual avoided costs. This will ensure it is fit for purpose and can achieve its stated objectives.

Figure 1 – Project staging at a glance

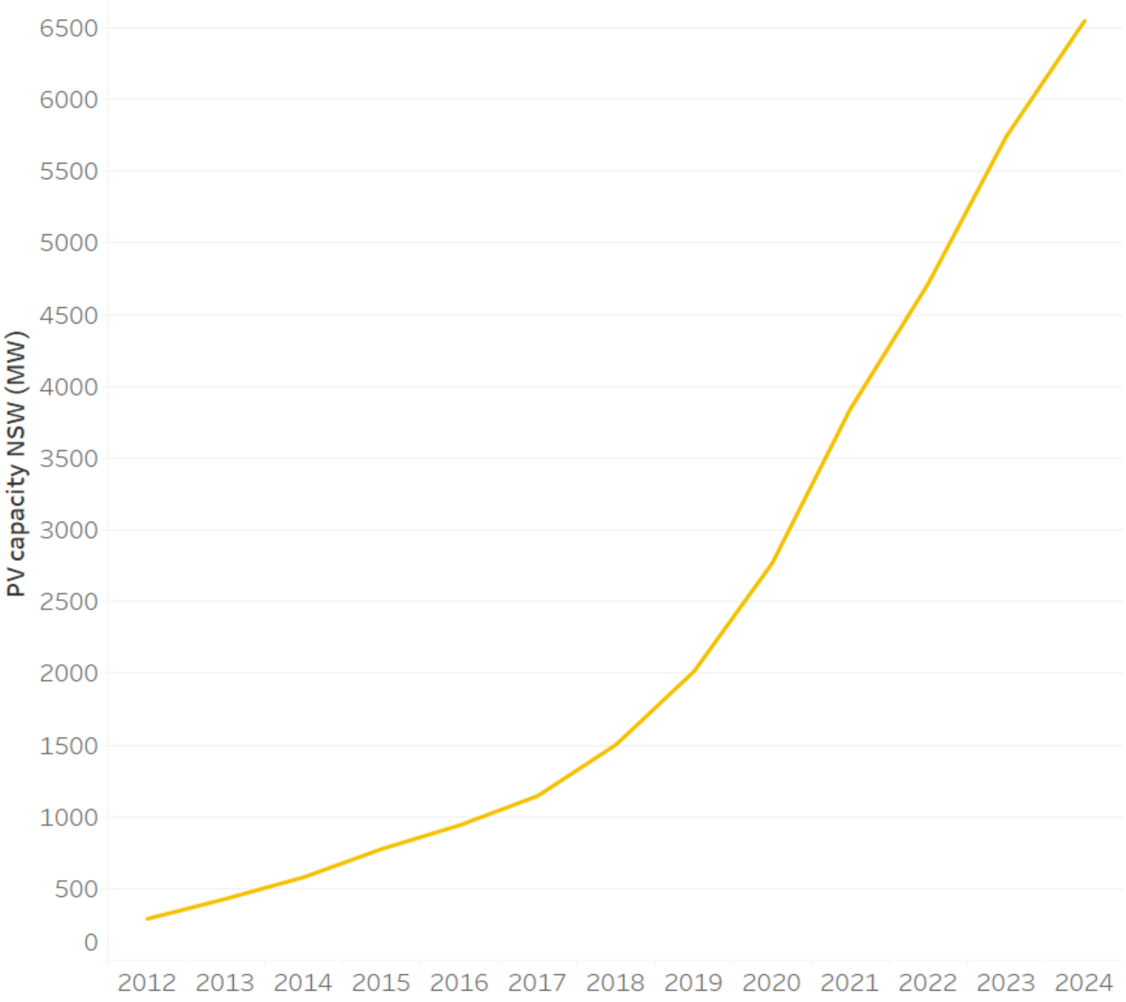
1	Current methodology	*Review current methodology provided by IPART*
2	Desktop research	*Collate and summarise other possible methodologies*
3	Quantitative analysis	*Analyse trends and data*
4	Findings	*Review and develop findings*

3. The current and emerging energy market

3.1. Uptake of solar PV

Since IPART's original methodology was developed in 2011 significant changes to the energy market have occurred. Most notable is the uptake of rooftop photovoltaics (PV) by NSW customers. Figure 2 shows the exponential growth in capacity since 2012. In 2012 there was 289 MW of solar PV installed and now as of March 2024, there is 6,550 MW of rooftop PV in NSW's electricity system.

Figure 2 - Historical installed rooftop PV capacity in NSW



Source: Endgame analysis using data from the Clean Energy Regulator[1].

This has substantially changed the operation of the wholesale energy market and consequently, prices leading to the famous "duck curve", shown in Figure 3. With a significant number of households accessing energy from their roofs during the day this has led to depressed prices at midday with large peaks at night, forming the "duck" shape. Changing

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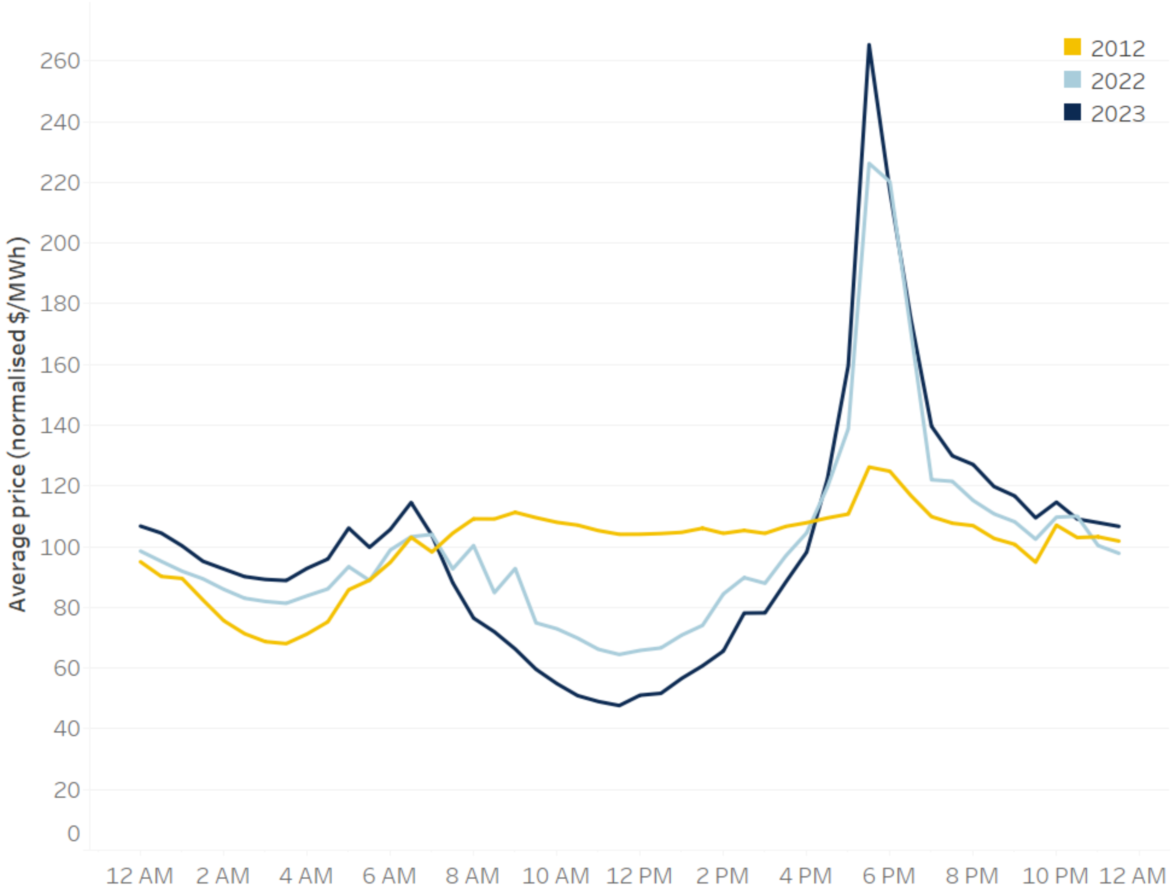
[1] Data for FY 2024 is only up to March 2024

wholesale prices impacts the value of solar exports which is an important factor in setting the feed-in tariff and forms part of the context for this review.

Figure 3 - Average historical time-of-day prices in NSW normalised to a time-weighted average price of $100/MWh



Source: Endgame Economics analysis using data from the Market Management System (MMS)

3.2. Impact of consumer energy resources on retailer's hedging strategies

The uptake of rooftop solar has depressed prices heavily in the middle of the day. This trend has impacted the types of contracts that retailers are using in their hedging strategies. Peak swaps are a hedging contract used by retailers to derisk their electricity purchases on behalf of their customers. These contracts are active from 7am to 10pm on weekdays (excluding public holidays), which appropriately captured elevated prices before rooftop solar depressed prices during daylight hours.[2] Although there are efforts to change the contracting periods of these contracts, they currently still span the 7am to 10pm times, resulting in them typically capturing both very low prices and demand during the day and very high prices in the evening. This has reduced their effectiveness as a hedging product for retailers seeking to hedge against periods of high prices and demand.

This can be seen in the reduction in trades in NSW for 2018 to 2024 peak swaps, as shown in Figure 4. Noting the independent axes between contract types, peak swaps are traded much less frequently than either base swaps or caps. It is not immediately obvious what is replacing peak swaps in a retailer's hedging strategy; however it could be that over-the-counter contracts are being signed in place of peak swaps, or retailers are using their own generators as a natural hedge during peak periods.

It is difficult to know whether the reduction in peak swap trades is driven by large or small retailers, since retailers rarely disclose their contracting position or counterparties. However, the Australian Energy Regulator (AER) notes that the minimum trade size on the ASX is "too high for smaller retailers", suggesting that, along with other barriers like credit requirements or clearing services, only larger retailers were likely to purchase peak swaps on the ASX in the past.[3] Instead, smaller retailers may prefer to purchase 'load following' hedges, reducing their need to purchase peak swaps, while larger retailers are more likely to own generation assets, reducing their reliance on buying contracts. Overall, the relative opacity of the contract market means that it is difficult to know whether the reduction in peak swap trades has affected the contracting positions of small retailers to a greater or lesser degree than large retailers.

Due to the reduction in peak swap trades, ASX is consulting on changes to peak swaps, with proposals including changing the active periods to evening only or morning and evening only.[4] These "super peak swaps" are aimed to more closely capture periods of high prices and demand, giving retailers more useful hedging options. Rooftop solar has meant that retailers are changing their hedging strategies to account for the reduced demand in the middle of the day, due to self-consumed rooftop solar generation.

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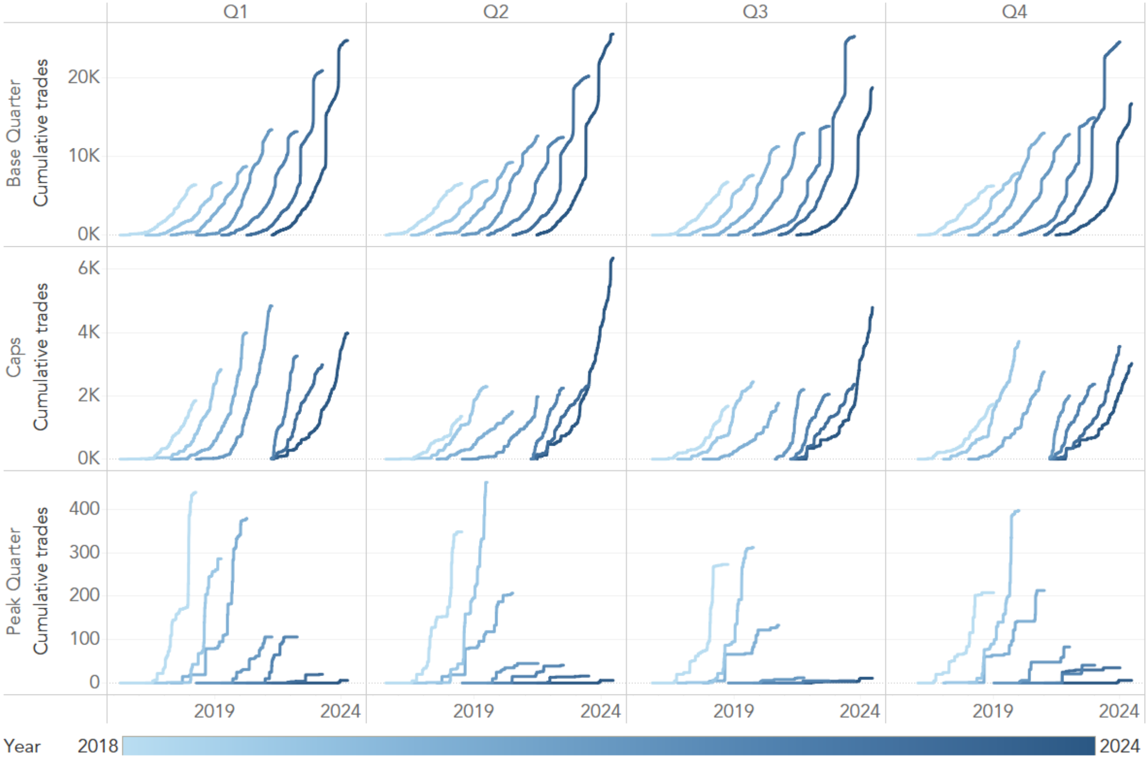
[2] ASX, ASX Australian Energy Products Fact Sheet

[3] AER, State of the Energy Market 2023, p. 51

[4] ASX, ASX Australian Peak Load Electricity Futures Contract Changes, Consultation Paper

Figure 4 – NSW energy contract trades from ASX Energy



Source: Endgame Economics analysis using data from ASX Energy

This change in contracting strategy has meant that other contracts, currently available over-the-counter, are being developed as listed instruments on exchanges, including the aforementioned super peak swaps, solar shape and inverse solar shape swaps.[5] The solar shape swap allows solar PV generators to sell a contract to derisk their revenue, however, it is noted that these typically trade at a discount to the base swap in NSW.[6] On the other hand, the inverse solar shape swap allows a retailer to hedge prices outside of daylight hours, complimenting a utility scale or rooftop solar generation profile.

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[5] Renewable Energy Hub, [Final Report, Renewable Energy Hub]()

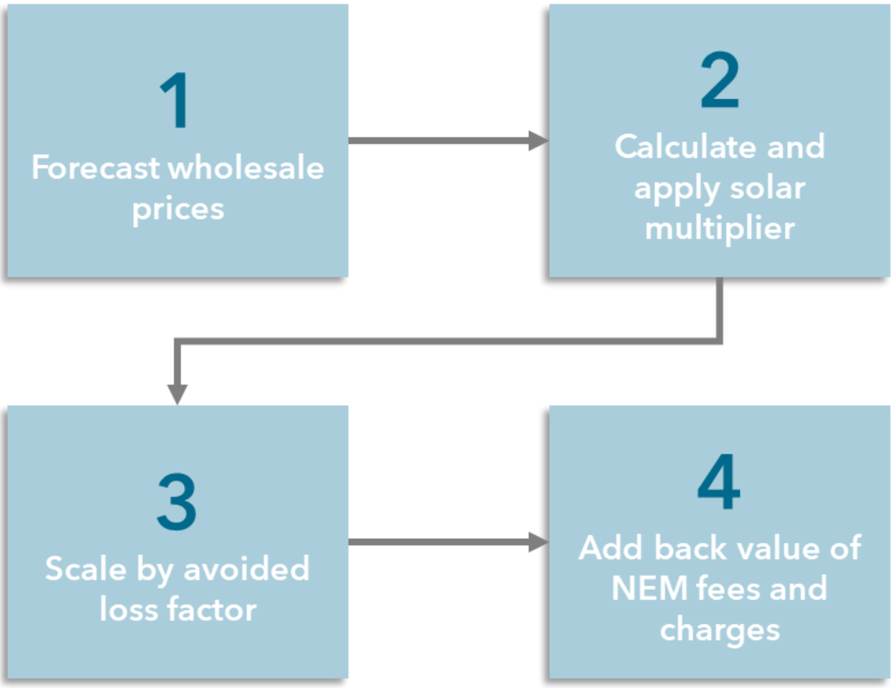
[6] Renewable Energy Hub, [Lesson Learned Report #1]()

4. IPART's method

4.1. Summary

IPART has a four-step methodology to calculate the solar feed-in tariff benchmark range, outlined by the diagram below, Figure 5. The methodology is based on the costs that a retailer avoids by obtaining energy from their customer's solar PV, instead of from the National Electricity Market (NEM).

Figure 5 – IPART's method



The methodology includes:

1. **Forecasting wholesale prices** – Use ASX Energy base swaps to determine a range of forecast wholesale prices.
2. **Calculate and apply the solar multiplier** - Calculate the ratio of rooftop solar export captured prices to time-weighted prices and apply it to forecast prices.
3. **Scale by avoided loss factors** - Scale upwards to account for avoided transmission and distribution losses.
4. **Add back the value of NEM fees and charges** - Include further uplift to account for avoidance by retailers of paying NEM fees and charges.

4.2. Avoided cost approach to value solar exports

IPART bases its methodology on the avoided cost of retailers obtaining energy from their customers' solar PV as opposed to the NEM. Generally, avoidable costs can be defined as expenditures that can be avoided by any large decrements in demand. Here the large decrement in demand for retailers purchasing wholesale energy occurs due to rooftop solar generation.

Rooftop solar reduces energy consumption from the network for a customer with rooftop solar and reduces the net purchases by the retailer from the wholesale market when the customer has excess generation which is exported. When solar is exported back into the grid retailers trade these exports with AEMO, receiving the wholesale spot price at the time. These exports are netted off the total amount of electricity that the retailer must purchase from the wholesale market. This reduces the costs they face by the price of electricity at the time of solar exports.

For example, consider a trading interval with $50/MWh wholesale price, and a single customer, customer 1, who imports 1 MWh of energy. For customer 1 the retailer would need to purchase 1 MWh of energy from the wholesale market, so they pay AEMO 1 MWh x $50/MWh = $50, see Table 1 below.

Table 1 – Settlement for one customer

Customer	Wholesale price ($/MWh)	Imports/exports	Settlement to AEMO
1	$50/MWh	1 MWh	$50

Now, let us consider what happens if the retailer has a separate customer who is exporting their excess solar generation. In this instance, the retailer has one customer importing 1 MWh of electricity while another customer is exporting 0.5 MWh of electricity. The spot price at this time is $50/MWh. The retailer can offset 0.5 MWh of customer 1's imports by using customer 2's exports. So, the total settlement with AEMO would be $50/MWh x (1 – 0.5) MWh = $25. In this instance, the retailer uses exports from customer 2 to avoid paying for energy from the wholesale market for customer 1.

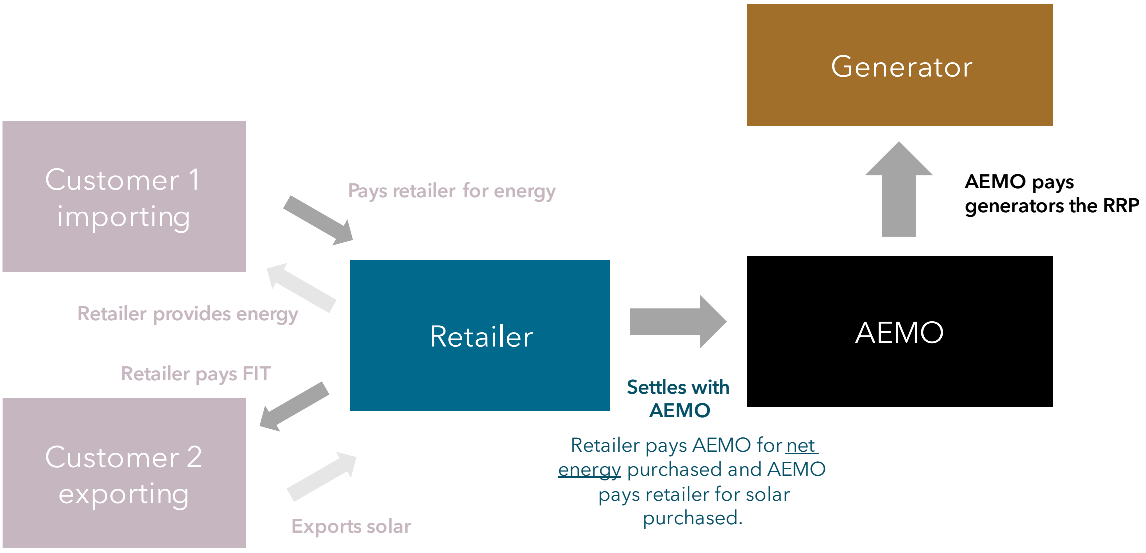
Table 2 – Settlement for two customers

Customer	Wholesale price ($/MWh)	Imports/exports	Settlement to AEMO
1	$50/MWh	1 MWh	$50
2	$50/MWh	-0.5 MWh	-$25
Total	**$50/MWh**	**0.5 MWh**	**$25**

If a retailer has customers whose aggregate solar exports exceeds their customers' load then the above settlement process holds, however in this instance the retailer would receive the wholesale price multiplied by load for the interval from AEMO.

The overall flows can be summarised by the diagram below, Figure 6. Most notably the customer exports solar which is managed by the retailer who receives the wholesale market value at the time solar is generating.

Figure 6 – Summary of flows



Now, let us consider what happens if the retailer has a contracting position with an importing customer. The total amount a retailer must pay in an interval would be the settlement cost with AEMO and any settlement with the contract counterparty. Take the example below, where the retailer has signed a 1 MW base swap with a strike price of $40/MWh. The retailer purchases electricity at the wholesale price for customer 1's load, at $50/MWh. Separately, the retailer receives $10/MWh from the counterparty, since the strike price is less than the wholesale price for this interval. In total, it costs the retailer $40/MWh to service customer 1's load.

Table 3 – Settlement for one customer with contracting position

Customer	Wholesale price ($/MWh)	Imports/exports	Settlement to AEMO	Settlement with counterparty
1	$50/MWh	1 MWh	$50	
1MW base swap at $40/MWh	$50/MWh	1 MWh		-$10 (receive from counterparty)

Now, consider a retailer servicing two customers, one who is importing and another who is exporting their excess solar generation, while also having the same contracting position above in the example above. In the example below, the retailer purchases net 0.5 MWh from the wholesale market at $50/MWh, so pays $25 to AEMO. On the other hand, the retailer receives $10 from the counterparty for the base swap settlement, resulting in a total cost of $15.

It is important to note that the costs a retailer avoided while they were contracted was the costs of purchasing load at the spot price. In this case, their costs reduced by $25, which was the 0.5 MWh of load they were able to avoid purchasing on the spot market to service customer 1, by customer 2 exporting excess solar generation. The avoided cost to a retailer is independent of their contracting strategy, once that strategy has been fixed – ie any settlement with the counterparty is independent of the settlement with AEMO and does not impact the avoided costs a retailer faces through their customer's rooftop solar exports.

Table 4 – Settlement for two customers with contracting position

Customer	Wholesale price ($/MWh)	Imports/exports	Settlement to AEMO	Settlement with counterparty
1	$50/MWh	1 MWh	$50	
2	$50/MWh	-0.5 MWh	-$25	
1MW base swap at $40/MWh	$50/MWh	1 MWh		-$10 (receive from counterparty)

The avoided cost method is sound since it reflects the value of solar - what retailers would pay if they instead bought the electricity from the market. In this way, solar PV is treated as a price-taking generator, that is the retailer gets paid or netted off the wholesale value of solar from AEMO in its settlement process. It is a simple, transparent and fair method to calculate the feed-in tariff benchmark if retailers were to adopt the voluntary guideline.

Consider a higher benchmark feed-in tariff that was greater than the value of solar, if retailers adopted the voluntary guideline, then customers with rooftop solar would have to be cross-subsidised by other customers since retailers would have to recover this cost somehow. This goes against the Terms of Reference to ensure there is no resulting increase in retail electricity prices. In addition, this is unfair for customers who don't have rooftop solar, especially for those who cannot afford it. On the other hand, if the benchmark feed-in tariff was lower than the value of solar, a retailer could enter and offer consumers a value equal to their avoided cost and compete the feed-in tariff upwards.

Rooftop solar displaces other electricity generated in the wholesale market by reducing demand on two fronts, self-consumption and neighbouring consumption. This means that the average price will be cheaper for all consumers when solar is exported. Therefore, solar also provides an economic benefit. However, consumers should not be compensated for this benefit because other incumbent generators such as wind and utility-scale solar which are also low cost do not receive additional payments for depressing prices by entering the market. Instead, all generation receives the spot price at the time they are generating.

In essence, IPART's approach seeks to forecast the solar export-weighted wholesale price of rooftop solar exports. This is the cost retailers avoid, by using rooftop solar generation retailers forgo buying additional electricity from the wholesale market and receive the regional reference price from AEMO for any exports.

5. Forecast wholesale prices

The first step in IPART's methodology is to forecast wholesale prices for the period when the feed-in tariff benchmark is being set. To do this, IPART uses averages of ASX Energy base swaps, which also form part of the range of the solar feed-in tariff. In particular, this step provides the maximum and minimum forecast of wholesale prices which is used to develop the benchmark range in accordance with the Terms of Reference provided to IPART.[7]

At one end of the range of wholesale prices, at the date of analysis, IPART takes an average of the last trading price of ASX futures baseload strip products for the previous 40 days of trading in the financial year of interest. For example, on 19 March 2024, they would take the average from 24 January 2024 - 19 March 2024, of the daily base swap price for FY 2025. This average is then adjusted down by 5 per cent to remove the contract premium that baseload swaps are assumed to trade at relative to the wholesale spot price.

The primary purpose of using publicly traded base swaps is to forecast the time-weighted avoided wholesale costs to retailers for the financial year that the benchmark feed-in tariff is being applied. It is our view that using the 40-day time-weighted average of the most recent days is a reasonable forecast of wholesale prices. This captures the market's latest views and incorporates all publicly available information, without capturing outdated information.

For the other bound, IPART takes a volume weighted average of all historical trades available for the financial year of interest. For instance, in FY 2025 they would take the volume weighted average from 1 April 2021, when these swaps became available. They also use the average of the low and high traded prices each day for this calculation. This estimate is not adjusted down by 5 per cent, to reflect the prices at which retailers are purchasing these contracts for hedging.

Volume weighted average prices using longer periods of 12 months, 24 months or all historical trades are typically used by regulators to provide regulatory certainty for retailers and to reflect the costs of contracts purchased by a retailer. We note that regulatory approaches differ on the use of a 40-day time weighted average or volume weighted average, and IPART has previously used only the 40-day time weighted average in setting the solar feed-in benchmark tariff range.[8]

It is our view that taking the volume weighted average of base swaps over the entire trading period, without accounting for the 5 per cent contracting premium, is not an accurate forecast of average wholesale spot prices. Taking the average over a longer period means that outdated information is being included in the wholesale spot price forecast and is unlikely to represent the best forecast. Retailers typically argue that they purchase contracts over a longer period, and this reflects their costs of hedging, and so should be used in determining the costs they face and can avoid. However, it is our view that the economic value of these contracts, represented by the 40-day time weighted average, is the best reflection of the costs a retailer faces and can avoid through their customers' solar exports. A similar argument can be made that in a competitive market the feed-in tariff should tend

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[7] Terms of Reference

[8] IPART, The value of electricity from small-scale solar panels in 2018-19

towards the long-run marginal cost of new entry, which is independent of sunk costs faced by incumbent retailers, including the prices at which they bought contracts.

As IPART is required to publish a range for the benchmark feed-in tariff, one way to determine this range is to add an error margin around the wholesale price forecast. For instance, in IPART's 2018-19 benchmark feed-in tariff a range of 10 per cent above and below the wholesale price forecast was introduced.[9] This simple approach is able to account for a certain amount of volatility in spot prices, however, likely sacrifices a small degree of accuracy in favour of ease of implementation and transparency. Alternatively, a range could be determined through analysis of how well base swaps have predicted the outturn wholesale price historically to create a forecasting error estimate. This approach sacrifices transparency and increases complexity, however, may increase the accuracy of the applied margin.

Finding

Using 40-day time weighted average swap prices provides the best estimate of wholesale prices, accounting for a contract premium.

Finding

For the purposes of creating a benchmark feed-in tariff range, applying an error margin to the forecast wholesale prices is appropriate. The error margin could be a simple 10 per cent addition and subtraction to the forecast, or more rigorous analysis may be undertaken to determine an alternative margin.

5.1. Alternative methods

5.1.1. Wholesale market modelling

One alternative method to forecast the average wholesale price is through wholesale market modelling. These models typically use forecasts of the supply and demand in the system to estimate dispatch outcomes by using mathematical optimisation. This aims to simulate the outcomes from the National Electricity Market Dispatch Engine (NEMDE) in future periods.

For these models to be accurate, a view must be taken on which generators are going to be in the market during the forecast financial year to be modelled, including relevant generator retirements, generator commissioning dates and generator outages. In addition to that, wholesale energy prices in the NEM depend upon weather patterns, so to ensure accuracy in wholesale price forecasting multiple weather reference years should be modelled.

Lastly, electricity demand is also an important input, including the impact of rooftop solar, behind-the-meter batteries, electric vehicles and electrification rates. Although the

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[9] IPART, The value of electricity from small-scale solar panels in 2018-19

forecasting would only be required for the next financial year, demand can fluctuate wildly depending on expected weather outcomes.

The accuracy of the above inputs will determine the accuracy of the wholesale energy price forecasts from market modelling. Since forward swaps are publicly traded on ASX Energy, it is assumed that the market has already factored in the expected supply-demand balance and has formed a view on it. It is unlikely that any single wholesale price forecast derived from one market modelling exercise is likely to consistently outperform the aggregate view of the market.

Accurate wholesale market modelling also requires a significant amount of domain knowledge and experience, so IPART may decide to outsource this given the significant amount of work required to maintain a wholesale market model. This needs to be considered should IPART use wholesale market modelling to forecast wholesale energy prices.

However, there could be some benefits to using a wholesale market modelling approach. Namely that multiple scenarios could be modelled, including varying demand, commodity prices and generator availability (among many other inputs), to inform the range calculated for the feed-in tariff benchmark. In addition, since half-hourly wholesale prices are a typical outcome of wholesale market modelling, this can be used alongside a solar export profile to directly calculate the solar export weighted price.

In conclusion, it is our view that the drawbacks of added complexity and lack of transparency of wholesale market modelling are likely to outweigh any benefits that wholesale market modelling may provide.

6. Calculate and apply solar multiplier

The solar multiplier is an adjustment factor used to reflect the price when rooftop solar exports occur during the day. The solar multiplier is determined by finding the ratio of the solar export dispatch weighted average price for a particular Distribution Network Service Provider (DNSP) to historical time-weighted average prices. The ratio is then multiplied by forecast wholesale prices to determine the forecast solar export dispatch weighted average price.

First, IPART uses half-hourly rooftop solar export data from the DNSPs and then normalises its output using total generation. Unfortunately, at the time of determining the solar feed-in tariff benchmark, export data is not available for the most recent financial year, therefore the data from two years ago is used. IPART then uses the latest 3 years of data available, to remove the impact outliers may have on the estimation. For example, the feed-in tariff benchmark in FY 2025 will be calculated using solar export data from FY 2021 - FY 2023.

To then get the solar-weighted average price they take the sum product of the normalised exports by the regional reference price (RRP) for:

- The most recent financial year
- The most recent 2 financial years together
- And the most recent 3 financial years together

IPART also calculates the time-weighted average price for:

- The most recent financial year
- The most recent 2 financial years together
- And the most recent 3 financial years together

IPART then takes the ratio of the solar-weighted average price and the historical observed time-weighted average price to create three solar multipliers which span different lengths of time. Finally, to get the solar multiplier, IPART takes the average of the maximum and minimum for each DNSP.

This approach is sound overall, however, care should be taken in using historical solar multipliers to set a forward-looking benchmark solar feed-in tariff, as this may not reflect future market dynamics. Below we explain alternative approaches that may address this.

6.1. Motivation for other methods

In this section, we explore the motivation for why a forward-looking approach may be preferable by analysing trends in rooftop solar uptake and its impact on depressing wholesale prices during the day. We also investigate the options of taking a forward-looking approach to estimating the solar multiplier for calculating the feed-in tariff benchmark.

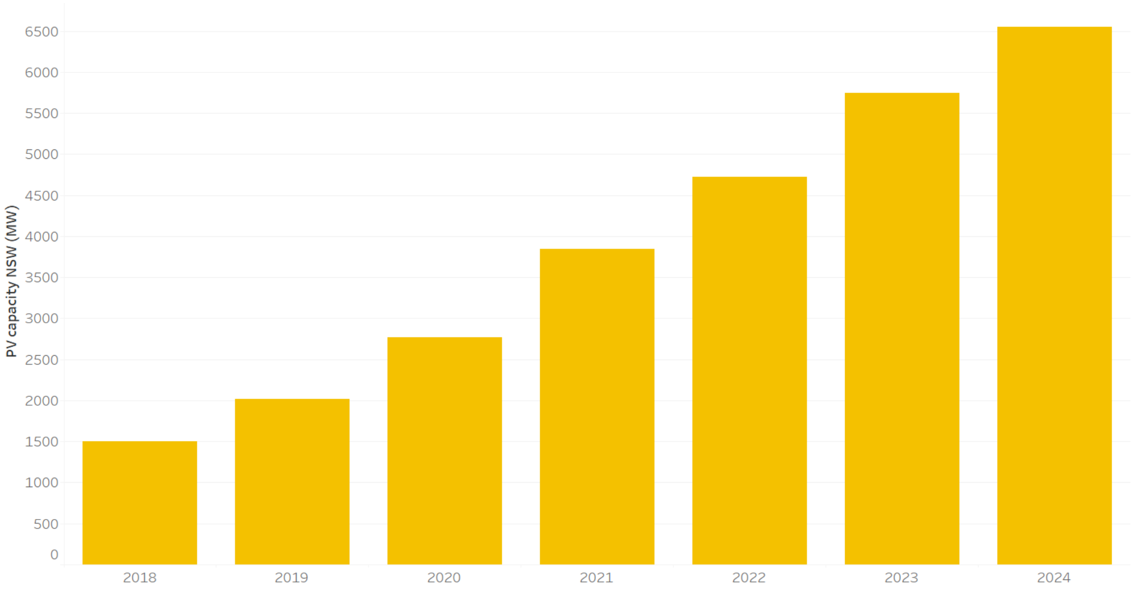
A forward-looking approach is likely to avoid locking in historical solar multipliers and will be able to account for the uptake of rooftop solar.

6.1.1. Solar PV uptake and generation

A major driver of solar feed-in tariffs is the negative correlation between wholesale energy prices and exports from rooftop solar. Thus, it is important to capture the entire range of possible wholesale energy and rooftop solar export shapes, not only the past few years of outcomes. The backward-looking analysis will bake in historical outcomes, which could be heavily impacted by previous uptake, weather patterns, demographic and regulatory landscapes.

New South Wales consumers are steadily adopting more solar, Figure 7 demonstrates the increase in rooftop PV capacity for NSW from FY 2018. Note that data for FY 2024 is only up to March 2024. High levels of installations each year mean that the data IPART uses in setting the feed-in tariff benchmark, from 2 years earlier, does not consider the new level of capacity and thus the effect of additional solar generation on the solar multiplier. For example, in setting the FY 2024-25 feed-in tariff benchmark, the latest wholesale price and solar export data available is from FY 2022-23.

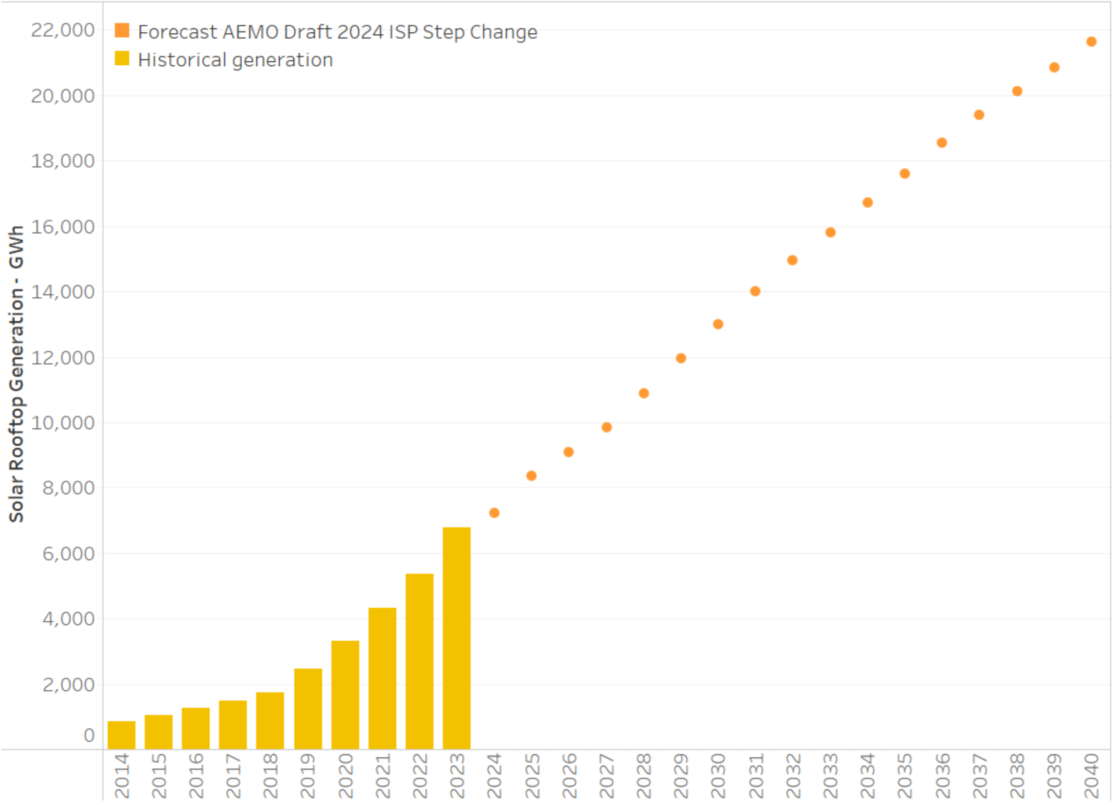
Figure 7 – Historical installed rooftop PV capacity in NSW



Source: Endgame analysis using data from the Clean Energy Regulator

In addition to not capturing the uptake of rooftop solar, historical data locks in the weather patterns over that period. Between 2020-2023, Australia has experienced La Niña, heavily limiting rooftop solar output. Using past weather patterns for the future may under- or overestimate captured prices for rooftop solar relative to outturn weather patterns. However, as Figure 8 demonstrates, the poor weather conditions are not limiting the growth in annual generation. Capacity increases typically conceal any minor variation in weather over a year.

Figure 8 – Historical and projected rooftop solar generation for NSW

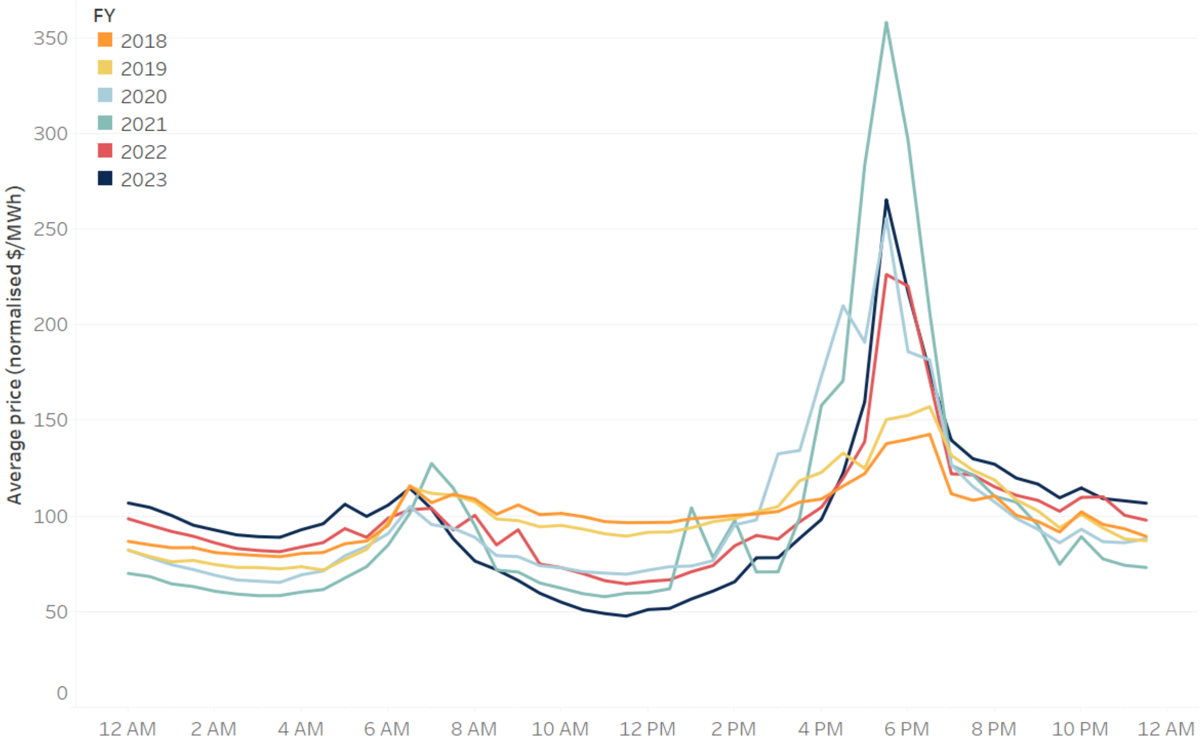


Source: Endgame analysis using data from OpenNem and AEMO's 2024 draft ISP

6.1.2. Relationship between rooftop solar generation and price

The large uptake of rooftop solar has depressed prices during the day whilst contributing to peakier prices at night. Figure 9 shows average time-of-day prices in NSW, normalised to an annual time-weighted average price of $100/MWh for the last six financial years. In FY 2018, prices were relatively flat throughout the entire day, however as each year progresses the 'duck curve' gets increasingly more pronounced.

Figure 9 – Average historical time-of-day prices in NSW normalised to a time-weighted average price of $100/MWh



Source: Endgame Economics analysis using data from the MMS

6.2. Alternative methods

There are a variety of alternative methods IPART could consider implementing should they want to forecast the solar multiplier. We have broadly split the methods into:

- Wholesale market modelling approach
- Market-based approach
- Statistical or machine learning approach

6.2.1. Wholesale market modelling approach

One way to forecast the solar multiplier would be to use wholesale market modelling. This approach would forecast prices at a granular level (typically half-hourly) for the year in which the feed-in tariff benchmark would apply. The half-hourly price series could then be used in conjunction with an appropriate half-hourly solar export profile to determine the relationship between solar and wholesale prices. The half-hourly solar export profile used should reflect the weather pattern and electricity demand used as an input to the wholesale market modelling. Typically, this would also involve forecasting a solar export profile.

Many of the drawbacks of this approach have already been discussed in Section 5.1.1. They include the difficulty in gathering inputs for future years (which will drive the results), forecasting error of inputs and assumptions, and the “black box” nature of wholesale market modelling. It also takes a considerable amount of effort to keep a wholesale energy market model up to date.

However, if IPART chooses to use wholesale market modelling to forecast wholesale prices, then there is a benefit to using the same modelling results to derive the relationship between solar exports and wholesale prices. This would ensure internal consistency within the modelling, and would also ensure that IPART is capturing the impact of the uptake of rooftop solar (assuming that this is accurately forecast as an input into the wholesale market modelling). It may make sense to employ wholesale market modelling to forecast both wholesale prices and the relationship between solar and wholesale prices, however this is not necessarily a requirement. For instance, IPART could use wholesale market modelling to determine only the solar multiplier, but rely on contracts traded on ASX Energy to forecast wholesale prices.

It is our view that the benefits of wholesale market modelling are unlikely to outweigh the drawbacks of this approach.

6.2.2. Market-based approach

There are three types of contracts traded on ASX Energy, base swaps, peak swaps and base caps. The prices at which these contracts are traded give the market’s view on the price of energy during the relevant periods. For instance, base swaps give the market’s expectation of the time-weighted average price (including a contract premium) for a period in the future. It is possible to use the information held within these contracts to scale a historical price series which, alongside a solar export series, could be used to determine a solar multiplier or the solar-weighted price.

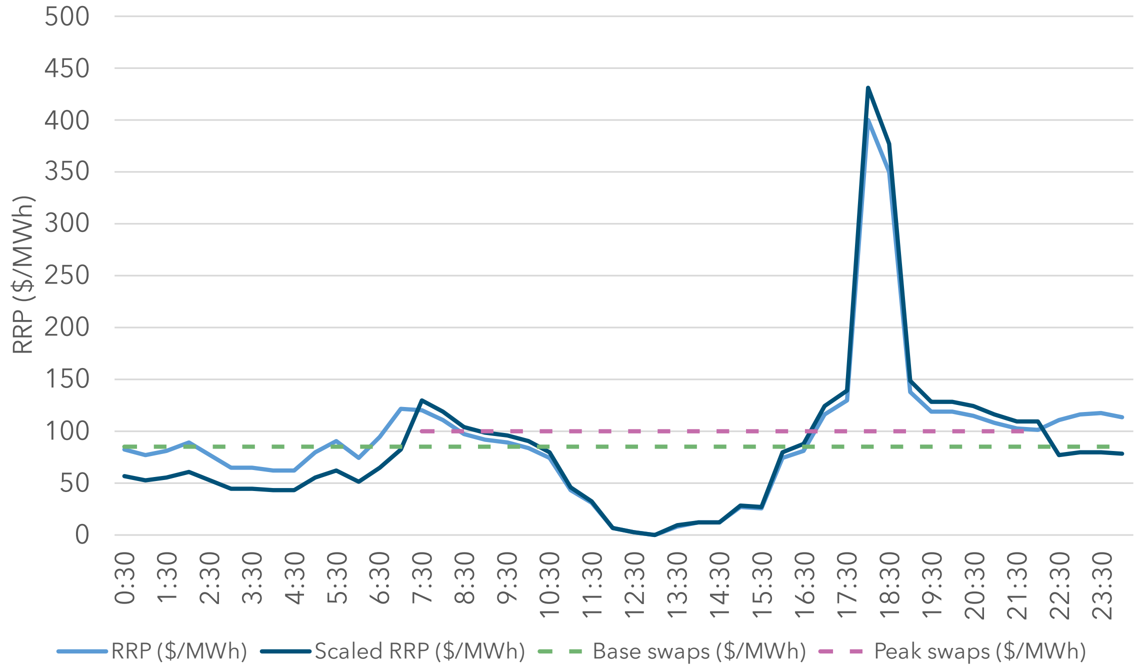
To do this, one would determine a starting price series, which could be taken from wholesale market modelling or a historical year. Once chosen, one would then scale iteratively to the fair value of each of the three base swaps, peak swaps and base caps. This creates a new half-hourly price series which has a fair value of contracts consistent with the market’s expectations.

To illustrate this, consider Figure 10, which uses crafted data to show the scaling process. The light blue line is an example half-hourly price mimicking a historical day in NSW, with the dotted green and pink lines representing the price of base swaps and peak swaps respectively (less a contract premium). The fair value of base swaps and peak swaps using the half-hourly price series differs from the traded value.

For instance, the average time-weighted price of the RRP is approximately $90/MWh. To ensure this is consistent with the base swap price of $85/MWh, it is scaled down such that the average is equal to $85/MWh. Similarly, the average of prices during peak swap periods is $92.65/MWh. To ensure this this consistent with the peak swap price of $100/MWh, prices during this period are scaled upwards such that the average during peak swap periods is equal to $100/MWh. In this simple example, we have assumed that contract prices have any contract premium removed.

When scaling to the price of peak swaps, this is likely to result in the half-hourly price series deviating from the base swap price. To ensure consistency, it would have to be rescaled to base swap prices again. This process would be repeated in an iterative manner until a predefined convergence criteria is met. The dark blue series in Figure 10 shows the half-hourly price series which has been iteratively scaled such that it matches the base swap prices and the peak swap prices. This series can then be used alongside the solar export profile taken from the same period as the half-hourly price series to calculate either the solar multiplier, or the solar export weighted average price directly.

Figure 10 – Example of scaling price series



Source: Endgame Economics analysis using modified data from the MMS

The above example only scaled the half-hourly price series to base swaps and peak swaps. Scaling to base swaps and peak swaps can be done objectively, given the average price of energy during their active periods should be equal to the traded contract price (accounting for a contract premium). However, base caps pose a slightly more difficult issue due to their non-linear nature.

Base caps are a contract that caps the price of energy at the strike price of the contract, which is $300/MWh on ASX Energy. This means that two different price series can differ only in prices below $300/MWh but have the same fair value of base caps if the series are identical above $300/MWh. In essence, this is not an issue, however, it could pose problems when trying to scale a price series to the fair value of base caps.

For example, the fair value of a base cap traded on ASX Energy depends upon the average of prices above $300/MWh. When scaling a price series, one could increase the number of instances above or below $300/MWh to get to the base cap price, or alternatively keep the number of instances constant, and just change the level of prices above $300/MWh. Either approach will ensure that the price series is scaled to the fair value of a base cap but will have a different impact on the shape of the price series. It is not immediately clear to us which approach should be taken without further investigation.

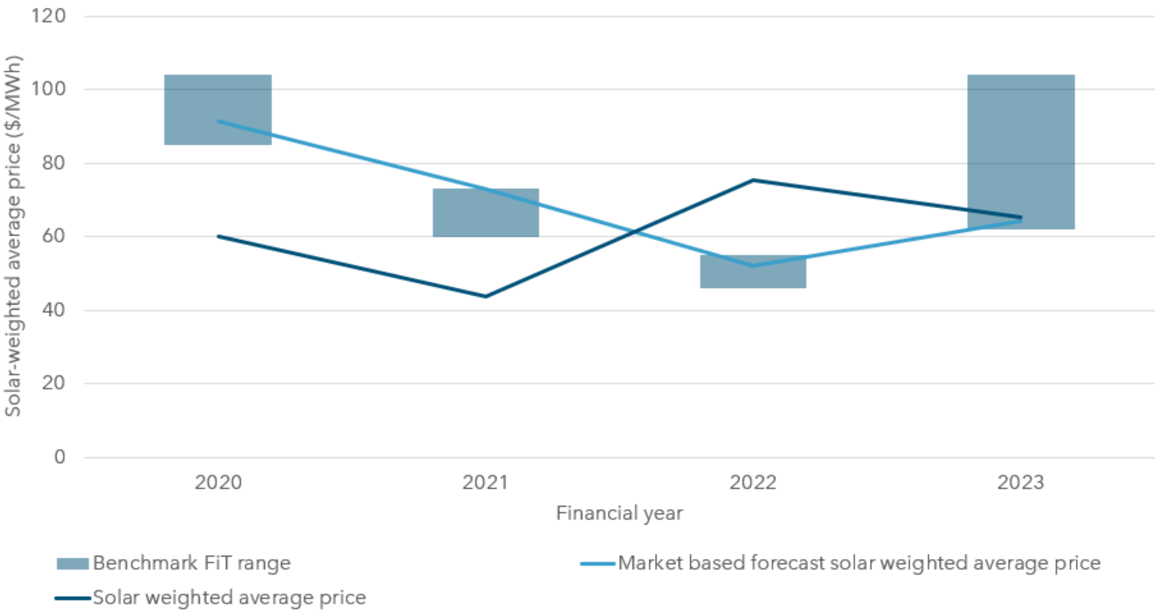
Accuracy of market-based approach

To test the accuracy of this approach, we have used it to backcast the fair value of the solar feed-in tariff in NSW. This approach was done using the data that would have been available to IPART at the time that the benchmark solar feed-in tariff was determined. For instance, when determining the financial year 2022 benchmark solar feed-in tariff, we assume that all data will be taken on 31 March 2021. This means that the latest historical half-hourly prices and solar exports available is financial year 2020, and the contract prices are the latest 40-day time-weighted average.

The market-based forecast of solar weighted average prices is closely aligned with IPART's historical benchmark feed-in tariff range, as shown in Figure 11. This is perhaps unsurprising, given the methodologies are closely aligned; they both use base swaps prices to forecast wholesale spot prices and the solar export profiles are the same. The only differences are the relationship between solar exports and prices, with IPART's methodology calculating a solar multiplier using the previous three years of data and the market-based approach relying primarily on only the previous year of data.

Given scaling half-hourly prices to peak swaps for all prices between 7am and 10pm, it likely distorts upward prices in the middle of the day, relative to evening and morning prices. If super peak swaps become publicly traded then this methodology may provide better forecasts as, implicitly, more information regarding daytime prices becomes available.

Figure 11 – Comparison of solar weighted average price and benchmark feed-in tariff range



Source: Endgame Economics analysis using data from ASX Energy and IPART

Currently, in addition to the drawback of subjectivity in the scaling approach, there are also issues of liquidity for peak swaps. Section 0 will go into more depth, but peak swaps have started to lose relevance as a hedging tool for retailers due to it typically covering both minimum and maximum demand periods. This has caused it to see a reduction in trade in recent years, which may mean the traded price is not an accurate view of its fair value.

Lastly, given the blocky shape of ASX Energy traded contracts, it is likely that a lot of the information held within the traded prices is not directly relevant to the solar multiplier. Instead, a solar weighted contract would be much better suited to use, however, there are no publicly available prices for such contracts. Over-the-counter contracts could be used but would require significant effort to gather data and would limit transparency.

In summary, a market-based approach could, in theory, be used to calculate the solar multiplier by using the market's expectation of the shape of prices. This could be used in conjunction with a solar export profile to determine the solar multiplier, which may lead to a more accurate forecast of the benchmark solar feed-in tariff. However, there are many subjective decisions to be made which may limit transparency and simplicity, and the use of illiquid ASX Energy traded contracts may result in lower forecast accuracy compared to IPART's approach. If more hedging contracts become available, like super peak swaps or solar swaps, then this method may prove useful. However, until then, it is unlikely to provide additional value compared to IPART's methodology.

Finding

IPART's methodology compares closely to a market-based approach which attempts to utilise additional information held in ASX Energy traded contracts. Outcomes are not significantly different due to both rely heavily on base swaps to forecast wholesale spot prices.

7. Scale by loss factors

When retailers buy energy from their customers through their rooftop solar exports the retailer avoids using the transmission network, and parts of the distribution network. Where energy is transported over large distances this leads to losses. However, with rooftop solar, generation is located near consumption and losses are reduced.

Therefore, IPART's method applies an uplift to the solar-adjusted forecast prices to account for avoided transmission and distribution losses. IPART uses a weighted average distribution loss factor multiplied by the NSW volume weighted marginal loss factor for transmission from AEMO.

This approach is economically sound and is the best approach given the data available. We do not see any reasonable alternative methodologies.

8. Account for NEM fees and charges

Similar to transmission and distribution losses, exports from rooftop solar allow retailers to avoid other NEM fees and charges which are largely based on consumed volumes. Retailers on-selling rooftop solar exports reduce the amount of energy bought in the wholesale market and can mitigate these fees. IPART applies an uplift to the feed-in tariff benchmark to account for avoiding these fees.

IPART uses the weighted average of the last three years of weekly customer recovery rates from AEMO for ancillary service fees. For other NEM fees, related market operations, planning services, compliance etc., IPART uses AEMO's annual budget and fees document. These fees are added to the loss-adjusted price forecast which results in the final feed-in tariff.

IPART does not explicitly mention Reliability and Emergency Reserve Trader (RERT) costs or other compensation costs, however, it is our understanding that they should be included similarly to NEM fees. This is discussed in more detail in Section 9.2.

Recent changes to the rules have allowed distribution network service providers (DNSPs) to introduce export charges from 1 July 2024. DNSPs can charge customers for exporting solar above a basic level threshold which will impact the value of solar and thus the feed-in tariff. This will need to be considered by IPART but is out of scope for our review of the wholesale market methodology.

This approach is economically sound and is the best given the data available. We do not see any reasonable alternative methodologies.

9. Other jurisdictions

In this section, we discuss how other jurisdictions in Australia estimate their feed-in tariffs.

9.1. Essential Services Commission in Victoria

The Essential Services Commission (ESC) sets a minimum feed-in tariff that retailers must comply with for customers with rooftop solar in Victoria. The *Electricity Industry Act 2000* requires that the ESC must set their estimate based on the value of solar exports, including the social benefits of reducing pollution associated with fossil fuel electricity generation.[10] However, in their feed-in tariff, the ESC also considers the positive externalities of solar and reducing pollution as an important component of its value.

Similar to IPART, the ESC uses a solar-weighted future wholesale electricity price, representing the price of energy when customers export to the grid. Prices are forecast using a 12-month volume weighted average of Victorian baseload swap futures traded on the ASX and a scaling factor is calculated from historical PV output and historical prices. Once the solar export weighted price is calculated, NEM fees and ancillary service charges, avoided losses and the avoided cost of carbon are added.

Our review is solely focused on the avoided wholesale energy costs a retailer faces from solar exports, and is not assessing the treatment of positive externalities like the ESC's social cost of carbon.

When people install rooftop solar they typically claim their Small-scale Technology Certificate (STC) upfront which gives them a discount on the purchase price of their system[11]. A retailer who has a customer with rooftop solar does not generate STCs since they were all 'generated' at the time of installation. If there were a positive externality that should be included in the feed-in tariff, that externality would have to be in addition to that already captured in the STCs. Else, adding an environmental charge to the feed-in tariff would double count the emissions benefit. IPART's treatment is consistent with the Terms of References by which IPART must abide.

Finding

Not including an allowance for positive externalities is consistent with the Terms of Reference by which IPART must abide.

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[10] Essential Services Commission, Minimum Electricity Feed-in Tariffs from 1 July 2024

[11] Clean Energy Regulator, Rooftop solar

9.2. Queensland Competition Authority in Queensland

The Queensland Competition Authority (QCA) sets the feed-in tariff for regional Queensland in Ergon Energy's distribution network.[12] The minister directs the QCA to set a flat rate using an avoided-cost methodology. Their feed-in tariff for 2023-2024 comprises of:

- The wholesale energy price
- NEM management and ancillary services fees
- Losses
- Irregular cost pass-through items – Reliability and Emergency Reserve Trader costs and compensation costs

The QCA uses wholesale energy estimates from setting regulated retail prices for regional Queensland which is based on a modelled price including a retailer's hedging position. This method is less transparent than IPART's since it uses wholesale price market modelling, demand forecasting and an assumed hedging strategy. Furthermore, the wholesale energy price is not adjusted to account for when solar is exporting during the day and prices are typically lower. Instead, the average wholesale energy cost is used to set the feed-in tariff, which is likely to overstate the actual avoided costs of a retailer.

To estimate the wholesale component of the solar feed-in tariff, the QCA assumes that a retailer can avoid the wholesale energy cost as set out under their regulated electricity price. This section will provide an overview of the methodology used by ACIL Allen to set the wholesale electricity component of the regulated electricity price for the QCA.

For the QCA, ACIL Allen uses their proprietary model *PowerMark*, which forecasts 561 spot price outcomes through wholesale market modelling, then determines a single hedging strategy and estimates the cost of electricity for each of the 561 forecast years. This wholesale electricity cost is then assumed to be avoided by an additional MWh of solar exports.

9.2.1. Forecast the load profile

ACIL Allen develops 51 demand profiles through a stochastic approach, taking into account the impact weather variability will have on both demand and variable renewable energy traces. This Monte Carlo sampling approach uses the past 51 years of weather data to find the 'closest' day in the past three years of historical demand data available from AEMO. This approach relies on the assumption that there is a relationship between weather and demand outcomes.

Once 51 years of demand have been created, these are then non-linearly scaled such that they match AEMO's central forecast of annual consumption and the distribution of seasonal peak loads matches the distribution implied by the POE10, POE50 and POE90 peak demand forecasts. A similar matching approach is used to match the Net System Load Profile (NSLP) and interval meter data to the 51 system load profiles created. This gives 51 years of residential and small business demand.

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[12] The QCA set a regulated feed-in tariff for regional Queensland because Ergon Energy is the only retailer servicing the area, resulting in no competition.

These demand profiles are all created excluding rooftop PV generation. A separate model is used to forecast the uptake of rooftop PV and the generation traces for each of the 51 weather years. This is subtracted from the demand traces to arrive at 51 years of residential and small business load, including the impact of rooftop PV generation.

9.2.2. Determine thermal station availability

Thermal station availability is an important supply side consideration for wholesale market modelling. ACIL Allen developed 11 outage traces, made up of planned and unplanned outages, through a stochastic availability model. The parameters of this are taken from recently observed historical outage outcomes for coal fired power stations, mid-merit gas plant, peaking gas plant and hydro plant. Further details of the sampling approach are not provided in their latest Estimated Energy Costs report for the QCA[13].

9.2.3. Forecast wholesale electricity prices

To forecast wholesale electricity prices, ACIL Allen uses their proprietary wholesale energy market model, *PowerMark*. Like any wholesale market model, *PowerMark* uses half-hourly electricity demand profiles for the NEM alongside supply assumptions like thermal availability, bidding behaviour and variable renewable energy availability traces. The weather patterns underlying the variable renewable energy availability traces used should be consistent with those underlying the 51 demand traces, to ensure correct weather correlation.

Using the 51 demand traces and 11 thermal outage traces, *PowerMark* calculates 561 (51 by 11) hourly spot price simulations for the forecast year. These spot prices, alongside the 51 residential and small business demand traces, can then be used to determine the wholesale energy costs by also using a contract position and associated contract prices.

9.2.4. Forward contract prices

Contract prices for base swaps, peak swaps and base caps are taken from ASX Energy. ACIL Allen uses the trade volume weighted average price as the estimate of futures prices, which aligns with the prices at which retailers have purchased the contracts, ie the prices they faced to build their book. These contract prices are only used in the settling calculations against each of the 561 price outcomes.

9.2.5. Calculate a hedging strategy

It is assumed that a retailer will adopt a single hedging strategy to cover their load for each of the 561 load and price outcomes. The contract volumes for the NSLP and interval meter load are calculated as follows for each quarter of the forecast period:

- Base swap volume is set to the 50th percentile of demand during off-peak periods across all 51 demand traces.

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[13] ACIL Allen, Estimated energy costs, For use by the Queensland Competition Authority in its Final Determination of 2023-24 retail electricity tariffs

- Base cap volume is set to 100 per cent of the median of peak demand across all 51 demand traces, less base swap volumes. This means that under some demand traces there will be exposure to load above the median peak demand.

Note that under this methodology no peak swap volumes are used in the hedging position. ACIL Allen notes that this aligns with the decline in traded volumes on ASX Energy of peak swaps, primarily due to the carve out of demand during daylight hours and the impact this has on spot prices during these periods.

This single hedging strategy is assumed to be contracted for all 561 demand and price traces. This approach, to some degree, captures the uncertainty retailers face when they are making decisions around their contracting positions.

9.2.6. Determine the wholesale energy costs

Finally, ACIL Allen determines the wholesale energy costs using the 561 spot prices, demand traces and single hedging position. This is calculated by determining the costs of purchasing load on the spot market, then adding or subtracting the appropriate contract settlement amounts. Note that in some of the 561 simulations, contract settlement will be a windfall gain since the fair value under the simulated spot prices may be higher than the contract prices determined as described in Section 9.2.4. Conversely, other simulations will have a windfall loss if the fair value of the contract is lower than the calculated contract prices.

This approach estimates a distribution of 561 wholesale energy costs (one for each *PowerMark* simulation). ACIL Allen then takes the 95th percentile of this distribution to arrive at their final estimation of wholesale energy prices.

9.2.7. Applying this to the regulated solar feed-in tariff

The QCA uses the wholesale energy costs estimated through the above methodology in setting regulated retail prices for regional Queensland. To determine a regulated solar feed-in tariff, the QCA then assume that this entire wholesale energy cost can be avoided.[14]

The wholesale energy cost is the cost a retailer faces when purchasing load for the assumed customer profile, in the case of the QCA it is a combination of the Net System Load Profile and interval meter data. This cost includes the cost of purchasing generation to match the demand profile, as well as any associated hedging costs. By assuming that the costs solar exports can avoid should be set equal to the wholesale energy cost, this makes the assumption that 1 MWh of solar exports is able to avoid 1 MWh of the assumed customer load profile. This appears to overlook the importance of the timing of solar exports.

In our view, this is likely to overestimate the costs a retailer can avoid due to solar exports in NSW. This is because the wholesale energy cost is not adjusted to account for when solar is exporting during the day and when prices are typically lower. Instead, the average wholesale energy cost is used to set the feed-in tariff, which is likely to overstate the actual avoided costs of a retailer in a competitive market, like that in NSW. In addition, this method sacrifices transparency when compared to IPART's methodology, since it uses wholesale price market modelling, demand forecasting and an assumed hedging strategy.

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[14] Queensland Competition Authority, Solar feed-in tariff for regional Queensland 2023-24, June 2023

9.2.8. Other avoided costs

Like IPART, the QCA takes into account NEM management and ancillary services fees and losses. However, the QCA also include irregular cost pass-through items such as Reliability and Emergency Reserve Trader (RERT) costs, directions compensation, suspension pricing compensation and administered pricing compensation. Where appropriate, IPART's methodology should also include these costs, as it includes other NEM fees.

The RERT scheme allows AEMO to contract emergency reserves (generation or demand response) when there is an expected shortfall in reserves. When AEMO activates RERT in response to a lack of supply to sufficiently meet demand, AEMO provides compensation to the RERT participants.

AEMO can issue directions to generators to ensure system security or reliability under the National Electricity Law and National Electricity Rules. If these directions cause a financial loss to the affected generators, they may be eligible for compensation payments from AEMO. Both these compensation costs and RERT costs are recovered from consumed energy at the regional reference node.

To illustrate the magnitude of these costs, we will estimate the costs associated with the June 2022 events in the NEM. This was a period of extreme circumstance in the NEM and is unlikely to be repeated in the near term. The total cost of compensation for the June 2022 NEM events for NSW was $133 million.[15] For the financial year 2022-23, NSW operational consumption was 65,305 GWh, so the unit cost of this compensation is $2.04/MWh (or 0.2c/kWh).[16] It is important to note that events of this nature are extremely rare, and should only be included in the benchmark feed-in tariff when appropriate.

Since these costs, like AEMO's NEM fees and ancillary services, are recovered from operational consumption at the regional reference node, retailers can avoid these costs through their customers' solar exports. Hence, an allowance should be considered for these charges in the benchmark solar feed-in tariff.

However, these charges are inherently difficult to forecast ahead of time, given their infrequent nature and unknown magnitude. For this reason, and given they are typically small in magnitude, it may instead be preferable for IPART to not include an allowance for RERT and compensation costs if there is not a reliable, publicly available forecast.

Finding

Where appropriate, IPART's methodology should also include RERT costs and other compensation costs if reasonable forecasts are available, similar to the treatment of other NEM fees.

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[15] Australian Energy Market Operator, June 2022 NEM Events: Compensation Update (6 June 2023)
[16] Australian Energy Market Operator, Electricity Annual Consumption for New South Wales on the Forecasting Portal

9.3. International jurisdictions

Many international jurisdictions have adopted feed-in tariffs to encourage the uptake of renewable technologies and hence reduce emissions. However, many of them do not differentiate between small scale (typically residential and small business) and utility scale generation. For example, countries such as Germany, Canada and France have all used a feed-in tariff to incentivise utility scale renewable generators to achieve their renewable energy goals. [17] This method typically seeks to underwrite generation by compensating the generator for all economic costs (typically only capital, fixed operating and maintenance costs for renewable generators) by setting the feed-in tariff to the levelised cost of energy. Broadly, this method takes capital and investment costs and divides by generation to determine the levelised cost of energy, jurisdictions may then add an uplift between five and ten per cent.

Canada, Germany and the United Kingdom have since stopped their programs due to the large adoption of solar PV. The United Kingdom had a payment for electricity generated by solar and also exported to the grid. The payment was set to give investors returns between five and eight per cent. However, now they have adopted the smart export guarantee where retailers are required to offer an export tariff.[18] These export tariffs are not regulated by the regulator in the United Kingdom, Ofgem, but are instead market offers. As such, the exact methodology used to create these offers is unknown.

Our review focuses on the wholesale costs a retailer can avoid, and we do not believe a levelised cost of energy approach reflects the costs a retailer can avoid from their customers' solar exports. However, there are some jurisdictions which use methodologies more closely aligned with the Terms of Reference specified for IPART.

Finding

Using a levelised cost of energy approach is not consistent with IPART's goal of calculating the cost a retailer can avoid through solar exports.

9.3.1. California Public Utilities Commission

California uses the avoided-cost method to determine the value of DER. The California Public Utilities Commission (CPUC) have developed a calculator that is used to determine the benefits of DER that are used for cost-benefit analysis and customer programs such as the Net-energy metering tariff which is their form of a feed-in tariff[19]. Net-energy metering is used to compensate consumers who send excess generation to the grid. The rate of compensation differs by network utility, but the methodology is as follows:

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[17] National Renewable Energy Laboratory, A Policymaker's Guide to Feed-in Tariff Policy Design

[18] Energy saving trust, Smart Export Guarantee

[19] California Public Utilities Commission, 2022 Distributed Energy Resources Avoided Cost Calculator Documentation

1. Wholesale energy market modelling is completed for a scenario without further distributed energy resources.
2. Value components are calculated on an hourly and monthly basis, including energy, generation capacity, transmission capacity, distribution capacity and losses, among others.
3. The average avoided cost is calculated using a normalised load shape.

In essence, this methodology estimates the costs that additional DER can avoid in the wholesale energy market, as well as other costs including transmission and distribution costs, and positive externalities, like reduction in greenhouse gas emissions. Although our review is focused on the avoided wholesale costs that a retailer can avoid and does not cover network costs or externalities, the avoided wholesale cost methodology that CPUC uses is in principle similar to IPART's methodology. Both methodologies calculate a solar export weighted average price to determine the avoided wholesale costs. Where the methodologies differ is in how the forecasts are calculated, IPART uses a solar multiplier applied to forecasts of time-weighted average prices, while CPUC uses wholesale market modelling to forecast wholesale prices.

9.3.2. New York Value of Distributed Energy Resources

To compensate energy created by DER in New York State, the Public Service Commission established the Value of Distributed Energy Resources (VER).[20] This is commonly referred to as the Value Stack, primarily because it is built up of the value provided by DER to multiple components. In essence, this methodology is an avoided cost approach, where each avoided cost component makes up part of the Value Stack.

There are five components that DER, including rooftop solar, can gain compensation for by avoiding the cost associated with each component. They are:

- **Energy Value:** The avoided cost of dispatching a different generator in the electricity system
- **Capacity Value:** The avoided cost of procuring additional capacity for the capacity mechanism present in New York State.
- **Environmental Value:** Any positive externalities that generation from renewable resources may provide.
- **Demand Reduction Value:** The avoided cost provided by reducing peak demand through generation from DER.
- **Locational System Relief Value:** The avoided cost of reducing network congestion.

Our review is focused on the wholesale costs that a retailer can avoid and does not cover network costs or externalities. So, the components of the value stack of relevance are the Energy Value and the Capacity Value. The National Electricity Market in Australia is an energy only market, which means that the Capacity Value component is bundled together with the Energy Value component. In other words, if a generator can avoid investment in additional capacity, this should be reflected in the spot price for energy.

The New York State Public Service Commission calculates the Energy Value component by calculating the solar export weighted day-ahead price, accounting for losses. In essence, this

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[20] New York Sun, The Value Stack

avoided cost approach is the same methodology applied by IPART, although it is not immediately clear how the Public Service Commission forecasts the energy price component of the Energy Value.

Finding

IPART's avoided cost methodology is similar to the methodology being applied in other jurisdictions, like New York State and California.

10. Statistical and machine learning approaches

IPART's methodology uses historical data to set a benchmark feed-in tariff range for a particular financial year in the future. This could be done by using a statistical or machine learning model to forecast components of IPART's methodology, like wholesale prices or the solar multiplier, or to forecast the benchmark feed-in tariff range itself.

There are two broad methods to forecast wholesale prices, the solar multiplier or the solar weighted average price (the avoided cost of rooftop solar); one could either forecast the half-hourly series of wholesale prices and/or rooftop solar output for the entire forecast period or forecast an aggregated value (like annually or quarterly) instead. Certain statistical or machine learning methods may be suited to one or the other, and there would also be a trade-off between complexity, accuracy and transparency.

10.1. Forecasting of aggregated values

Forecasting annual (or other aggregated) values is a much simpler exercise than half-hourly time series forecasting. However, if only the annual time weighted average price is forecast using this approach, it would have to be paired alongside a forecast of the solar multiplier to determine the cost of energy avoided by rooftop solar. Similarly, if only the solar multiplier was forecast using this approach, then a forecast of the time weighted average price would have to be used to determine the cost of energy avoided by rooftop solar. Note that this section will focus on forecasting annual values of either wholesale prices or the solar multiplier (or both), however, other granularities could also be forecast, for example, seasonal or quarterly averages.

Methods suited to forecast the annual averages may include linear regression, generalised linear models, and robust regression (eg lasso or ridge regression). These models are relatively simple and would use the relevant historical annual average as the dependent variable. Examples of relevant independent variables to test in the model could include:

- Annual (or seasonal) electricity consumption
- Annual (or seasonal) peak demand
- Coal and/or gas prices
- Weather variables
- Available variable renewable energy capacity and/or generation
- Available firm capacity and/or generation
- Installed rooftop PV capacity and consumer energy resources

As part of the model validation process combinations of the above independent variables should be tested to decide upon the best explanatory variables while not overfitting. The independent variables chosen should have robust projections available when using the fitted model to predict the forecast values. For example, AEMO provides forecasts of annual electricity consumption and seasonal peak demand, so these may be good candidates based on projected data availability.

Linear models are transparent and relatively simple, however, they may not necessarily be easy to implement, depending on the number of independent variables identified and tested as useful predictors. Lastly, this approach may not accurately capture some market dynamics that are important to consider in the future. For example, coal retirement is likely a major driver of time weighted average prices, however, there may not be enough historical instances to accurately capture the impact of these variables.

Linear models are likely better suited to forecasting the solar multiplier on an annual basis, rather than the time weighted average price. This is because the solar multiplier has shown a strong linear trend, while time weighted average prices are much more variable with complex underlying drivers less suited to simple linear models. IPART's method gathers enough historical data to create a simple linear model to forecast the solar multiplier. We have used this data provided by IPART to create a simple linear model to forecast the solar multiplier, which will be detailed in the next section.

10.1.1. Forecasting the solar multiplier

Using historical data overestimates the solar multiplier

To demonstrate the simplicity of a linear regression model and the benefit it might provide, we have used data provided by IPART to forecast the solar multiplier and compared it against IPART's method.

This was done by calculating the solar multiplier for each historical year (referred to as the "outturn solar multiplier") and comparing this to the multiplier used by IPART in setting the feed-in tariff benchmark. We followed the same methodology listed in Section 4.[21] Figure 12 shows the comparisons of the solar multiplier for Ausgrid from FY 2018 projected out to FY 2025.

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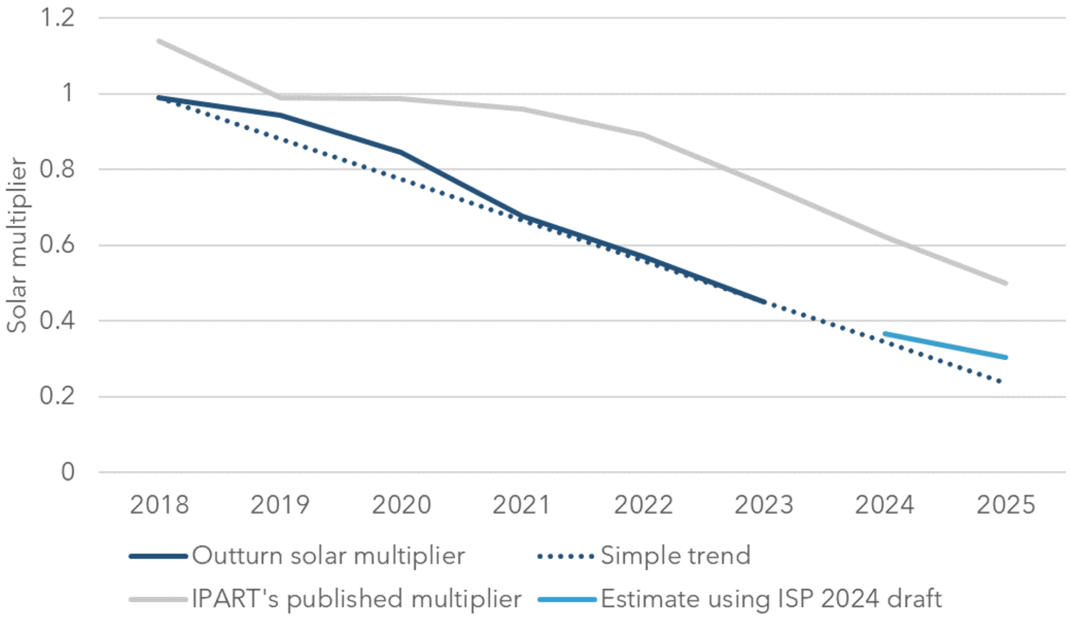
[21] We only calculated the solar multiplier for each year. We didn't calculate it for the previous 2 and 3 years then take an average.

Figure 12 – Ausgrid's historical outturn solar multiplier compared to IPART's solar multiplier used in setting the feed-in tariff benchmark



Source: Endgame Economics analysis using data from the MMS and IPART

In recent years, the actual solar multiplier has been lower than IPART's calculation due to the use of historical data. The calculation incorporates data three years prior and does not consider the increasing level of solar saturation in the market, leading to an overestimation of the feed-in tariff benchmark for any given year.

To address this issue, the solar multiplier can be forecast with a linear regression as shown in the chart. One method is to extrapolate the trend using a simple time trend, as shown by the dotted line. A more robust method is to use historical and forecast rooftop solar capacity for NSW as an exogenous variable to predict the solar multiplier. Care should be taken when performing regressions on time series data to ensure the series are stationary. For the estimate using ISP 2024 draft PV uptake we have regressed on the first differences.

One could also choose to include additional variables if desired, however there are a limited number of observed data points. For this analysis, we used AEMO's 2024 draft ISP assumptions for the step change scenario as a regressor to estimate the multiplier for FY 2024 and FY 2025. The expected increase in capacity and therefore solar generation contributes to a lower feed-in tariff for those years, compared to IPART's estimate for that year.

However, care should be taken when using a simple linear regression without considering the underlying impact that changes in market dynamics may have on the solar multiplier. For instance, midday prices may increase in the future due to a combination of the increase in electric vehicles, electrification, utility scale batteries, pumped hydro energy storages and behind-the-meter batteries increasing the demand for electricity during the middle of the day. In addition, the reduction in prices of large-scale generation certificates (LGCs) and the retirement of coal plant are likely to further increase prices during periods of high rooftop solar penetration, all else equal. A linear regression model, although simple, is likely to be unable to capture these market dynamics and could underestimate the solar feed-in tariff if the trend in midday prices changes from decreasing to increasing.

More complex types of regression may be able to account for these, like multivariate additive regression splines or robust regression, or the inclusion of appropriate independent variables, like quadratic terms or hinge terms. However, without the appropriate historical data and independent variables, it may be difficult to capture significant changes in trends.

Since the wholesale price of electricity is the same in all networks, it is not unexpected that these results hold for all networks. Any differences in the solar multipliers across networks are due to the difference in the solar export profiles, which only exhibit minor differences. Both Essential Energy and Endeavour Energy share similar results as indicated in the Figure 16 and Figure 17 in the Appendix.

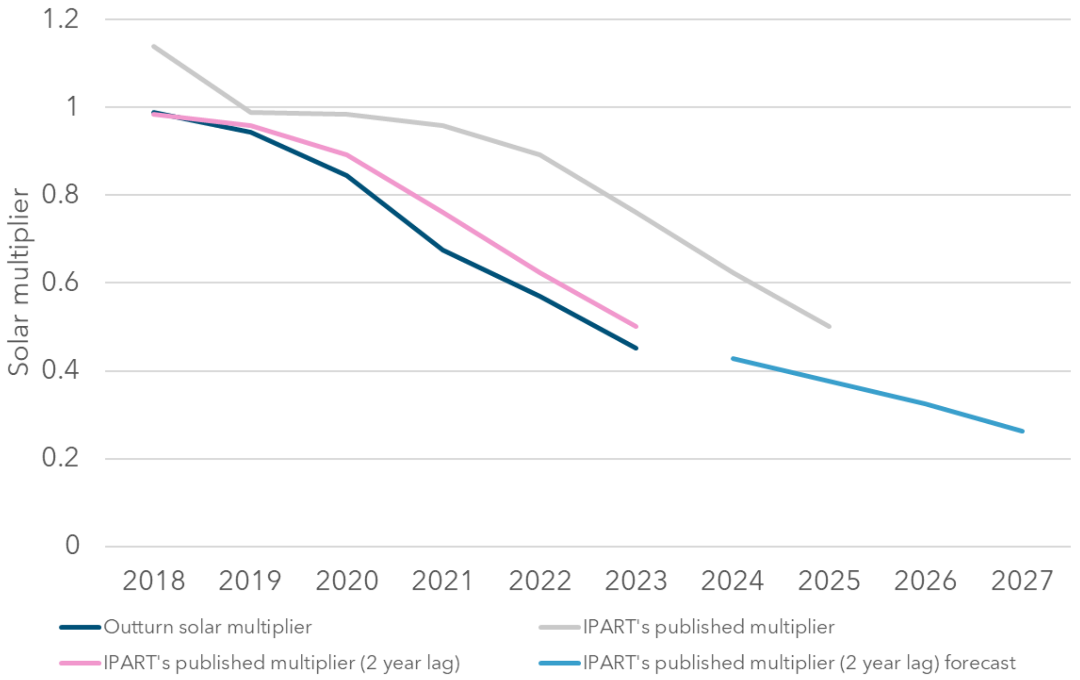
Considering multiple years of data

The method above uses one year of historical data for each data point, if abnormalities are present historically this could skew the feed-in tariff. If this is a concern, IPART could use its method of considering three years which weighs the first year more heavily and then forecast the multiplier. For example, IPART uses data from FY 2023 for the FY 2025 feed-in tariff. If we take the solar multiplier that IPART used for the FY 2025 benchmark back two years to FY 2023, as shown in the light blue line in Figure 13, then one could use those as dependent variables to forecast the future multiplier as shown by the blue line.

It should be noted that in this example by using a linear approach it is estimating a very low solar multiplier in 2027. As seen later in the report, this does not reflect higher average wholesale prices predicted by wholesale market modelling. Caution will need to be taken if this approach is considered.

However, this methodology has the benefit of using multiple years of data to smooth out outlier years, but accounts for the increased uptake of rooftop solar in future years and hence the impact on the solar multiplier. The linear regression approach is simple, transparent and can quickly and easily be implemented. We suggest starting with this method and noting that further work will need to be done to consider the impact of electrification in the future which may require a review of the forecasting approach and or the functional form of the regression and or the inclusion of other independent variables. As the energy market becomes more volatile with the retirement of coal plant, it may be beneficial to look to wholesale market modelling. However, in the interim a linear regression approach is likely sufficient.

Figure 13 - Ausgrid's historical and forecast multiplier



Source: Endgame Economics analysis using data from the MMS and IPART

IPART's methodology is unlikely to capture changes in the market at the time IPART must publish their feed-in tariff benchmark. IPART could consider implementing an approach to forecast the solar multiplier, however, it should be carefully applied each year as the underlying market forces may change in the future.

Finding

Contemplate a methodology to forecast the solar multiplier, with particular consideration being given to a simple and transparent linear regression approach.

10.1.2. Forecasting of half-hourly series

An alternative to forecasting the average annual wholesale price and applying a forecast solar multiplier is to forecast half-hourly prices and calculate the solar-weighted average price directly. Forecasting the half-hourly price series is not a trivial exercise, with many underlying factors impacting the electricity spot price.

Depending upon the exact model specification chosen, the complexity of this approach could range from relatively simple to extremely complicated. Statistical models are more likely to ensure reproducibility and transparency, however, machine learning models may provide more accurate forecasts at the cost of transparency.

Time series models, like autoregressive integrated moving average (ARIMA) and ARIMA-generalised autoregressive conditional heteroskedasticity (GARCH) models, could be used to determine a series of spot prices for the forecast financial year for the benchmark solar feed-in tariff. However, if these models do not use independent variables representing the supply and demand conditions in the wholesale electricity market then they are unlikely to provide accurate forecasts of spot prices.

Some models that may be more suited to forecasting half-hourly spot prices are neural networks, multivariate adaptive regression spline (MARS), support vector regression (SVR) and random forests. In general, these models can take a large number of independent variables which would be required to forecast electricity spot prices at a half-hourly level accurately. Important independent variables include:

- Half-hourly electricity demand
- Coal and/or gas prices
- Bidding behaviour of generators and storages
- Weather variables, including wind and solar availability
- Available generator capacity
- Installed rooftop solar capacity and consumer energy resources

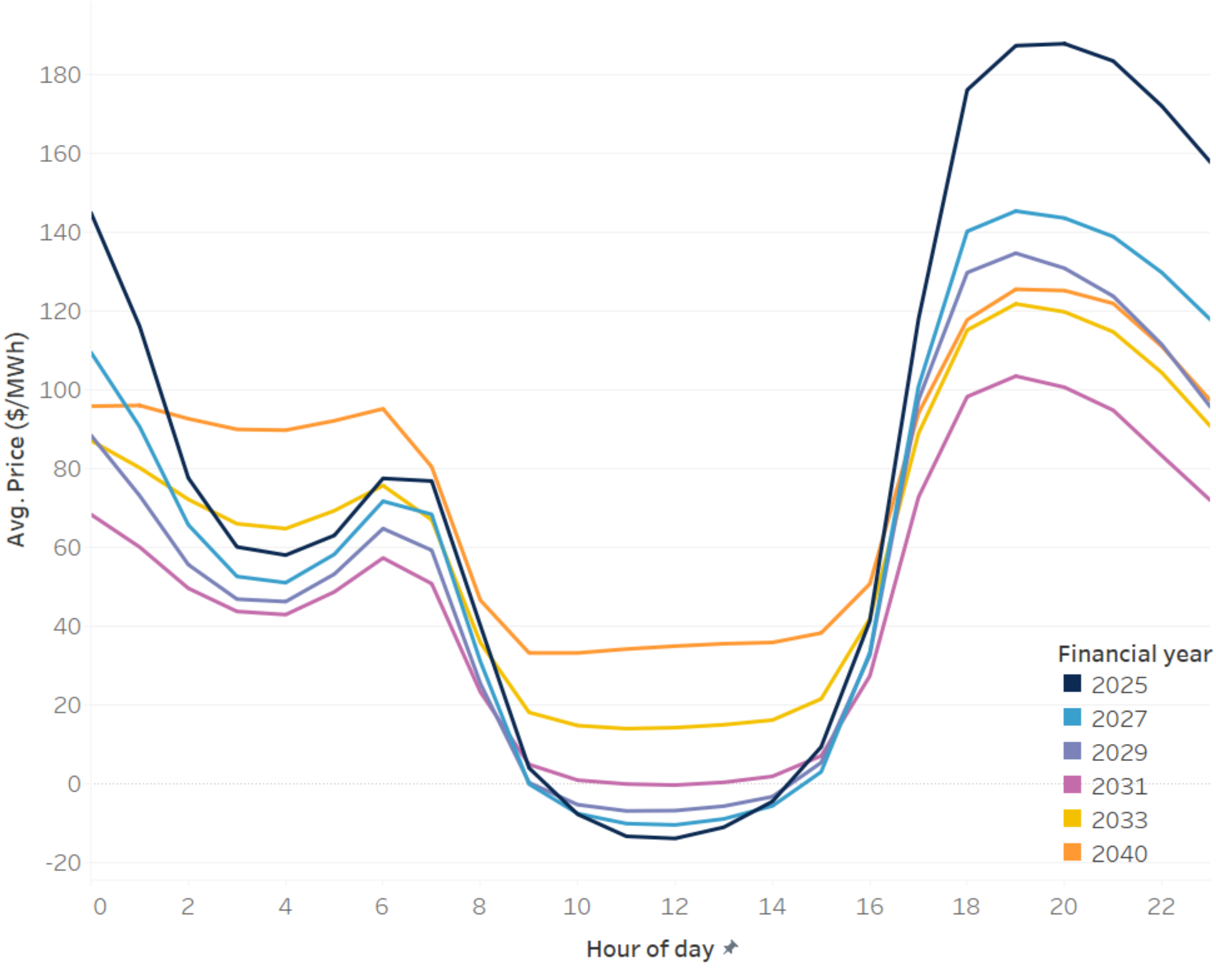
Care should be taken not to overfit the model and to deal with outliers in the data. Additionally, the energy system is in a state of evolution, meaning that historical data may not accurately predict outcomes in future years. This is particularly the case when more batteries and electric vehicles (EVs) enter the system, as prices during the day may increase relative to previous years, and this impact may be difficult for some models to learn using historical data.

Figure 14 shows projected time-of-day average prices in NSW using Endgame Economics' wholesale market modelling of an orderly transition scenario which closely resembles AEMO's step change ISP build path. Under this particular scenario, midday prices from FY 2027 onwards are expected to increase relative to previous years due to a combination of the uptake of electric vehicles, electrification, utility scale batteries, pumped hydro energy storages and behind-the-meter batteries increasing the demand for electricity during the middle of the day. Negative prices in the middle of the day are driven by a surplus of renewable energy bidding at negative prices to generate large-scale generation certificates (LGC). As midday demand increases, there is also a reduction in prices of LGCs and the retirement of coal plant (notably Eraring, Vales Point and Bayswater), reducing the level of negative renewable generator bids and reduction of baseload supply, putting upwards pressure on prices.

Complex statistical and machine learning models are likely able to capture the impact of some of these dynamics, like demand levels, coal plant availability and LGC prices, since these are available, to some degree, in the historical data. However, they may be less able to learn the bidding and charging behaviour of batteries, as well as behind-the-meter batteries, and the impact this will have on spot prices since they are less frequent in historical data. This may mean that forecasts for FY 2027 and onwards may be inaccurate if the forecasting model does not accurately capture the impact of EVs, batteries and electrification.

Regardless of the model used (whether simple linear extrapolation or complex machine learning), care should be taken to ensure the results capture underlying dynamics in the market, in particular any expected changes in the solar multiplier or solar weighted average price.

Figure 14 – NSW future average time of day prices



Source: Endgame's orderly price projection Q2 2024

11. Considering the avoided cost of hedging approach

IPART requested that Endgame provide advice on the **impact of solar exports** on retailers' strategies and practices to manage wholesale electricity costs, given differences in approach, retailer size and structure (ie stand-alone retailers versus gen-tailers). If a retailer can avoid hedging costs, then this may be an alternative way to set a feed-in tariff, and IPART may use this in their estimation of the feed-in tariff benchmark.

We will consider the impact that rooftop solar exports have on hedging strategies through two lenses:

- Changes to contract settlement
- Changes to a retailer's hedging position

11.1. Changes to contract settlement

The first question which must be addressed is what costs a retailer avoids when they have already locked in their contracting position (ie. costs avoided in the short term). To determine this, we will consider a retailer that uses base swaps and base caps to hedge their retail load. These contracts are publicly traded on ASX Energy, alongside peak swaps.

11.1.1. Overview of contracts

A retailer may utilise many forms of hedging tools to derisk the load of their customers, by purchasing publicly traded contracts on ASX Energy, over-the-counter products or generation assets. The details of over-the-counter products and purchases of generation assets are opaque, given the costs are typically not released publicly. However, contracts that are traded on ASX Energy allow us insight into hedging costs associated with those contracts traded on the platform.

The three publicly traded, primary hedging tools available to retailers are base swaps, base caps and peak swaps. We will briefly explain the usefulness of these contracts below.

Base swaps are a contract that locks in a specific price for a flat megawatt of load over a specified period of time, typically a quarter or year. These contracts are active for all periods of the contract period. It is important to note that these contracts are purely financial, they do not require one party to physically deliver or receive energy. Instead, there is a financial side payment between the parties to settle the contract.

For a base swap, the payment is made such that the purchaser of the contract pays the strike price for the contract volume over the contract period, regardless of the underlying spot price. For example, if the average spot price was $60/MWh and the strike price was $50/MWh, then the purchaser would receive from the seller $10/MWh. On the other hand, if the average spot price was $30/MWh, then the purchaser would pay $20/MWh to the seller. This ensures that the seller receives the strike price for the contracted volume, and the purchaser pays the strike price, regardless of the underlying spot price.

For a base cap contract, the purchaser is ensuring that the maximum price they pay for the contracted volume of energy is the strike price, typically $300/MWh. In return for receiving a capped price, they pay the seller a premium. Like base swaps, this is purely a financial contract that is settled separately from the AEMO settlement process.

Lastly, peak swaps are like base swaps, although, they are only active during certain times of the contract period. In particular, peak swaps traded on ASX Energy are active between 7am and 10pm Monday to Friday, excluding public holidays. Apart from this feature, they are settled similarly to base swaps. However, peak swaps have seen a decline in open interest in recent years, due to their falling usefulness as a hedging tool.[22] The active period is becoming outdated due to the uptake of rooftop solar reducing demand during the middle of the day, meaning peak swaps now typically span both minimum and maximum demand.

When considering an alternative approach to valuing solar exports to a retailer, we will assume that they have locked in their hedging position using base swaps and base caps. As noted above, peak swaps have seen a significant reduction in trade. The value of solar exports will be the costs a retailer can avoid under a hedged position.

Recall that the contract position is locked in, and the settlement of these contracts is purely financial and independent of the imports or exports of a retailer’s customers. In particular, the retailer will make a settlement payment for their customers’ net imports with AEMO, and then separate settlement payments for any contracts signed with the counterparties. The settlement payments with AEMO depend only upon the spot price and volumes over the relevant period, and the settlement payments with counterparties depend upon the strike price and volume of the contracts. Importantly, contract settlement does not depend on the imports or exports that the retailer is facing. Thus, the value of solar exports to the retailer is independent of their contract position.

Since the cost avoided by a retailer’s customer’s solar exports is independent of their contracting position, the avoided cost is instead equal to the solar export-weighted average spot price, as explained in Section 4.2. IPART’s methodology calculates the solar export-weighted average spot price, and thus the avoided cost a retailer faces due to solar exports.

11.2. Changes to hedging position

The uptake of rooftop solar has changed the way that retailers hedge their load, primarily through the reduction in the usefulness of peak swaps. Previously, retailers purchased a combination of base swaps, base caps and peak swaps to hedge, however, peak swaps are becoming less relevant due to their defined active period. So, it is reasonable to consider a method that values solar exports through changes to a retailer’s hedging position, and the associated change in their wholesale energy costs.

It is important to note that the feed-in tariff benchmark published by IPART is set on the value of solar exports only, not the value of rooftop solar (and the value of the self-consumed portion of energy generated by the system). One way we can look at this value is how a retailer can use the exported solar to supply the imports of other customers, and whether this will reduce the retailer’s contracting needs. A retailer typically purchases contracts to reduce the volatility risk of purchasing energy from the spot market to meet their customer’s load.

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[22] ASX Energy, [Consultation on ASX Australian Peak Load Electricity Futures Contract Specifications]

As an alternative, a retailer could use the electricity from a customer who is exporting their solar to meet another customer's load instead of purchasing contracts. Since base swaps and base caps apply to the entire quarter in which they are purchased, if a retailer would still like to have the same level of hedging during high load and high price periods, they would still have to purchase the same level of contracts. It is unlikely that solar is exported during these periods of high risk. In addition, since solar exports are weather dependent it is unlikely that a retailer can reliably use them to hedge the load of other customers.

It is also important to note that this methodology requires making assumptions about the hedging strategy and customer mix of a retailer. A retailer who primarily seeks residential customers will have a different hedging strategy than a retailer who seeks customers from a broader base, including small business and large industrial loads. Similarly, smaller retailers may struggle to contract efficiently due to the nature of purchasing in 1 megawatt increments on ASX Energy, while larger retailers may not. Of course, over-the-counter contracts can be appropriately sized for all retailers, however, they are not transparent so may be difficult to use when setting a benchmark solar feed-in tariff.

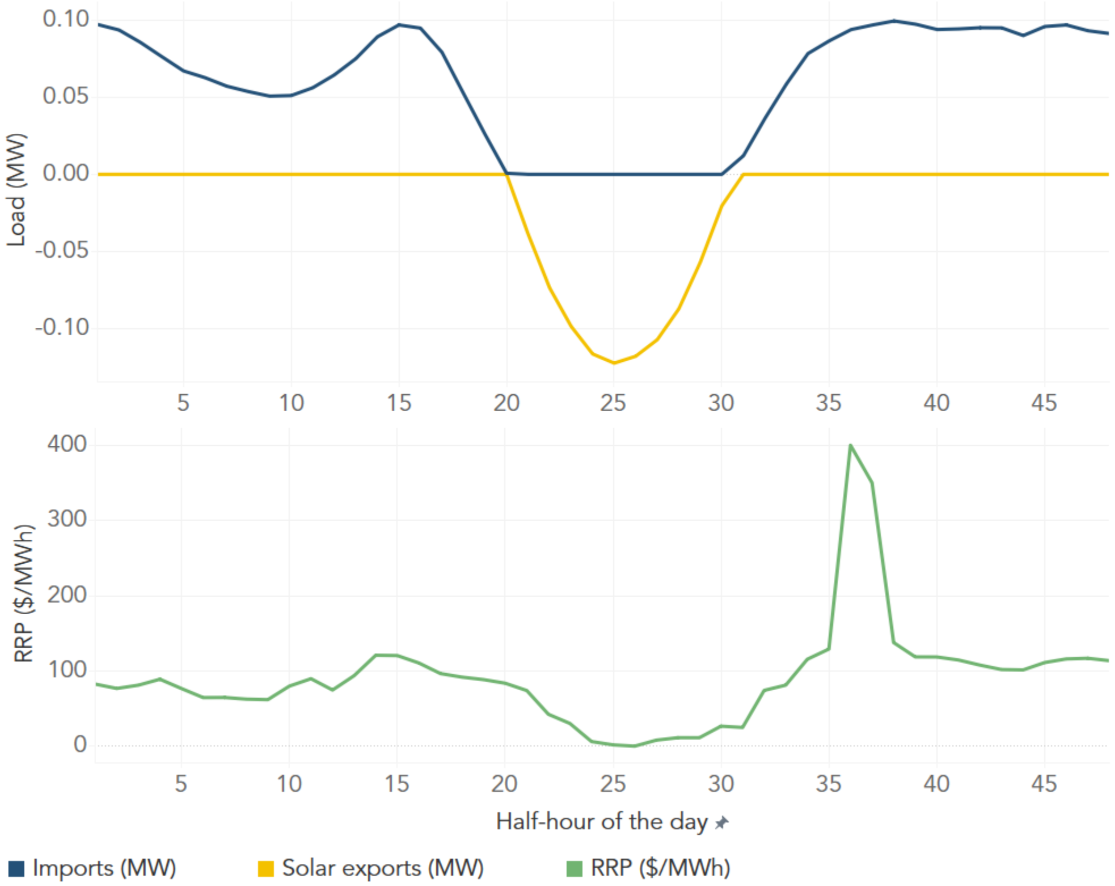
To ensure that the benchmark solar feed-in tariff does not unfairly disadvantage certain retailing strategies or retailer sizes, care should be taken to ensure it is neutral in this regard.

To ensure a methodology that is independent of retailer size, and to a certain degree hedging strategy, we propose to only consider a customer with solar exports. To calculate the avoided costs a retailer faces through avoided hedging costs, one would take the difference in wholesale energy costs to service a customer with solar exports and one without solar exports. Note that in both cases, the customer has rooftop solar, and their imports from the grid are the same, the only difference is whether excess generation from their rooftop solar is exported to the grid or instead curtailed.

This pattern can be seen in Figure 15, which shows the import and export pattern of an example residential customer. The blue line is the grid imports of a given customer, which flattens out at zero during the middle of the day while they are exporting their excess rooftop solar generation. Residential customers typically exhibit a high degree of correlation between their load and the wholesale spot price.

The counterfactual customer to the solar export customer is not a customer without solar, but rather one with solar but does not export. This ensures any change in costs for retailers can be attributed to solar exports, and not the value of rooftop solar, which includes self-consumed solar generation. For reference, this is comparing the cost of hedging the blue line with the cost of hedging the blue and yellow line in Figure 15.

Figure 15 – Example import and export profile for a residential customer, with underlying wholesale price



Source: Endgame Economics analysis using modified data from the MMS and IPART

The reason retailers hedge is to derisk their customers' load. In particular, they typically hedge to ensure that they are not unnecessarily exposed to periods of high customer load and high prices, both of which typically occur in the evening peak. If a retailer's hedging strategy is primarily driven by their peak load, then it is unlikely that solar exports are going to significantly change their hedging strategy.

An alternative way to consider this would be to determine the mix of base swaps and caps a retailer would sell if their generation profile was equal to their customers' solar exports. Since solar exports are unable to reliably defend either contract, it is unlikely that a retailer would sell either type of contract, since they would likely be exposed to unfunded difference payments. If a retailer is not selling contracts from their customers' solar exports, then it is instead sold on the wholesale spot market (or avoiding purchases from the spot market). So, solar exports are avoiding the wholesale spot price at the time of exporting. The fair value of the solar exports is thus the solar export weighted spot price.

Lastly, if the avoided costs of hedging to a retailer of solar exports were significantly different from the avoided spot costs, there is an arbitrage opportunity to be exploited. Retailers would be able to form a position whereby they earn arbitrage revenue due to the difference in avoided costs and what a customer is willing to accept for their solar exports. For example, if the value of avoided hedging costs was greater than the export-weighted spot price, then retailers would compete for solar customers through higher feed-in tariffs until the arbitrage opportunity is competed away. Similarly, this would occur if the avoided hedging costs were less than the export-weighted spot price.

All of this culminates in the thought that, in the long term, if there is an avoided cost of hedging to retailers, then this should be equivalent to the solar export weighted spot price, which is IPART's methodology.

11.3. Issues with calculating a time-varying feed-in tariff

If the avoided hedging cost methodology were adopted, it is not entirely clear how one would calculate a time-varying feed-in tariff. In principle, one could estimate the wholesale energy cost of the imports for a customer with solar exports and compare that against the wholesale energy cost of that same customer with solar exports only during a particular time period. The difference in wholesale energy costs would then be the feed-in tariff for that time period.

Consideration should be given to the fact that, depending on the hedging strategy used, a different contract position could be determined for different time periods. This assumes that a retailer can offer a customer a feed-in tariff which is made up of a combination of contract positions in different time periods. However, if using ASX Energy traded contracts, a retailer's contract position is not nimble enough to do this in practice. For example, a base swap is bought and sold for the entire quarter or year and is active for all hours during that period. It cannot be turned on or off by trading interval as determined by the retailer.

Similarly, if this methodology gave a significantly different value for time-varying solar exports, there would be an arbitrage opportunity that could be exploited. This is the same argument that was made for the flat feed-in tariff and can be applied to a time-varying feed-in tariff.

11.4. Issues with the hedging approach

There are a number of issues which should be considered when deciding whether to use an avoided cost of hedging approach. In our view, the additional complexity of an approach like this far outweigh any perceived benefit. In particular, IPART would have to determine an optimal hedging position for each of the two customer loads, which is not trivial. This may also disadvantage small retailers, who may find it more difficult to hedge using 1 MW contracts if they have a small customer base.

Finding

We do not consider an avoided cost of hedging approach to better estimate the avoided costs a retailer faces due to their customers' solar exports which is likely to increase complexity and reduce transparency.

12. Conclusion

Our review finds that IPART's methodology is sound and achieves the objectives required of it by the Terms of Reference. We have identified and considered alternative methods for calculating the benchmark solar feed-in tariff. In our view, IPART's methodology strikes a good balance between complexity, transparency and accuracy.

Alternative methods, including wholesale market modelling and machine learning approaches, typically increase complexity and have lower transparency and ease of implementation.

Wholesale market modelling requires significant time invested to ensure a model is kept up to date in the fast-changing energy sector and would likely require IPART to outsource this. Doing so is unlikely to be transparent or make it easy for IPART to reproduce results or be easy to implement.

Statistical models and machine learning approaches were also reviewed. These models can range in complexity but may still be thought of as a "black box" by many and suffer from reduced transparency. Reproducibility may also be difficult for certain machine learning approaches, and careful consideration would have to be given to the changing market dynamics due to electric vehicles, behind-the-meter batteries and electrification. However, there is merit in considering a simple statistical approach given the ability to account for the forecast uptake of rooftop solar and the impact this will have on the feed-in tariff benchmark. Care should be taken when considering the impact electric vehicles, electrification and behind-the-meter batteries will have on daytime prices.

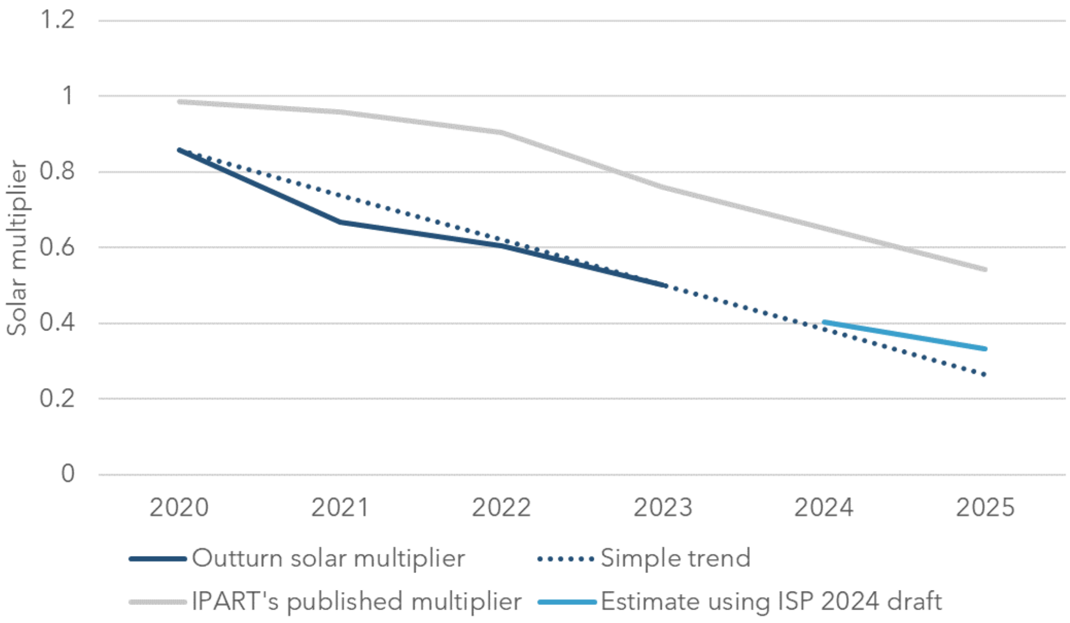
Lastly, IPART should consider including Reliability and Emergency Reserve Trader and compensation costs where appropriate in addition to the NEM fees already included in their methodology. These costs are avoided by retailers who have customers with solar exports, and so the feed-in tariff benchmark should reflect this.

In summary, IPART should:

1. Review the purpose of the volume weighted average swap price, since in our view this does not represent the best available forecast of wholesale energy prices. Instead, an error margin should be applied to the 40-day time weighted average swap price, accounting for the 5 per cent contract premium, to create a range for use in the benchmark.
2. Consider a methodology to forecast the solar multiplier, since the data available to IPART at the time the benchmark is set is two years before the period to which the benchmark applies.
3. Where appropriate, include Reliability and Emergency Reserve Trader (RERT) and compensation costs in their methodology.

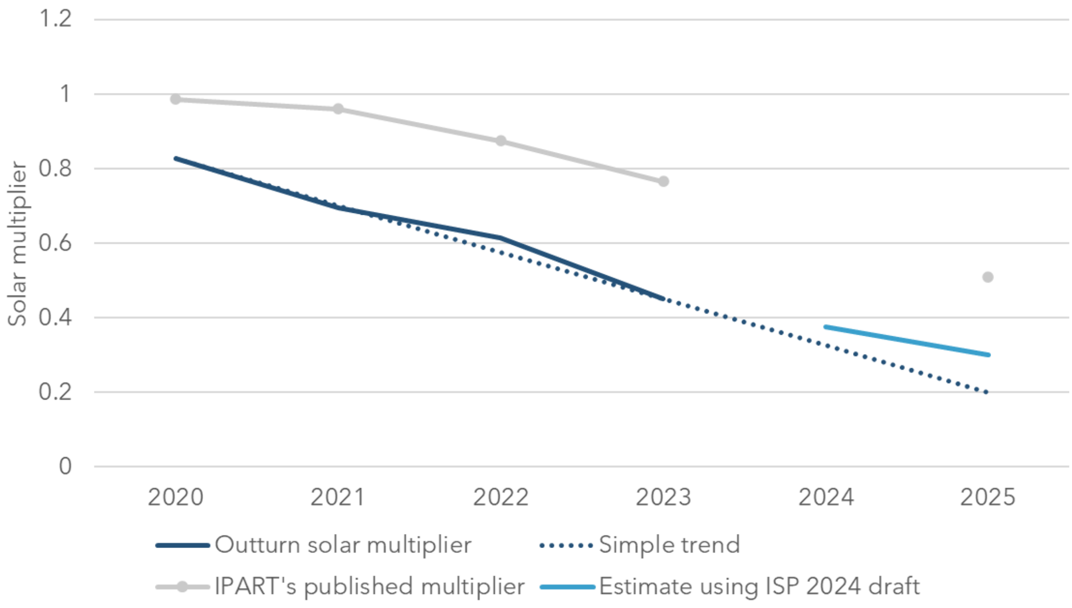
Appendix

Figure 16 – Essential Energy's historical outturn solar multiplier compared to IPART's solar multiplier used in setting the feed-in tariff benchmark



Source: Endgame Economics analysis using data from the MMS and IPART

Figure 17 – Endeavour Energy's historical outturn solar multiplier compared to IPART's solar multiplier used in setting the feed-in tariff benchmark



Source: Endgame Economics analysis using data from the MMS and IPART

Note that in FY2024 IPART did not calculate a solar multiplier for Endeavour Energy due to data quality issues.

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