VALUE OF RELIEVING CONSTRAINTS ON SOLAR EXPORTS

A REPORT FOR AUSNET SERVICES

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AusNet Services' network has been experiencing strong growth in solar PV connections. To ensure that voltage remains within acceptable bounds, AusNet Services is required to impose constraints on the volume of solar electricity that is exported to the grid. In response, AusNet Services has developed an investment plan to better integrate distributed energy resources (DER) in its network and to increase the amount of solar electricity that can be exported to the grid. AusNet Services has proposed using the Victorian single rate feed in tariff (FiT) as a proxy for the value of the benefit of removing constraints on solar exports on its network.

Using the FiT as a proxy for the value of solar exports

In our view, the key benefit categories that arise from additional solar exports are:

- **Avoided generation dispatch costs** – greater solar PV exports will reduce the volume of electricity required to meet consumer demand. This will in turn reduce the amount of electricity that wholesale generators are required to produce, leading to a saving equal to the SRMC of the grid sourced generation that is displaced as a result of the additional solar PV exports (which is generally reflected in spot prices).
- **Avoided network losses** – as electricity flows through networks, a proportion of energy is lost due to electricity resistance and the heating of conductors. Rooftop solar PV panels are located closer to the point of consumption than utility-scale generators, so electricity exported from rooftop solar PVs is transported a shorter distance through electricity networks. It follows that an increase in rooftop solar PV exports would be expected to reduce network losses.
- **Environmental benefits** – greater solar PV exports will reduce the amount of electricity required to be generated by coal and gas fired plants in the NEM, thereby reducing the amount of greenhouse gas emissions that are produced in meeting electricity demand.

In our view, the FiT represents a reasonable proxy to measure the benefit of AusNet Services' investment program because it captures all of these benefit categories. We note that the FiT also includes forecasts of avoided market fees and ancillary services charges. This should not be included in measuring the benefit of additional solar exports since it reflects a redistribution of costs rather than a net market saving. Having said this, we note that it represents only a very small proportion of the total FiT (accounting for less than 0.6%), and so will not materially affect AusNet Services' assessment of the benefit of its DER investment program.

We believe that use of the FiT is also in line with the Australian Energy Regulator's regulatory investment test for distribution (RIT-D). The RIT-D guideline includes fuel cost savings and changes in electrical energy losses as acceptable categories of market benefit. It also allows the AER to identify other classes of market benefits. As discussed above, an increase in solar exports will reduce the amount of electricity that is generated by coal and gas fired plants, and therefore reduce greenhouse gas emissions. In our view, if there is a social cost to carbon, then it would be appropriate to include any reduction in greenhouse gas emissions as a market benefit under the RIT-D.

Comparison with SAPN's avoided cost of dispatch

The AER has noted that the price used by AusNet Services to determine the benefits of its DER program is relatively high compared to the value used by SAPN to assess the benefit of relieving constraints on solar exports in South Australia.

The SAPN analysis was informed by a report prepared by HoustonKemp.[1] In our view, there are several reasons why it would not be appropriate for AusNet Services to apply SAPN's estimate of the avoided cost of dispatch to estimate the benefits of its DER program. In particular:

- the assumptions underpinning HoustonKemp's analysis are either unknown or unsupported;
- HoustonKemp's analysis only captures the benefit from avoided dispatch costs, and does not include any other relevant benefit from relieving constraints on solar exports; and
- HoustonKemp's analysis is based on expected electricity market outcomes in South Australia and is not applicable to Victoria.

In addition, we note that the magnitude of the difference between HoustonKemp's forecast outcomes for 2018 and actual wholesale market outcomes in that year suggest that there are fundamental problems with its approach. In particular, HoustonKemp estimates the average avoided dispatch cost for solar exports in 2018 in South Australia as $50.15/MWh. However, we calculate the *actual* average solar weighted wholesale price in 2018 in South Australia as $96.70/MWh, which is substantially higher than (almost double) the estimate provided by HoustonKemp.

[1] HoustonKemp Economists, *Estimating avoided dispatch costs and the profile of VPP operation – a methodology report*, 9 January 2019 (hereafter referred to as the 'HoustonKemp report').

1 INTRODUCTION

Frontier Economics has been engaged by AusNet Services to assess whether the Victorian feed in tariff (FiT) is a reasonable proxy for the value of removing constraints on solar exports on its network.

1.1 Background

AusNet Services' network has been experiencing strong growth in solar PV connections. This has been principally driven by:

- falling technology prices, particularly for rooftop solar panels and battery storage
- changes in consumer preferences, towards more 'green' energy sources
- government rebates, such as those provided under the Victorian Solar Homes Program.

We understand that the volume of this additional solar PV capacity and the intermittent nature of solar generation has a material impact on AusNet Services' obligation to provide a safe, secure and reliable network service, consistent with the National Electricity Rules (NER) and jurisdictional requirements. In order to ensure that voltage remains within acceptable bounds, AusNet Services is required to impose constraints on the volume of solar electricity that is exported to the grid. It notes that:[2]

- approximately 1.3% of total connected solar customers are export limited
- over the past two months, for new connections:
  - 13.1% of all connection applications have had a (non-zero) export limit applied
  - 1.3% of connection requests are unable to have solar connected at their premises, even with an export limit, because there is no hosting capacity available.

In response, AusNet Services has developed an investment plan to better integrate growing distributed energy resources (DER) and to increase the amount of solar electricity that can be exported to the grid. This includes:[3]

- optimising the network using existing technologies, which we understand will be funded through the existing operating expenditure allowance;
- deploying intelligent technology to improve the distribution network's ability to handle additional DER; and
- augmenting the distribution network to enable additional DER connections.

AusNet Services is seeking to include these capital expenditure forecasts in its regulatory proposals for the 2022-26 regulatory control period. In line with this, AusNet Services has estimated the expected net benefit of the proposed investments by estimating the value of solar generation that is constrained due to voltage non-compliance issues and comparing this to the cost of augmentation options. In undertaking

2 AusNet Services, *Deep Dive 4: Capital expenditure 1: Innovation and distributed energy resources: Background reading – DER,* May 2019, p.18.

3 AusNet Services, *Deep Dive 4: Capital expenditure 1: Innovation and distributed energy resources: Background reading – DER,* May 2019, p.3.

this assessment, AusNet Services used the Victorian single rate FiT of $0.12/kWh as an estimate of the value of relieving constraints on solar exports.[4]

1.2 Overview of task

We understand that a draft of this benefit assessment was provided to the Australian Energy Regulator (AER). In response, the AER noted as follows:

> *AusNet Services has based the benefits of its DER program on the Vic Feed in Tariff (FiT) of $120/MWh. This is a relatively high value and includes some inputs that may not be directly applicable to NER framework (in particular a value on carbon). By contrast, the value used in the SA reset was $50/MWh. There are a number of projects (Oakley Greenwood, and others) also looking into this value in parallel with the reset processes. It would be helpful for AusNet to provide justification for the use of the Vic FiT.*

In light of this feedback, AusNet Services has asked us to consider:

- whether the Victorian single rate FiT is a reasonable proxy for the value of removing constraints on solar exports on AusNet Services' network; and
- by extension, whether the value of $50/MWh that was used by SAPN is appropriate to use in AusNet Services' analysis of the value of removing constraints on solar exports on its network.

We consider each of these issues, in turn, in the sections below.

[4] AusNet Services, *Deep Dive 4: Capital expenditure 1: Innovation and distributed energy resources: Background reading – DER,* May 2019, p.68.

2 THE VALUE OF REMOVING CONSTRAINTS ON SOLAR EXPORTS

In this section, we consider whether the Victorian single rate FiT is a reasonable proxy for the value of removing constraints on solar exports on AusNet Services' network.

2.1 Wholesale market impact of removing solar exports

The NEM is an energy-only market. That is, electricity generators are paid in the NEM only when they supply power. At a high level, the process involves the following steps:

- **Generators submit bids** – the process begins with generators making offers to AEMO which specify the quantity of electricity they will produce at various prices. These offers are submitted for 5-minute periods, or 'dispatch intervals.'
- **AEMO dispatches generators** – AEMO will collate all bids received from generators and produce a generation merit-order (or 'stack'), which ranks the offers from the lowest price to the highest price. Generators will be dispatched in ascending price order such that cheaper generation is dispatched before more expensive generation until demand is satisfied (in practice, transmission and generator constraints mean that generators may often be dispatched 'out-of-merit order').
- **AEMO determines wholesale spot prices** – AEMO will first determine dispatch prices for each 5-minute period. In an unconstrained environment, this is the offer price of the highest (marginal) priced MW of generation that is dispatched to meet demand during that period. AEMO will then determine a spot price for each half-hour (trading interval) based on a simple average of the six dispatch prices in that period. Financial settlement occurs on the spot price, not the dispatch price.

Different electricity generators have different short run marginal cost (SRMC) largely reflecting differences in fuel costs and differences in the efficiency with which fuel is used to generate electricity. For instance, base load plant (such as coal plants) have relatively low running costs, mid-merit plants (such as combined cycle gas turbines, or CCGTs) have higher running costs and peaking plants (such as open cycle gas turbines, or OCGTs) generally have the highest running costs. Renewable generators, like wind and solar farms, which do not require fuel, have an SRMC that is at, or close to, zero.

The design of the wholesale market is directed towards promoting competition between generators that leads to generator bids, and prices, which reflect those variable SRMCs. Although generators are permitted to offer electricity at any price (subject to a $14,700/MWh market price cap), the existence of competing offers by alternative plant owners normally constrains the prices that generators do bid.

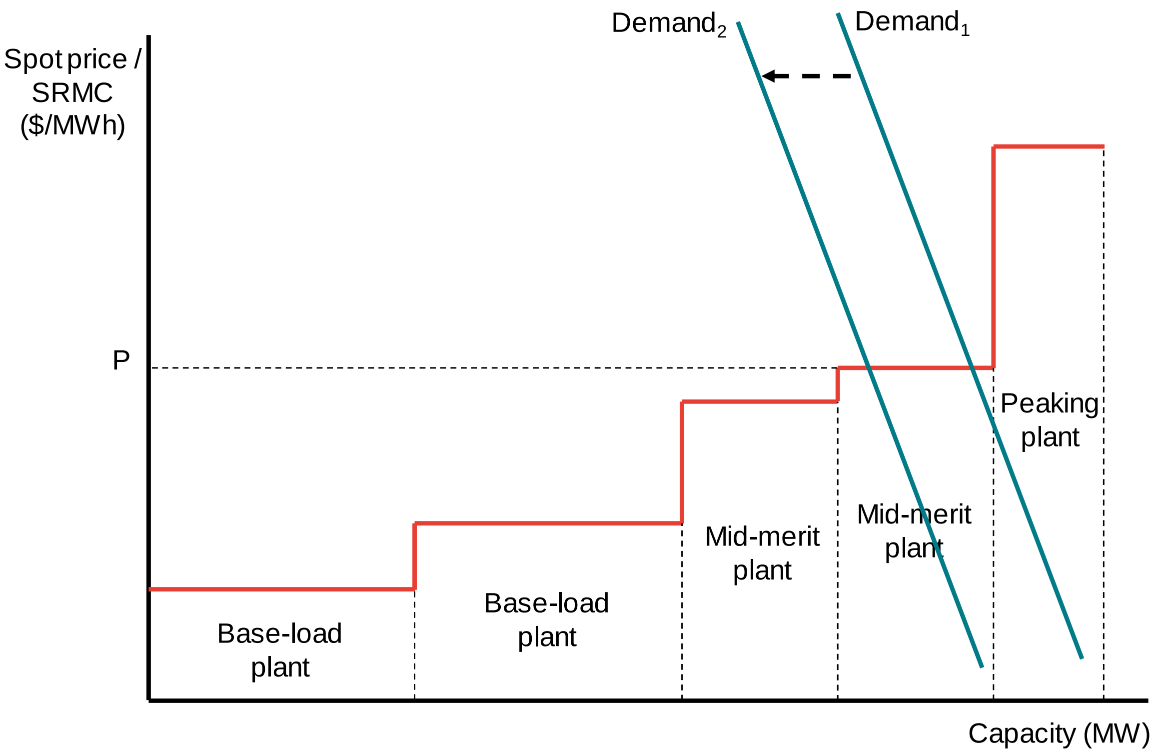
For example, a base load plant that bids substantially above its SRMC risks not being dispatched and being forced to incur the expense of shutting down and restarting its plant. For this reason, generators can *generally* be expected to offer to supply electricity to the market at a price that reflects their SRMC and are *generally* scheduled to run in line with their economic 'merit order'. The exception to this is during times of scarcity, i.e., when there is a possibility that existing generation capacity will not be able to meet demand. In this scenario, prices may rise above the variable SRMC of the marginal generator to reflect the additional cost of curtailing excess demand (to a maximum equal to the market price cap).

As a consequence of this market design, spot prices in the NEM generally reflect the average SRMC of the marginal generators that are dispatched in each trading interval.

Now, consider a scenario where constraints on solar exports are removed. Each unit of additional solar electricity exported to the grid is a unit of electricity that does not need to be produced by a NEM generator. As set out in **Figure 1** below, this decrease in demand for NEM generation leads to a shift in the demand curve. By being able to access solar exports that have an SRMC of zero, the total cost of generation falls; in this simple example the reduction in total cost is equal to the reduction in demand multiplied by the SRMC of the mid-merit plant whose generation is reduced. The *average* cost saving, therefore, is the SRMC of the mid-merit plant.

Because this mid-merit plant is the marginal generator (that is, the generator that sets the spot price) the average cost saving is equal to the spot price. As we explain further below, because the FiT was calculated to reflect the spot price at the time of solar generation, the FiT also directly reflects the fuel savings (and savings in other variable costs) that arise from the solar export. As such, the FiT is a reasonable proxy to use in calculating the value of solar generation.

Figure 1: High level illustration of wholesale market impact



Source: Frontier Economics.

2.2 Determining the value of solar exports

In our view, the benefit of relieving constraints on solar exports should be equal to the costs that will be avoided due to additional solar electricity exported to the grid. This should be assessed from a 'whole of market' perspective – that is, the focus should be on the costs that will be avoided by the National

Electricity Market (NEM), rather than by an individual participant in the NEM. This ensures that the cost benefit analysis is based on actual societal savings, rather than a redistribution of costs between different market participants.

We believe that the principle categories of cost savings that arise from additional solar exports are:

- **Avoided generation dispatch costs** – greater solar PV exports will reduce the volume of electricity required to meet consumer demand. This will in turn reduce the amount of electricity that wholesale generators are required to produce, leading to a saving equal to the SRMC of the grid sourced generation that is displaced as a result of the additional solar PV exports (which, as noted in the preceding section, is generally reflected in spot prices).
- **Avoided network losses** – as electricity flows through networks, a proportion of energy is lost due to electricity resistance and the heating of conductors. Rooftop solar PV panels are located closer to the point of consumption than utility-scale generators, so electricity exported from rooftop solar PVs is transported a shorter distance through electricity networks. It follows that an increase in rooftop solar PV exports would be expected to reduce network losses.
- **Environmental benefits** – greater solar PV exports will reduce the amount of electricity required to be generated by coal and gas fired plants in the NEM, thereby reducing the amount of greenhouse gas emissions that are produced in meeting electricity demand. If greenhouse gas emissions impose a cost on the economy, their avoidance reduces costs.[5]

As we will show in the next section, these benefit categories are captured by the FiT.

2.3 Overview of the Victorian feed-in tariff

Under the *Electricity Industry Act 2000*, the Essential Services Commission (ESC) is required to set the minimum FiT for small renewable generation for each financial year.

In its most recent determination for the year 2019-20, the ESC set both a flat and time-varying minimum FiT. The values are based on the ESC's assessment of the price that retailers avoid paying on wholesale electricity purchases when a small scale generator exports electricity to the grid. In other words, the FiT reflects the price a retailer would pay if the electricity provided by a small scale generator needed to be purchased from the NEM in 2019-20. It is comprised of the following:

- the avoided cost of purchasing electricity from the wholesale market, accounting for price changes throughout the day and seasonally, including:
  - avoided wholesale electricity purchase costs
  - avoided ancillary service charges and market fees
  - avoided value of network (distribution and transmission) losses
- avoided social costs of carbon and avoided human health costs.

A breakdown of the single rate FiT approved by the ESC is provided in **Table 1**.

[5] Over the longer term, there may be other benefits that arise from relieving constraints on solar exports. This includes, for instance, avoided transmission network investment costs, i.e., greater solar PV exports may remove (or at least delay) the need for additional augmentation or replacement investment in transmission electricity networks. If this occurs, it will give rise to cost savings equal to the net present value (NPV) of any avoided network and financing costs.

Table 1: Breakdown of the Victorian single rate FiT for 2019/20

COMPONENT	C/KWH
Forecast solar-weighted average wholesale electricity price	8.90
Avoided market fees and ancillary service charges	0.07
Value of avoided distribution and transmission losses	0.49
Value of avoided social cost of carbon	2.50
FiT rate	12.0

Source: ESC, Minimum electricity feed-in tariffs to apply from 1 July 2019 – Final Decision, 28 February 2019, p.28.

The solar-weighted average wholesale electricity price was forecasted by Frontier Economics based on historical relationships between solar PV exports and wholesale spot prices, but adjusted to account for expected prices of electricity in 2019/20 (based on the prices of futures contracts for 2019/20). It reflects the average wholesale price of electricity expected to be displaced when solar PV is generating. The key steps in determining the wholesale component of the FiT are set out in **Box 1** below.

Box 1: Estimating avoided generation dispatch costs for the FiT

Forecasting the wholesale price for the single rate minimum FiT involves five steps:

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

  The price level for 2019/20 is represented by the average prices of 2019/20 quarterly baseload future swaps (after adjusting for an assumed 5 per cent contract premium), weighted by traded volume over the 40-day period. For the purposes of calculating the FiT for 2019/20, we used average contract prices over 40 days to 18 January 2019.

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

  We used historical prices from Q4 2017 to Q3 2018, which at the time of our FiT report was the most recent four quarters from which both historical prices and solar export data was available.

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

  For each historical quarter (i.e. from Q4 2017 to Q3 2018), we calculated the average price for that quarter by taking a time-weighted average across all half-hourly prices. We then calculate the scaling factor for that quarter by dividing the relevant ASXEnergy price for the equivalent quarter by that time-weighted average price. For example, if the average price for the historical quarter Q3 2018 was $80/MWh, and the ASXEnergy price for Q3 2019 was $100/MWh, the scaling factor for Q3 would be 1.25.

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

  Each half-hourly price data identified in Step 2 was multiplied by the relevant scaling factor in Step 3. This provides forecasts of half-hourly prices for 2019/20. We also performed checks to confirm that these half-hourly prices would not exceed the NEM market price cap and floor, or the cumulative price threshold.

- **Step 5: Calculate a solar weighted average of forecast prices**

  We calculated a solar weighted average of the wholesale price forecasts determined in Step 4, by using forecasts of solar generation in Victoria provided by the ESC.

Source: Frontier Economics, Wholesale price forecasts for calculating minimum feed-in tariff: A report for the Essential Services commission, 4 February 2019, p.11-13.

In our view, the approach described in **Box 1** is consistent with what we consider to be best practice:

- The approach allows the correlation between half-hourly solar exports and half-hourly market prices to be maintained, so that the resulting FiT accurately reflects the relationship between the two.
- Price profiles have been scaled to meet future expectations of spot prices using ASXEnergy contract prices (adjusted for an assumed contract premium), which provides the best indicator of the market's view of future prices based on future expected demand and supply conditions.
- The approach is simple, transparent, and easily replicable.

2.4 Using the FiT as a proxy for the value of solar exports

In our opinion, the Victorian FiT represents a reasonable proxy for the value of relieving constraints on solar exports. To understand why, we consider each of the components of the FiT set out in **Table 1**.

Forecast solar-weighted average wholesale electricity price

As discussed, the FiT includes a component to account for avoided wholesale electricity price.

For the purposes of estimating the benefit of relieving constraints on solar exports, the wholesale benefit should be equal to the *costs* that will be avoided due to additional solar electricity exported to the grid. Specifically, the costs that are avoided are principally the fuel costs incurred by the marginal generators. Generation costs are avoided because solar PV exports reduce the volume of electricity required to meet demand, leading to a saving equal to the SRMC of the wholesale generation that is displaced as a result of the additional solar PV exports.

The methodology for calculating the ESC's single rate FiT is based on the weighted average wholesale electricity *price* at the time of solar PV exports.[6] Our view is that the weighted average wholesale electricity price at the time of solar PV exports will be a good proxy for the SRMC of grid sourced generation that is displaced as a result of the additional solar PV exports. As discussed in Section 2.1, the reason is that the wholesale electricity price at the time of solar PV exports represents the marginal offer to supply electricity to the NEM. As long as competition between generators drives generators to offer to supply electricity to the NEM at an offer price that is equal to their SRMC, the wholesale electricity price and the SRMC of the generation that is displaced as a result of additional solar PV exports will be the same; it will be the marginal generator (which sets the spot price) that will be the first generator displaced as a result of additional solar PV exports.

For this reason, our view is that the forecast solar-weighted average wholesale electricity price that is incorporated into the FiT is a good estimate of the average avoided cost of generation as a result of additional solar PV exports. This is not because the electricity price is itself determinative of changes in costs, but because the electricity price is a good proxy for the SRMC of the marginal generator. While there may be instances in which generators offer to supply electricity to the NEM at a price above SRMC, our view is that this does not invalidate the use of the forecast solar-weighted average wholesale electricity price as an estimate of the average avoided cost of generation as a result of additional solar PV exports. Indeed, given the complexity of estimating SRMC for a generator – which includes difficult conceptual and methodological issues and the practical issue of estimating key inputs – there will be estimation error using any approach to estimate the SRMC of the marginal generator. Our view is that drawing on actual pricing outcomes to inform an estimate of the average avoided cost of generation is a pragmatic approach and one that is likely to reflect the various technical and economic complexities that drive a generator's SRMC.

Avoided market fees and ancillary service charges

As discussed, the FiT includes a component to account for avoided market fees and ancillary service charges. These costs are determined by AEMO, and recovered from retailers (and generators) that purchase energy from the wholesale market.

For the purposes of calculating the FiT, market fees and ancillary services are counted because a retailer with customers that export solar PV reduces the payments it makes to AEMO for market fees and ancillary service.

However, for the purposes of determining the costs that will be avoided due to additional solar electricity exported to the grid, our view is that these should not be included. The reason is that it is not clear that the total cost to AEMO of operating the market (which are recovered through market fees), or the total cost to AEMO of procuring ancillary services, will be materially affected because of additional solar exports. While individual retailers may experience savings in the market fees and ancillary service

[6] The time of use FiT is based on the weighted average wholesale electricity *price* at the time of solar PV exports, the only difference being that export weighted average prices are separately calculated for each time-of-use period.

charges they are required to pay to AEMO from greater solar exports, the market as a whole will not necessarily experience a benefit.

For this reason, our view is that the forecasts of avoided market fees and ancillary services charges that is incorporated into the FiT do not represent avoided costs as a result of additional solar PV exports. However, we note that the category of avoided market fees and ancillary service charges is only a very small proportion of the total FiT (accounting for less than 0.6%). In our view, its inclusion in an estimate of the costs that will be avoided due to additional solar electricity exported to the grid will not materially affect AusNet Services' assessment of the benefit of its DER investment program.

Value of avoided distribution and transmission losses

As discussed, the FiT includes a component to account for avoided distribution and transmission losses. Avoided distribution and transmission losses represent additional generation that is avoided, and so represent a cost that will be avoided due to additional solar electricity exported to the grid for the same reasons that avoided generation costs do.

Value of avoided social cost of carbon

As discussed, the FiT includes a component to account for avoided social costs of carbon. Greater solar PV exports will reduce the amount of electricity required to be generated by coal and gas fired plants in the NEM, thereby reducing the amount of greenhouse gas emissions that are produced in meeting electricity demand.

In our view, if the avoided social cost of carbon is incorporated in the FiT then it is consistent for it to be incorporated in the benefit of relieving constraints on solar exports. The estimate of the generation costs that will be avoided due to additional solar electricity exported to the grid (as discussed above) does not include any cost associated with the carbon emissions that will be avoided due to additional solar electricity exported to the grid; the methodology for estimating this amount is based on the price (as a proxy for SRMC) of the marginal offer to supply the NEM. Under current policies, generators will not incorporate any cost of carbon in the price of their offers to supply the NEM; if there is a social cost of carbon, therefore, it is consistent to account for that as an additional cost that is avoided due to additional solar electricity exported to the grid.

2.5 Consistency with the RIT-D

In our view, use of the FiT as a proxy for the value of solar exports is not inconsistent with the RIT-D.[7] In particular, we make the following observations:

- The AER, in its RIT-D guideline, states that it will accept changes in fuel consumption arising through different patterns of generation dispatch as an additional benefit category.[8] Fuel costs are the largest component of a generator's SRMC. In our view, the wholesale component of the FiT provides a good estimation of the expected SRMC of the dispatched generation, and so any fuel cost savings that arise from an increase in solar exports. In saying this, we noted above that spot prices may, in certain cases, rise above the SRMC of the marginal generator. If the FiT reflects generator bids above SRMC then it may overstate the size of the fuel consumption savings.
- Clause 5.17.1(c)(4) of the NER states that an acceptable class of market benefit includes changes in electrical energy losses. This is explicitly captured by the avoided distribution and transmission losses component of the FiT.

[7] AER, *Applicable guidelines – Regulatory investment test for distribution*, December 2018.

[8] AER, *Applicable guidelines – Regulatory investment test for distribution*, December 2018, p.33.

- While the RIT-D does not explicitly mention environmental benefits, clause 5.17.1(c)(4) of the NER allows the AER to identify other classes of market benefits to be relevant for the purposes of applying the RIT-D. As discussed above, an increase in solar exports will reduce the amount of electricity that is generated by coal and gas fired plants, and therefore reduce greenhouse gas emissions. In our view, if there is a social cost to carbon, then it would be appropriate to include any reduction in greenhouse gas emissions as a market benefit under the RIT-D.

Since the RIT-D is focussed on 'whole-of-market' benefits, it does not include avoided market fees and ancillary service charges. We acknowledge that its inclusion in AusNet's assessment of the benefit of its DER investment program (by virtue of being included in the FiT) is not in line with the RIT-D. However, as noted above, this cost component is only a very small proportion of the total FiT and so is unlikely to materially affect AusNet Services' assessment.

2.6 Conclusion

We recognise that there are some limitations with using the FiT rate as a measure of the value of relieving constraints on solar exports. In particular:

- The FiT includes avoided market fees and ancillary service charges, which is not a market-wide cost saving as a result of additional solar PV exports. However, this is a small component of the overall FiT and could be removed for the purposes of valuing removed solar constraints.

- The FiT was determined in 2018 using futures prices available at that time, and historical price and export data available at the time – since the determination of the FiT, more recent historical price and export data is available, and more recent ASXEnergy futures prices are available, which would provide a more up-to-date view of the market's expectations of wholesale prices in the future. It is difficult to predict the level of the FiT in future. The approach used in estimating the FiT for the ESC relies in ASXEnergy futures prices, which only extend for a year or two. More generally, while greater investment in solar PV would be expected to result in lower prices during the day (and a lower FiT) there are a range of other factors that will also affect the FiT, including demand growth, generation retirements and investments and changes in fuel costs.

- The FiT is only a single year estimate – the FiT estimates the price that Victorian retailers may avoid paying on wholesale electricity purchases when a small scale generator exports electricity to the grid in 2019-20. However, the benefits of AusNet Service's DER program will only arise sometime after the start of the next regulatory period, which begins on 1 July 2021.

Notwithstanding these limitations, in the absence of detailed wholesale market modelling of expected demand and supply conditions in the NEM, which is complex and time-consuming, we believe that the FiT provides a reasonable estimate for the value of relieving constraints on solar exports.

3 REVIEW OF SAPN'S AVOIDED COST OF DISPATCH

The AER has noted that the price used by AusNet Services to determine the benefits of its DER program is relatively high compared to the value used by SAPN to assess the benefit of relieving constraints on solar exports in South Australia, which was about $50/MWh. The SAPN analysis was informed by a report prepared by HoustonKemp.[9]

In our view, there are a number of problems with the HoustonKemp methodology that bring into question the veracity of the results obtained. However, even putting these problems to one side, there are several factors which suggest that using the SAPN value would be inferior to using the Victorian FiT for the purpose of determining the benefit of AusNet Services' DER program. We explore these below.

3.1 Overview of HoustonKemp's analysis

HoustonKemp states that the value of additional distributed generation exports in a dispatch period is the marginal cost of grid-sourced generation that would otherwise be expected to generate in that dispatch period.[10] They note that these marginal costs of grid-sourced generation can be considered the dispatch costs saved by additional distributed generation, since they represent the generators that would have otherwise been called on to supply the market.[11]

For the avoidance of doubt, the way that HoustonKemp thinks about the value of additional distributed generation exports in a dispatch period is analogous to the way that avoided costs to retailers is calculated for the purposes of the FiT. HoustonKemp seeks to identify the cost of the marginal generator at times of solar PV export, while the FiT is based on the spot price at the times of solar PV export. In the NEM, the spot price is equal to the offer of the marginal generator and that offer is likely to reflect the SRMC of the generator.

However, the methodology that HoustonKemp uses to estimate the value of additional distributed generation exports in a dispatch period is quite different from the methodology use to estimate the FiT. The methodology that HoustonKemp uses for this purpose is summarised in **Box 2**.

9 HoustonKemp Economists, *Estimating avoided dispatch costs and the profile of VPP operation – a methodology report*, 9 January 2019 (hereafter referred to as the 'HoustonKemp report').

10 HoustonKemp report, p.8.

11 HoustonKemp report, p.8.

Box 2: Overview of HoustonKemp's methodology for estimating avoided dispatch costs

- For the 2017 base year, identify the generators that were marginal (price setters) at each five-minute (dispatch) interval in South Australia.
- Calculate the projected marginal costs for each of these generators ($/MWh), for each year to 2035, based on assumed heat rates, fuel prices and variable opex forecasts.
- Assign sequential blocks of dispatch intervals with similar marginal costs to notional 'generator categories', approximately based on fuel type of marginal generator.
- Derive profiles for the marginal cost of generation for each generator category and dispatch interval for each year to 2035, based on two scenarios:
  - Scenario 1: where the mix of marginal generators continues to reflect that in 2017
  - Scenario 2: where the mix of marginal generators changes over the period.
- Adjust the estimated marginal cost profiles for the projected uptake of future increases in solar PV in South Australia.
- Aggregate the marginal cost profiles by computing the average marginal cost per year for each scenario, weighted by a solar PV profile.

Source: HoustonKemp Economists, Estimating avoided dispatch costs and the profile of VPP operation – a methodology report, 9 January 2019, p.8.

3.2 Shortcomings with the HoustonKemp methodology

HoustonKemp attempts to model the marginal cost of displaced grid sourced generation. In principle, this is the same type of cost modelled under the avoided wholesale cost component of the Victorian FiT (albeit for South Australia, rather than Victoria). That is, both approaches are trying to estimate the same type of cost. However, in our view, there are several problems with the approach used by HoustonKemp which bring into question the robustness of its estimates.

Under its Scenario 1, HoustonKemp assumes that the mix of marginal generators will remain constant over time, and will be the same as the mix of marginal generators in 2017. However, this approach won't account for expected changes in the generation mix over time. In particular, the mix of generation technologies in the NEM is expected to change as a result of factors including asset retirement and investment (including driven by changes in technology), and the mix of marginal generators in the NEM can additionally be expected to change as a result of changes in fuel costs, operating costs, demand and government policy (e.g., environmental targets).

Under its scenario 2, HoustonKemp does consider changes in the mix of marginal generators over time. The profiles of marginal generation are purported to be informed by AEMO's ISP forecast generation mix, and assumptions on future additional interconnection and increased renewable generation. However, the assumptions underpinning HoustonKemp's analysis are either unknown or unsupported. In particular, we make the following observations:

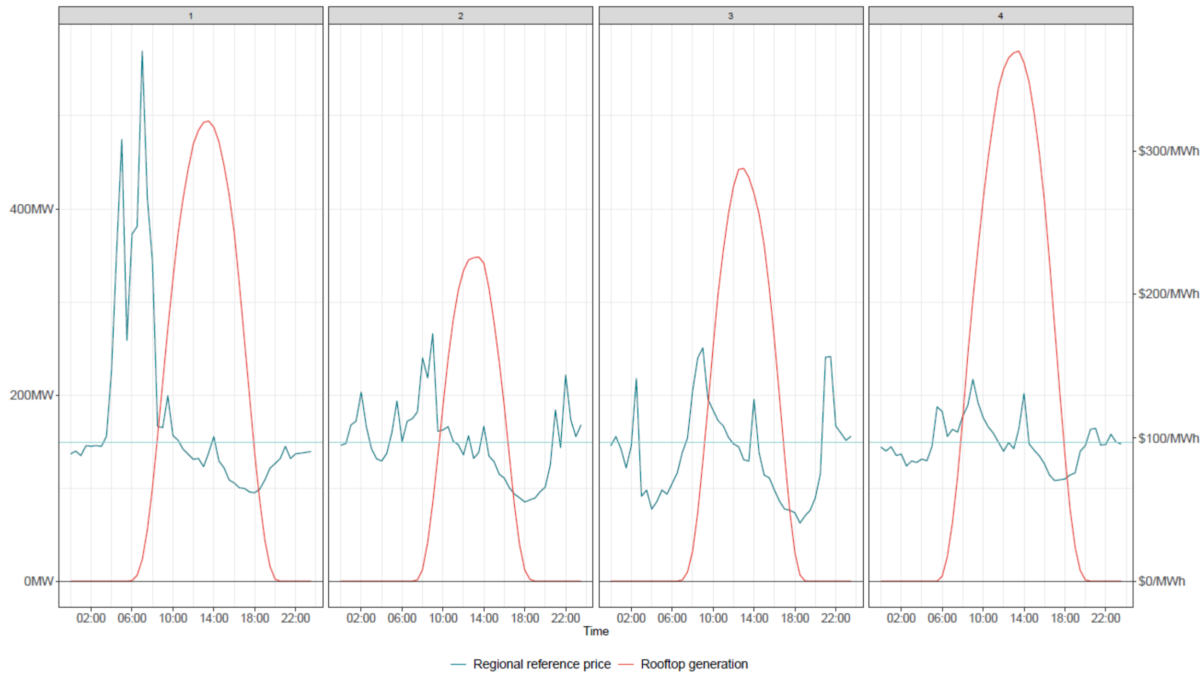
- HoustonKemp states that its analysis was 'informed by AEMO's ISP forecast generation mix, but not directly derived from it' – however, it does not specify how the AEMO data was used or modified to inform their scenarios, or any assumptions that were made as part of this analysis. Nor does it specify how forecast changes in generation mix are used to forecast changes in the mix of marginal generators.

- HoustonKemp notes that it has accounted for ‘the impact of future additional interconnection’ – however, it does not specify which NEM jurisdictions will be interconnected, the estimated capacity of the interconnections, or when the interconnections are expected to be operational.
- HoustonKemp states that it has taken into account changes in the SRMC of generation over time – however, they have provided no indication of their forecasts of heat rates, fuel prices and variable operating costs that feed into their SRMC calculations.
- HoustonKemp has made assumptions around the forecast uptake of grid scale solar – however, it has provided no justification for the uptake scenarios that were provided, nor any explanation as to why these scenarios would represent efficient investment in solar generation over the period.

In the absence of further information on the assumptions that HoustonKemp has adopted, it is not possible to conclude that its results are robust.

Notwithstanding this, the magnitude of the difference between HoustonKemp’s forecast outcomes for 2018 and actual observed wholesale market outcomes in that year suggest that there are fundamental problems with its approach. In particular, HoustonKemp estimates the average avoided dispatch cost for solar exports in 2018 in South Australia as $50.15/MWh. However, we calculate the *actual* average solar weighted wholesale price in 2018 in South Australia as $96.70/MWh, which is substantially higher than (almost double) the estimate provided by HoustonKemp. The results of our analysis are set out in **Figure 2**, and explained in more detailed in **Appendix A**.

Figure 2: Average solar weighted wholesale price in 2018 in South Australia



Source: Frontier Economics analysis of AEMO data

3.3 Other limitations with using SAPN’s benefit estimate

There are several other factors to suggest that the value used by SAPN would be inferior to the Victorian FiT for the purpose of estimating the expected benefit of AusNet Services’ DER program.

First, the SAPN value only captures the benefit from avoided dispatch costs, and does not include any other relevant benefit from relieving constraints on solar exports. As noted in section 2.1, other relevant benefit categories include avoided network losses and avoided environmental costs. The existence of other benefits in addition to avoided dispatch costs, and hence the conservative nature of the value used in its analysis, was recognised by SAPN in its submission to the AER:[12]

> *The RIT guidelines allow for consideration of certain other benefits such as avoided transmission costs, the impact of avoided or deferred investment in new generation and reduction in network losses. Our analysis does not seek to quantify these additional benefits… Within the limits of the modelling, we consider, therefore, that the market benefits quantified in the analysis are conservative, and more likely to understate the actual value than to overstate it.*

For this reason, we believe the value used by SAPN likely underestimates the true benefit from removing solar constraints in South Australia.

Second, the SAPN value is based on expected electricity market outcomes in South Australia and is not applicable to Victoria. The benefits of relieving constraints on solar exports are unlikely to be the same in all jurisdictions in the NEM. The value of this benefit will vary as a result of differences in generation profiles, transmission constraints and solar PV export profiles, which lead to different marginal generators and hence spot prices in between jurisdictions. In our view, any analysis of avoided dispatch costs from AusNet's DER program must be made with reference to expected wholesale market outcomes in Victoria, and there is no basis to say that these outcomes are likely to be the same as those in South Australia.

[12] SAPN, 5.*18 – LV Management Business Case*, 25 January 2019, p.19.

A CALCULATION METHODOLOGY

This appendix summarises our approach to calculating the historical avoided cost of dispatch of rooftop solar PV in South Australia for 2018.

The data necessary for this analysis was:

- South Australian electricity prices on a half hourly basis for 2018[13]
- rooftop solar PV generation on a half hourly basis for 2018.[14]

Combining these datasets gives 17,520 datapoints (number of half hours in a typical year) for calendar year 2018, with each point having a value for the South Australian regional reference price as well as the corresponding South Australian rooftop PV generation. This was then used to calculate an output weighted price of rooftop PV for calendar year 2018 using the formula below:

$$OWP = \frac{\sum_{i=1}^{17520} RRP_i * Output_i}{\sum_{i=1}^{17520} Output_i}$$

Where

RRP_i = Half hourly wholesale price

$Output_i$ = Half hourly gross solar generation.

This provides an average avoided cost of solar PV in 2018 in South Australia of $96.70/MWh.

13 Obtained from AEMO: http://nemweb.com.au/Reports/Archive/Public_Prices/

14 Obtained from AEMO: http://nemweb.com.au/Reports/Archive/ROOFTOP_PV/

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