Queensland Competition Authority

Final report

Request for advice: Time-varying solar price for regional Queensland for 2017–18

July 2017

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Contents

THE ROLE OF THE QCA—TASK, TIMING AND CONTACTS

The Queensland Competition Authority (QCA) is an independent statutory body that promotes competition as the basis for enhancing efficiency and growth in the Queensland economy.

The QCA's primary role with respect to electricity pricing is to set regulated retail electricity prices in accordance with the requirements of a delegation from the Minister for Energy, Biofuels and Water Supply (the Minister) and the *Electricity Act 1994* (the Electricity Act).

Under section 253AA of the Electricity Act, the Minister may give the QCA a written direction to provide information or advice on any matter related to the Queensland electricity market. This final report provides advice in response to a Direction from the Minister, pursuant to section 253AA (**Appendix A**).

Key dates

Release of draft report	9 June 2017
Submissions on draft report due	30 June 2017
Release of final report	no later than 28 July 2017

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1 INTRODUCTION

The Queensland Competition Authority (QCA) has received a Direction from the Minister for Energy, Biofuels and Water Supply (the Minister) to provide advice on the matters outlined below to inform a time-varying solar price.

The Direction specifies that for the period from 1 July 2017 to 30 June 2018, the QCA is to calculate and report on Queensland spot wholesale electricity pool price values under a range of different time periods, calculate a price build-up and illustrate the impacts and outcomes of different peak and off-peak periods to inform solar customers' understanding.

1.1 Minister's Direction notice

On 21 May 2017, the Minister directed the QCA under section 253AA of the Electricity Act, to provide advice to inform a time-varying solar price for regional Queensland for 2017–18.

The Direction requires the QCA to calculate Queensland spot wholesale price values, for each of the peak time periods below, and corresponding off-peak periods covering the remaining hours of the day.[1] The peak time periods to be calculated are:

- a peak period not less than two hours which provides the highest wholesale energy value when solar photovoltaic (PV) is generating
- a period not less than two hours which reflects the highest electricity demand on the Ergon Energy network
- a peak period from 5 pm to 7 pm
- a peak period from 4 pm to 7 pm
- a peak period from 3 pm to 7 pm.

The Direction also requires the QCA to calculate a build-up in cents per kilowatt hour (c/kWh) of peak and off-peak values which include:

- the wholesale values calculated above
- energy losses for Ergon Energy's east pricing zone
- National Electricity Market (NEM) and ancillary services fees.

The QCA is to provide an illustration of the impacts and outcomes of the different peak and off-peak periods to inform solar customers' understanding. The Direction notice specifies that this must include presenting each of the potential peak and off-peak periods against a typical solar generation profile for a relevant location covered by the Ergon Energy network.

1.2 Background

For each of the past four tariff years[2], the QCA has been directed by the Minister to set a solar feed-in tariff for regional Queensland.[3] The latest solar feed-in tariff Direction (for 2017–18),

[1] That is, the peak and off-peak periods jointly cover 24 hours each day.
[2] 2014–15, 2015–16, 2016–17 and 2017–18.

indicated that, in determining the flat feed-in tariff, the QCA should use the same general methodology applied for the 2014–15, 2015–16 and 2016–17 tariff years and consider the following additional matters:

- the effect of the feed-in tariff on competition in the Queensland retail electricity market
- the arrangements in place for Origin Energy to provide retailer services to Queensland customers connected to the Essential Energy supply network in southern Queensland
- any other matter it considers relevant.

Our decision on the 2017–18 flat rate feed-in tariff was released on 31 May 2017. This provided for an increase of around 35 per cent on the 2016–17 flat rate feed-in tariff of 7.448 c/kWh. The increase was driven primarily by increases in wholesale energy costs. The final flat rate feed-in tariff price for 2017–18 was set at 10.102 c/kWh.

Prior to the QCA's solar feed-in tariff price determinations, solar feed-in tariff prices were determined under the Queensland Solar Bonus Scheme (the Scheme), which was closed to new customers on 30 June 2014.

The Scheme is a Queensland Government policy administered by the Department of Energy and Water Supply (DEWS). The Scheme pays eligible customers a prescribed feed-in tariff for surplus electricity generated from small-scale solar PV systems and exported to the Queensland electricity grid.

In the past, the Scheme operated with two feed-in tariff amounts:

- 44 c/kWh—this is legislated to end on 1 July 2028
- 8 c/kWh—this ended on 30 June 2014, replaced by the mandatory feed-in tariff for regional Queensland, as described above.

1.3 Consultation

The Minister's Direction instructs the QCA to consult with Ergon Energy Queensland on the calculation of the wholesale values, and to undertake public consultation on the timing of the peak and off-peak periods.

Based on the public consultation process, the QCA is to report to Government on which periods are preferred by stakeholders.

The QCA has consulted with Ergon Energy Queensland in establishing the inputs used by ACIL Allen Consulting (ACIL) to estimate the spot wholesale electricity pool price values. Ergon Energy Queensland has also provided data on network system loads and PV generation profiles, which were applied in the calculations and analysis described in Chapters 3 and 4 of this final report.

Draft report

On 9 June 2017, the QCA released its draft report. In accordance with the Direction, we sought submissions on the timing of the peak and off-peak periods. Submissions were invited by 30 June 2017.

[3] The solar feed-in tariff is available to small customers in regional Queensland with grid-connected PV systems not exceeding 5 kilowatt (kW) capacity. The Queensland Government has indicated an intention to increase the maximum capacity to 30 kW during 2017.

One submission, from the Australian Energy Council (AEC) was received. The AEC's comments are considered in the following chapters of this report.

1.4 Consultant's advice

To assist with the calculation of spot wholesale electricity price values, and the build-up of peak and off-peak values, the QCA engaged ACIL to provide expert advice.

ACIL has provided two reports to inform this final report, both of which are available on the QCA's website.[4,5] (www.qca.org.au).

[4] ACIL Allen 2017b.
[5] ACIL Allen 2017c.

2 METHODOLOGY FOR CALCULATIONS

The Direction indicates that the QCA should calculate spot wholesale electricity pool price values for each of the peak and off-peak periods identified, and calculate a build-up of peak and off-peak values including:

- wholesale cost of energy
- energy losses for Ergon Energy's east pricing zone
- NEM and ancillary services fees.

This chapter describes the methodology for calculating each of these inputs.

2.1 Time periods

The Direction outlines five different scenarios, which are summarised in Table 1 below. Some specific assumptions were required in determining the appropriate peak and off-peak time periods for Scenario 1 and Scenario 2. These assumptions are explained below.

The methodology used to estimate spot wholesale electricity pool price values is described in Section 2.2.

A number of the variables applied in the scenarios described below vary seasonally. While calculating values on a seasonal basis would not be inconsistent with the Direction, we considered that the specificity with which each of the scenarios was described in the Direction suggests that the intention was not for the QCA to complicate them further. Should the Government adopt a time-varying solar price, it might wish to examine whether seasonally varying either the time-period or rate would deliver a material net benefit, noting the additional complexity that would be required to implement such an approach.

Table 1 Scenarios

	Peak	***Off-peak***
Scenario 1 (a peak period not less than 2 hours which provides the highest wholesale energy value when solar PV is generating)	5 pm–7 pm	All other times
Scenario 2 (a period not less than 2 hours which reflects the highest electricity demand on the Ergon Energy network)	6 pm–8 pm	All other times
Scenario 3	5 pm–7 pm	All other times
Scenario 4	4 pm–7 pm	All other times
Scenario 5	3 pm–7 pm	All other times

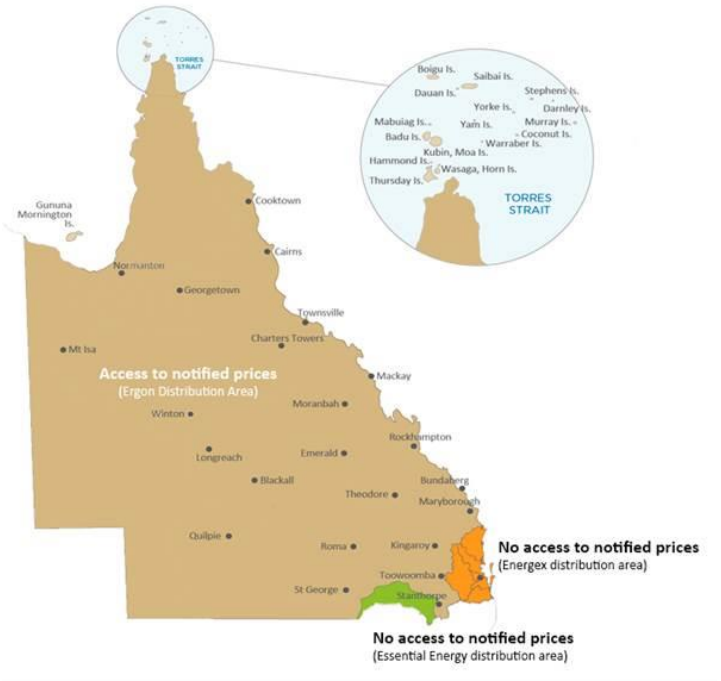
Note: The identification of the time periods for Scenario 1 and Scenario 2 is discussed below.

Scenario 1—solar PV generation timeframe

The Direction describes Scenario 1 as being: 'a period not less than 2 hours which provides the highest wholesale energy value when solar PV is generating.'

The Ergon Energy distribution area, as shown in Figure 1, covers a large geographical area—more than a million square kilometres.[6]

Figure 1 Ergon Energy distribution area



Source: Ergon Energy 2016, p. 15.

Opportunities for generating solar energy vary across the distribution area, depending on the time of year (by between 20 minutes and an hour). To approximate when solar PV is generating for the purpose of calculating the peak period for Scenario 1, we have adopted the earliest sunrise and latest sunset as the bounds within which to assess the greatest value of solar PV energy to customers.

Based on the Ergon Energy distribution area, we selected a list of towns across the area and compared the earliest sunrise and latest sunset estimates for 2017–18 (see Table 2). As the spot wholesale electricity pool prices in ACIL's model (below) are calculated hourly, we have rounded the earliest sunrise time up to the nearest hour and the latest sunset time down to the nearest hour.

On this basis, we identified the earliest sunrise as 5 am (4.47 am rounded to 5.00 am) and the latest sunset as 7 pm (7.29 pm rounded to 7.00 pm). The identification of these time period bounds for Scenario 1 is discussed further in ACIL's original report.[7]

[6] Ergon Energy 2016, p. 5.
[7] ACIL Allen 2017b, pp. 4–7.

Table 2 Sunrise and sunset times

Location	*Earliest sunrise*	*Latest sunset*
Mount Isa	5.52 am	7.29 pm
Winton	5.35 am	7.18 pm
Cunnamulla	5.13 am	7.18 pm
Stanthorpe	4.47 am	7.55 pm
Hervey Bay	4.50 am	7.44 pm
Mackay	5.13 am	7.51 pm
Cairns	5.34 am	7.57 pm
Emerald	5.12 am	7.59 pm
Solar PV generation interval	**4.47 am**	**7.29 pm**

Source: Geoscience Australia 2017

As part of its calculation of spot wholesale electricity price values for the 2017–18 tariff year, ACIL analysed a series of market simulations and calculated the distribution of annual price outcomes (ACIL's methodology for this is discussed further below).

ACIL's analysis of the simulations indicated that defining the peak period as 5 pm to 7 pm provides the highest wholesale energy value for a period of not less than two hours when solar PV is generating.[8]

The QCA has accepted ACIL's advice that a peak period of 5 pm to 7 pm is the most appropriate period to use for the purposes of Scenario 1. We note this means that Scenario 1 is then defined to be the same as Scenario 3.

Scenario 2—highest demand on the Ergon Energy network

The Direction describes Scenario 2 as being: 'a period not less than 2 hours which reflects the highest electricity demand on the Ergon Energy network.'

For the Ergon Energy distribution network area, we had the option of using either the net system load profile (NSLP) or system load. System load reflects the total demand on the Ergon Energy distribution network, by all users. The NSLP reflects the electricity consumed by accounts with accumulation meters (i.e. Type 6 meters[9], e.g., small businesses and households) and consumption from unmetered sources (i.e. streetlights).

The Direction did not identify whether we ought to use the system load or the NSLP in determining when electricity demand is the highest. We note that we have used the NSLP in setting the flat rate feed-in tariff for regional Queensland in the past. However, we consider that as the system load reflects total demand, and the Direction refers to the highest electricity demand on the Ergon Energy network, the system load will best match the requirements of this scenario.

The data on system load provided by Ergon Energy Queensland indicated that the appropriate time period to use for this scenario was 6 pm to 8 pm; we have therefore selected this period to

[8] ACIL Allen 2017b, p. 13.

[9] Type 6 meters are 'general purpose' or 'accumulation' meters that record accumulated energy data only—this means data is collected at an aggregated level and not at an interval level.

apply to Scenario 2. The selection of this time period is discussed further in ACIL's original report.[10]

2.2 Spot wholesale electricity pool prices

The Direction requires that, for each of the five scenarios described above, the QCA calculate the spot wholesale electricity pool price values for the 2017–18 tariff year.

The spot wholesale electricity pool price is different to the avoided cost of wholesale energy figure that the QCA has used to calculate the regional solar feed-in tariff in the past.[11] Spot values refer to the price for wholesale electricity at a specific point in time. As the NEM is settled in 30-minute intervals, this means there are 48 different spot prices determined each day. The spot wholesale pool price reflects the actual price that generators receive for producing a unit of energy.

To estimate the Queensland spot wholesale electricity pool price values, we engaged ACIL to provide expert advice. ACIL has informed the QCA's electricity determinations since 2010–11 and has estimated the avoided wholesale energy cost for each of our past four solar feed-in tariff determinations. ACIL has also provided a range of advice to government agencies in Victoria and South Australia on the appropriate way to compensate owners of distributed generators—most recently, on the value of distributed generation as an input into the Victorian Essential Services Commission's inquiry into the true value of distributed generation.

For the purposes of the draft report, ACIL used its stochastic demand model and stochastic outage model to develop:

- 46 weather-influenced simulations of hourly demand traces for 2017–18 (using temperature data from 1970–71 to 2015–16 and demand data from 2011–12 to 2015–16)
- 11 hourly power station availability simulations.

ACIL then applied its proprietary electricity model (PowerMark) to run 506 simulations of hourly pool prices for 2017–18 in the NEM, using the stochastic demand traces and power station availabilities as inputs. ACIL's PowerMark model simulates generator behaviour in the NEM based on a set of generator bidding, demand, weather and power station availability scenarios.[12] ACIL has used the system demand data profile provided by Ergon Energy Queensland to inform its estimates of demand (this data was provided as part of the QCA's consultation with Ergon Energy Queensland).

Each simulation consists of 8,760 hourly wholesale electricity spot prices in chronological order (from the hour beginning at midnight 1 July 2017 to the hour beginning at 11 pm on 30 June 2018).

In its original report, ACIL found that modelled prices ranged from a low of $64.47 per megawatt hour (MWh) to a high of $141.39/MWh. Compared to prices from the past 16 years, ACIL's simulations covered a wide range of potential prices for 2017–18.[13] ACIL considered that, although the lower part of the distribution of simulated outcomes sits above a number of the

[10] ACIL Allen 2017b, pp. 7–8.
[11] The avoided cost of wholesale energy reflects the expense that electricity retailers avoid when they use energy generated by small-scale solar generators.
[12] See ACIL Allen 2014, pp. 33–36 for a more detailed discussion of ACIL's PowerMark model and its use for simulating wholesale price values.
[13] ACIL Allen 2017b, p. 10.

actual outcomes (particularly for the earlier years of the market)[14], changes to energy supply and demand that have occurred over the last 16 years could reasonably be expected to have increased the lower bound of annual price outcomes. ACIL was satisfied that, in an aggregate sense, the distribution of the 506 simulations for 2017–18 cover an adequately wide range of possible annual pool price outcomes.[15]

From within the range of simulations carried out, ACIL recommended that we adopt the risk-weighted average spot price. Simply put, for each hour, the risk-weighted average spot price is a simple average of the pricing outcomes from the 506 simulations. This approach takes an unbiased view of the influence of short-term stochastic influences—that is, random events like weather-driven demand and renewable generation coupled with power station availability (hence the description 'risk-weighted').

The key findings of the simulations were detailed in ACIL's original report.[16] The report shows the mean Queensland spot wholesale electricity pool prices for 2017–18 (i.e. the simple average of the risk-weighted average spot price from ACIL's 506 simulations).[17]

The QCA's calculation of the wholesale spot values for scenarios described above are shown in Chapter 3.

2.3 NEM and ancillary services fees

The Direction instructs the QCA to estimate NEM participation and ancillary services fees, and to include them in the build-up of peak and off-peak values.

NEM participation fees are levied on retailers by the Australian Energy Market Operator (AEMO) to cover the costs of operating the NEM. Ancillary services charges cover the costs of the services used by AEMO to manage power system safety, security and reliability.

For the purposes of this exercise, we have used the NEM and ancillary services fees recently estimated by ACIL when calculating regulated retail electricity prices for 2017–18 (see Table 3). There have been small increases in these costs since the 2016–17 feed-in tariff was set.[18]

Table 3 NEM and ancillary services fees for 2017–18

	c/kWh
NEM participation fees	0.053
Ancillary services fees	0.034
Total	**0.087**

Source: ACIL Allen 2017a.

2.4 Energy losses

The Direction instructs the QCA to estimate energy losses for Ergon Energy's east pricing zone, and to include them in the build-up of peak and off-peak values. We have estimated energy losses, and included the *value* of these energy losses in the build-up, as we believe that was the intent of the Direction.

[14] ACIL Allen 2017b, p. 10. See Figure 4.2 and discussion in text.
[15] ACIL Allen 2017b, p. 10.
[16] ACIL Allen 2017b, pp. 10–15.
[17] ACIL Allen 2017b, p. 12. See particularly Figure 4.4.
[18] ACIL Allen 2017a.

For the purposes of this advice, we have adopted the loss factors for Ergon Energy's east pricing zone used in our final determination on 2017–18 regulated regional electricity prices. These loss factors reflect the estimated weighted-average transmission losses for the Ergon Energy east pricing zone and distribution loss factors published by AEMO. The relevant loss factors were calculated by ACIL as part of its earlier advice regarding the 2017–18 regulated prices[19], and incorporated into its report for this time-varying solar price matter.[20]

The distribution loss factor is multiplied by the transmission marginal loss factor to arrive at the total combined loss factor (CLF) for the region. The loss factors we have applied are set out in Table 4.

Table 4 Loss factors—Ergon Energy's east pricing zone, 2017–18

	Loss factor
Transmission marginal loss factor	0.985
Distribution loss factor	1.096
Combined loss factor (CLF)	**1.079**

Note: For presentation purposes, figures in the table have been rounded from the figures originally reported by ACIL. Therefore, the CLF does not multiply exactly.

Source: ACIL Allen 2017a.

The calculation of the *value* of losses then depends on the spot wholesale electricity values for each scenario described earlier. The calculated values of losses are provided in Chapter 3.[21]

[19] ACIL Allen 2017a, pp. 31–32.
[20] ACIL Allen 2017b, p. 8.
[21] The calculated values of losses provided in Chapter 3 do not multiply exactly due to rounding.

3 CALCULATIONS

Based on the Terms of Reference in the Direction, the QCA is required to calculate:

- Queensland spot wholesale electricity pool price values for each of the peak, and corresponding off-peak, periods associated with the scenarios described earlier
- a build-up of peak and off-peak values (in c/kWh), including the wholesale values, energy losses and NEM and ancillary services fees.

In each case, we have undertaken the calculations in accordance with the methodology and inputs described in Chapter 2. The calculations and methodology are also discussed further in ACIL's original and final reports.[22]

Both our draft and final estimates of these values are provided below.

3.1 Queensland spot wholesale electricity price values

3.1.1 Draft report values

The Queensland spot wholesale electricity pool prices for the 2017–18 tariff year that we calculated for our draft report are shown in Table 5.

The values calculated are the forecast peak and off-peak prices for each of the scenarios outlined in the Direction, and described in greater detail earlier in this report.

Table 5 Spot wholesale electricity pool price values (c/kWh)—Draft

Peak period definition	*Peak price*	*Off-peak price*
Scenario 1—not less than 2 hours which provides the highest wholesale energy value when solar PV is generating (i.e. from 5 pm to 7 pm)	18.344	7.313
Scenario 2—not less than 2 hours which reflects the highest electricity demand on the Ergon Energy network (i.e. from 6 pm to 8 pm)	16.348	7.495
Scenario 3—from 5 pm to 7 pm	18.344	7.313
Scenario 4—from 4 pm to 7 pm	17.020	6.977
Scenario 5—from 3 pm to 7 pm	15.362	6.807

Note: Totals may not add due to rounding.

Source: ACIL Allen 2017b; QCA calculations.

3.1.2 Submission

In its submission, the AEC highlighted that immediately prior to the release of the draft report, the Queensland Government published its strategy to guide the state through its short and long-term energy challenges: the *Powering Queensland Plan* (the Plan). The AEC noted that the

[22] ACIL Allen 2017b; ACIL Allen 2017c.

Plan directs Stanwell Corporation (Stanwell) to 'undertake strategies to place downward pressure on wholesale prices.'[23]

The AEC also noted that, as the contract market in Queensland is in 'backwardation', and therefore future year prices are expected to be lower, it is plausible that prices in the first half of 2018 will be reduced. It added that this is particularly likely given the conclusions of AEMO's recent *Energy Supply Outlook*, which proposes that the supply–demand balance is not as bad as originally projected.

The AEC concluded that a review of wholesale pricing estimates prior to the QCA's final report is required.

3.1.3 QCA response

While we note that the Direction does not specifically require an update of the wholesale pool price estimates between the draft and final reports, we considered the AEC's request on its merits, and determined that some supply-side assumptions underpinning the values calculated for the draft report had changed.

On that basis, we asked ACIL to remodel the spot wholesale electricity price values in order to determine whether those changed supply-side assumptions would have a significant impact on the estimates. ACIL's remodelled values are contained in its updated report.[24]

In its updated report, ACIL advised that the following supply-side changes could affect wholesale electricity pool price values (in addition to the Government's instruction to Stanwell):

- the Swanbank E 385 megawatt (MW) gas-fired power station to resume service from January 2018
- several solar and wind farm projects are now expected to be fully commissioned early in 2018[25]
- an update in the uptake of rooftop PV (only a minor change).

On the demand side, ACIL reported that the updated demand forecasts AEMO released in its most recent *Energy Supply Outlook* suggest that Queensland's peak summer and winter demand for 2017–18 are likely to be between 300 MW and 600 MW lower than previously projected.

The updated supply-side changes (as described in the above three dot points) and demand forecasts (as per AEMO's *Energy Supply Outlook*), for Queensland and other NEM regions, have been adopted in ACIL's updated modelling.[26]

ACIL did not specifically alter its assumptions to reflect the Queensland Government's direction to Stanwell to 'undertake strategies to place downward pressure on wholesale prices.' ACIL said 'It is unclear at this stage what these strategies may be, and to what extent they may impact on price outcomes.'[27]

Given these changes in the modelling assumptions, the updated Queensland spot wholesale electricity pool prices for the 2017–18 tariff year are shown in Table 6.

[23] Australian Energy Council 2017, p. 2.
[24] ACIL Allen 2017c.
[25] For a complete list, see ACIL Allen 2017c, p. 3.
[26] ACIL Allen 2017c.
[27] ACIL Allen 2017c, pp. 3–4.

Table 6 Spot wholesale electricity pool price values (c/kWh)—Final (updated)

Peak period definition	*Peak price*	*Off-peak price*
Scenario 1—not less than 2 hours which provides the highest wholesale energy value when solar PV is generating (i.e. from 5 pm to 7 pm)	14.749	7.057
Scenario 2—not less than 2 hours which reflects the highest electricity demand on the Ergon Energy network (i.e. from 6 pm to 8 pm)	13.018	7.214
Scenario 3—from 5 pm to 7 pm	14.749	7.057
Scenario 4—from 4 pm to 7 pm	13.770	6.830
Scenario 5—from 3 pm to 7 pm	12.523	6.732

Note: Totals may not add due to rounding.

Source: ACIL Allen 2017c; QCA calculations.

Table 6 shows that the Scenario 1 (5 pm to 7 pm) peak price provides the highest peak price, and that by extending this definition to include 4 pm and 3 pm progressively decreases the peak price.[28]

Comparing Table 5 and Table 6, it is clear that the biggest change between our draft and final reports is to the peak prices. ACIL reported that the lower peak demands forecast by AEMO and the return of Swanbank E assumed in the updated analysis reduce price volatility (i.e. high peak prices) far more than uniformly reducing prices across all hours of the year.

Overall, the analysis indicates material decreases in all of the peak period values (of between approximately 18 per cent and 20 per cent) and much smaller decreases in all of the off-peak values (less than 4 per cent).

3.2 Build-up of peak and off-peak values

Based on the wholesale values above, and the energy loss factors and NEM and ancillary services fees values described in Chapter 2, we have calculated a build-up of peak and off-peak values for each scenario (consistent with the Direction).

The build-up of these values for the 2017–18 tariff year is shown in Table 7 (draft report) and Table 8 (final report) below.

The decrease in losses between the draft and final reports reflects the application of the same loss factor to a smaller base.[29] Overall, in the updated final analysis, values in the peak periods, across the various definitions, have fallen by between three and four cents per kWh.

As with the wholesale pool price values, the updated values are materially lower than the original values for each of the peak periods, with the difference being much smaller for each of the off-peak periods.

[28] ACIL Allen 2017c, p. 6.

[29] The base being the spot wholesale electricity pool price values (Table 6).

Table 7 Build-up of peak and off-peak values (c/kWh) — Draft

	Scenario 1		*Scenario 2*		*Scenario 3*		*Scenario 4*		*Scenario 5*	
	Peak	***Off-peak***	***Peak***	***Off-peak***	***Peak***	***Off-peak***	***Peak***	***Off-peak***	***Peak***	***Off-peak***
Spot wholesale electricity pool price	18.344	7.313	16.348	7.495	18.344	7.313	17.020	6.977	15.362	6.807
Value of energy losses	1.456	0.585	1.298	0.599	1.456	0.585	1.351	0.558	1.220	0.545
NEM and ancillary services fees	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
Build-up	**19.887**	**7.985**	**17.733**	**8.181**	**19.887**	**7.985**	**18.458**	**7.622**	**16.669**	**7.438**

Note: Totals may not add due to rounding.

Source: ACIL Allen 2017b; QCA calculations.

Table 8 Build-up of peak and off-peak values (c/kWh) — Final (updated)

	Scenario 1		*Scenario 2*		*Scenario 3*		*Scenario 4*		*Scenario 5*	
	Peak	***Off-peak***	***Peak***	***Off-peak***	***Peak***	***Off-peak***	***Peak***	***Off-peak***	***Peak***	***Off-peak***
Spot wholesale electricity pool price	14.749	7.057	13.018	7.214	14.749	7.057	13.770	6.830	12.523	6.732
Value of energy losses	1.172	0.564	1.035	0.577	1.172	0.564	1.095	0.546	0.996	0.539
NEM and ancillary services fees	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087	0.087
Build-up	**16.008**	**7.708**	**14.140**	**7.878**	**16.008**	**7.708**	**14.951**	**7.464**	**13.606**	**7.358**

Note: Totals may not add due to rounding.

Source: ACIL Allen 2017c; QCA calculations.

4 IMPACTS ANALYSIS

The Direction instructs the QCA to illustrate the impacts and outcomes of different peak and off-peak periods to inform solar customers' understanding.

This chapter contains the analysis that the QCA has undertaken to fulfil this requirement of the Direction, applying the updated wholesale electricity pool price values. The decrease in the peak period prices has reinforced the conclusions presented in the draft report: namely that, based on the assumptions described below, and subject to developments discussed in Section 4.45, it is unlikely that typical customers will be better off on any of the time-varying options presented, than on the existing flat rate feed-in tariff.

4.1 Overview

The Direction indicates that this analysis (the 'impacts analysis') must include presenting each of the potential peak and off-peak periods against a typical solar generation profile for a relevant location covered by the Ergon Energy network. The impacts analysis is intended to allow solar customers to understand how the timing of their solar generation compares with the possible peak and off-peak periods.

The QCA has also conducted preliminary analysis on the potential financial outcomes for PV customers under the peak and off-peak scenarios modelled in this advice, compared with the existing flat-rate regional feed-in tariff applying for 2017–18.

This analysis should be considered indicative only. Actual outcomes will vary significantly from household to household due to a range of factors including, but not limited to:

- PV installation size (kW)
- installation characteristics (tilt and orientation)
- geographical location and climatic conditions
- panel age and condition
- household consumption (total amount and daily profile of usage).

4.2 Methodology

To estimate the potential outcomes for solar PV customers under each scenario, we have modelled estimated gross PV generation and net PV exports for five hypothetical PV systems in a relevant location. We then applied the peak and off-peak periods and prices presented in this advice to illustrate the potential outcomes.

The financial impacts analysis is limited to modelling the potential financial impact on PV customers from net energy exports only (under each scenario), based on a fixed consumption profile. It does not attempt to estimate overall net household electricity bill outcomes, which would also vary according to the customer's consumption tariff.

As outcomes for individual solar customers are sensitive to many factors, it is necessary to establish some simplifying assumptions for this analysis. These assumptions are discussed below.

Household consumption

Household consumption is a function of total usage (total consumption), and the pattern of that usage across the day (the consumption profile).[30]

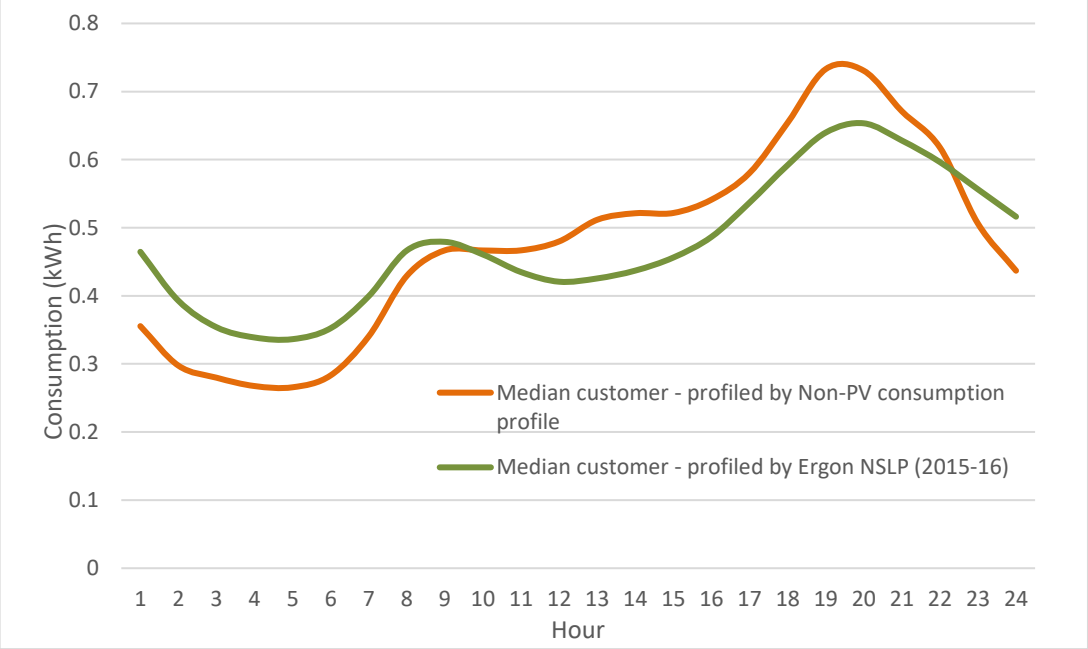
Total consumption used in this analysis represents the median[31] consumption for Ergon Energy Queensland customers on tariff 11, during 2015–16.[32] This annual total consumption value has been converted into an indicative average 24-hour consumption profile, using data provided by Ergon Energy Queensland, which reflects consumption by a sample of households without solar PV installed.

We considered using the Ergon Energy Queensland NSLP as an assumed consumption profile; however, we rejected this on the basis that the NSLP does not include solar PV energy consumed in-house. This is important, as the total consumption for a household with solar PV is the sum of PV generation consumed, and the energy drawn from the network at any given time.

Figure 2 presents the Ergon Energy Queensland NSLP and non-PV sample profiles, both scaled to the Ergon Energy Queensland median tariff 11 consumption level. This illustrates how the effect of in-house PV consumption creates a 'carve-out' in the NSLP during daylight hours.

For this reason, we consider the non-PV household consumption profile is a more relevant indicator of total household consumption for the purposes of estimating net PV exports, noting that consumption patterns vary significantly across households.

Figure 2 Consumption profiles



The assumed consumption profile (and hourly consumption level) has been held constant across all modelled scenarios.

[30] Note that other factors, such as seasonality, also influence usage and consumption.
[31] The typical customer for a given retail tariff is the median or middle customer (in terms of consumption) out of all customers on that tariff in regional Queensland.
[32] 4,173 kWh per year. This is consistent with the median consumption assumption used for estimating retail price impacts for the QCA's superseded 2017–18 retail pricing final determination.

The financial value derived from feed-in tariffs will vary significantly according to each household's consumption profile, and the extent to which it is able to modify consumption behaviour throughout the day. Consumption and exporting patterns may also change in response to the price signals that customers receive from time-varying solar prices and time-varying consumption tariffs. We note this analysis does not seek to take into account these additional complexities.

PV generation

PV generation profiles have been modelled for five hypothetical system sizes in a relevant location using the PV Watts online calculator[33]—for each of the five peak/off-peak scenarios examined in this report. Simulated generation profiles are presented as daily gross generation profiles, representing the average of one year of daily simulations for each system size. To illustrate a range of potential outcomes, we have chosen to simulate generation profiles for 3 kW, 4 kW, 5kW, 10 kW and 30 kW PV systems.[34]

For the purposes of estimating PV generation output, we have assumed each hypothetical system is located in Bundaberg. This location was selected as it contains the highest concentration of rooftop PV installations in the Ergon Energy network area, by postcode.[35] On this basis, it is considered a relevant location in which to model potential outcomes, as required by the Direction.

Geographical location is an important parameter in modelling potential PV output, as it determines certain variables including average solar radiation, climatic conditions and elevation—which all influence the generation output of rooftop PV systems. The maximum output of any given PV system is also sensitive to various technical parameters, including panel orientation, tilt angle, inverter efficiency, and panel age and degree of deterioration.

The assumptions used for simulating the hypothetical generation curves are set out in Table 9.

[33] http://pvwatts.nrel.gov/.

[34] Information from Ergon Energy Queensland indicates that the mean capacity (as measured by panel capacity installed) in the Ergon Energy network area is 4 kW.

[35] Clean Energy Regulator, *Postcode data for small-scale installations—SGU Solar.csv*, accessed 30 May 2017, at http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/postcode-data-for-small-scale-installations#Postcode-data-files

Table 9 Parameters used for modelling PV generation profiles

Parameter	*Assumption*
Locality	Bundaberg [a]
Latitude (degrees South)	23.87
Longitude (degrees East)	151.22
Elevation (meters)	17
DC system size (kW)	Various
Module type	Standard
Array type	Fixed (roof mount)
Array tilt (degrees)	22.5
Array azimuth (degrees)	0
System losses	14
Inverter efficiency (%)	96
DC to size ratio	1.1
Capacity factor (%)	18.8

a. We note that the PV Watts online calculator defaults to Gladstone airport as the closest TMY2 (Typical Meteorological Year data source 2) weather file for Bundaberg. We do not consider the impact of this simplifying assumption to be material for this analysis.

Net PV exports

Legislated feed-in tariff arrangements in Queensland are net-metered schemes. This means that PV energy generated by rooftop panels is first used to meet the electricity demand of the household, with any excess energy being fed back into the distribution network. It is this excess energy, or net export, which attracts a feed-in tariff payment.

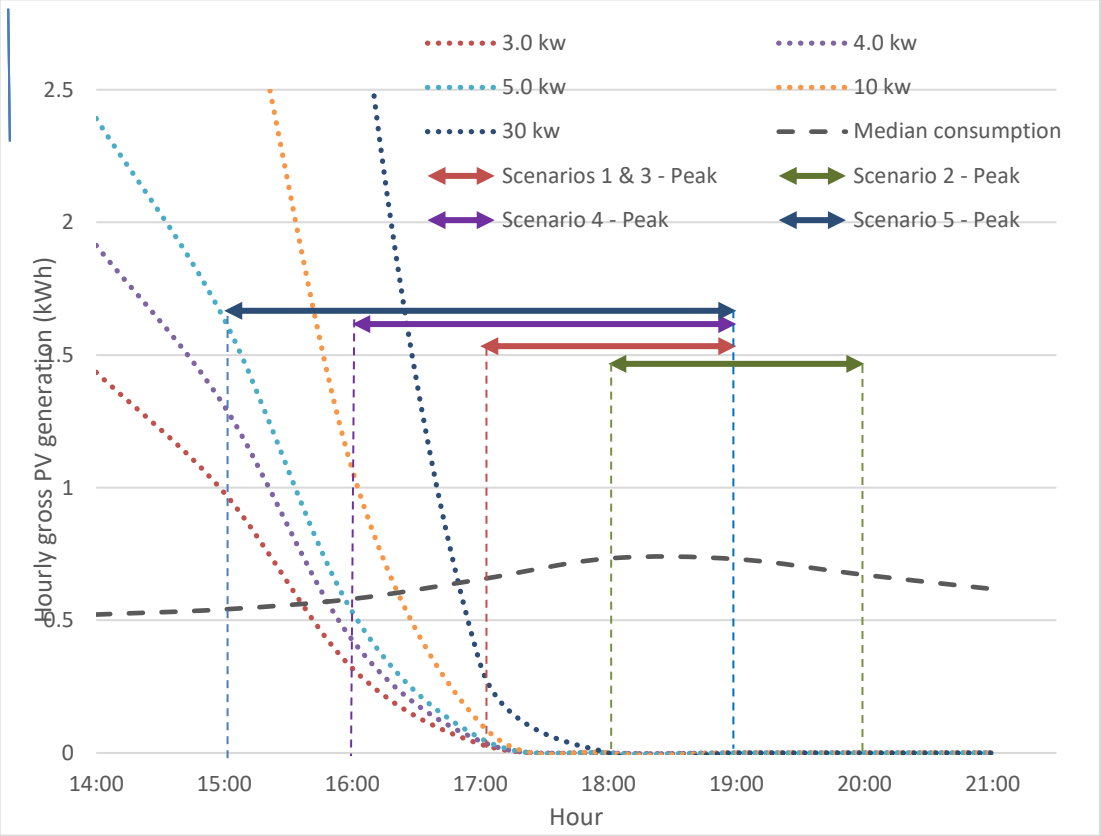
For the purpose of this impacts analysis, Net PV exports have been calculated as the difference between hourly total PV generation, and the hourly profiled consumption curves described above.

4.3 Indicative outcomes

Peak periods and generation profiles

Figure 3 illustrates the incidence of each modelled peak period with the simulated generation curves of the hypothetical five PV systems (i.e. 3 kW, 4 kW, 5kW, 10 kW and 30 kW). For clarity, we present only the portion of the generation and consumption profiles relevant to the modelled peak periods.

Figure 3 Incidence of peak periods and gross PV generation output



Source: QCA analysis.

Figure 3 illustrates the logical outcome that larger capacity PV arrays generate more energy overall, and offer greater opportunity for gross generation during the modelled peak periods. The financial analysis below considers net export outcomes, which are more relevant to Queensland's net-metering arrangements for feed-in tariffs.

Indicative financial outcomes

Figures 4 to 8 illustrate the potential annual financial outcomes for each peak/off-peak price combination, based on the five hypothetical PV systems.

Based on this analysis, only quite large PV systems (larger than 5 kW) would provide sufficient output for a typical household to export excess energy after 4 pm.

For all hypothetical installation sizes modelled, typical households would realise the greatest total financial revenue in 2017–18 under the existing flat regional feed-in tariff rate, compared with the two-part price structures presented in this advice.

Rooftop solar PV output typically declines rapidly in the late afternoon towards sunset. This decline coincides with the time that households typically begin increasing consumption. As a result, most of the limited solar PV output available during the modelled peak times is used in-house, with little or no excess energy available for export.

Figure 4 Scenario analysis—3 kW PV system

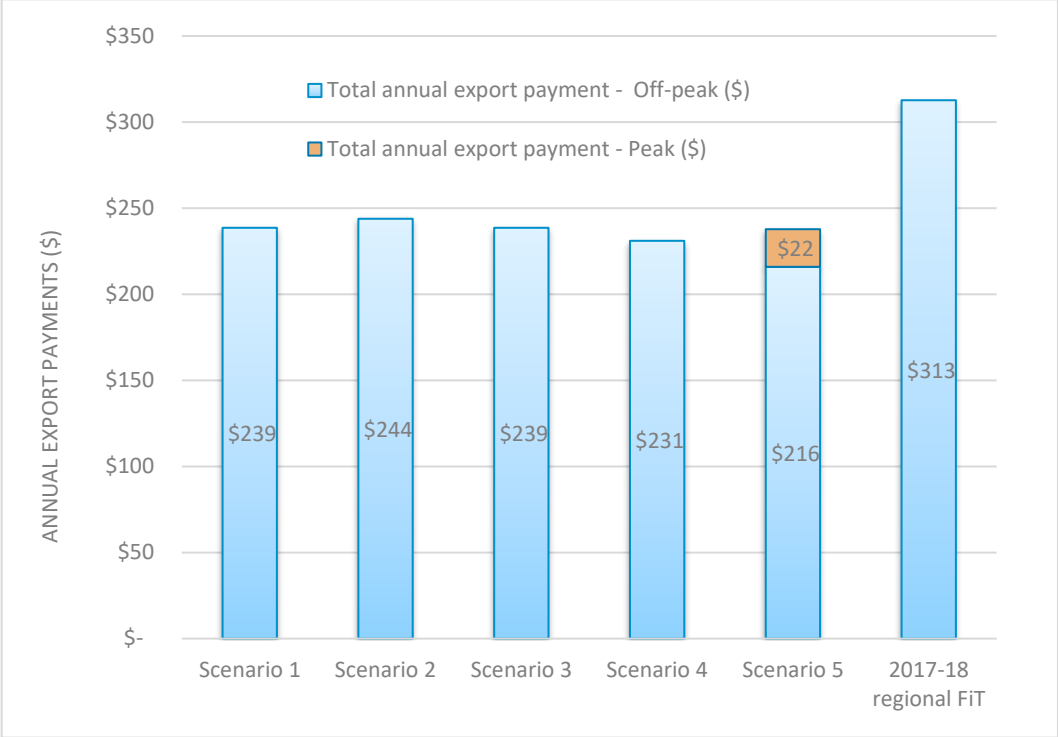


Figure 5 Scenario analysis—4 kW PV system

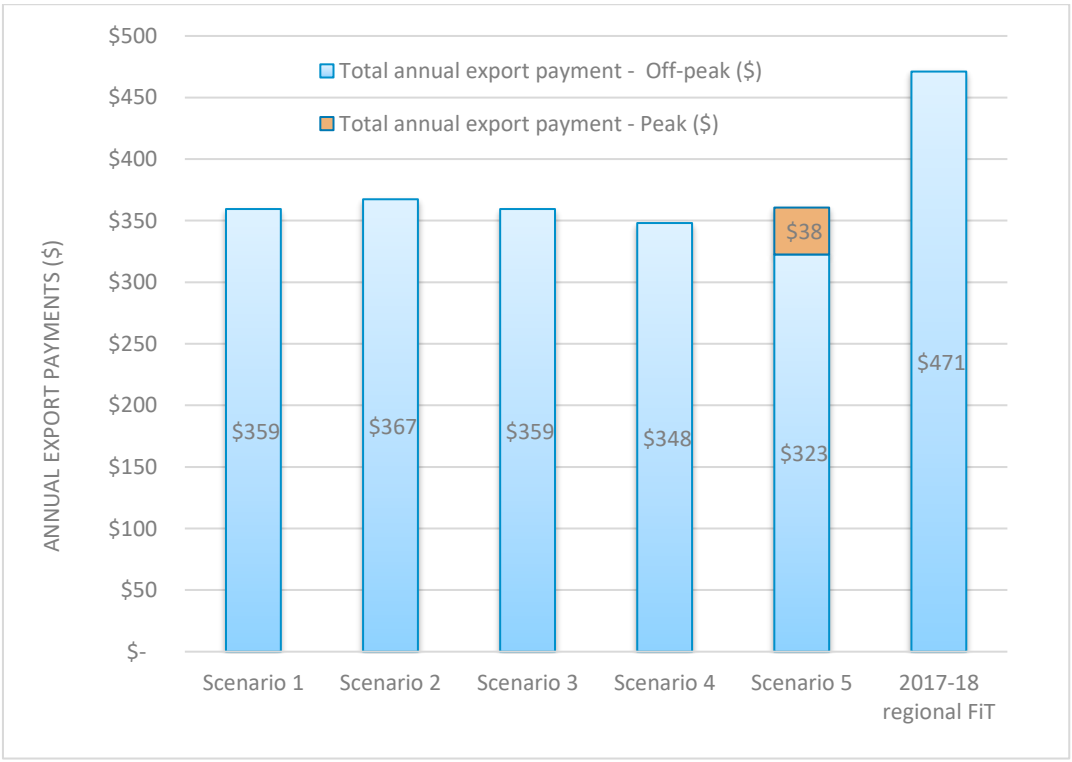


Figure 6 Scenario analysis—5 kW PV system

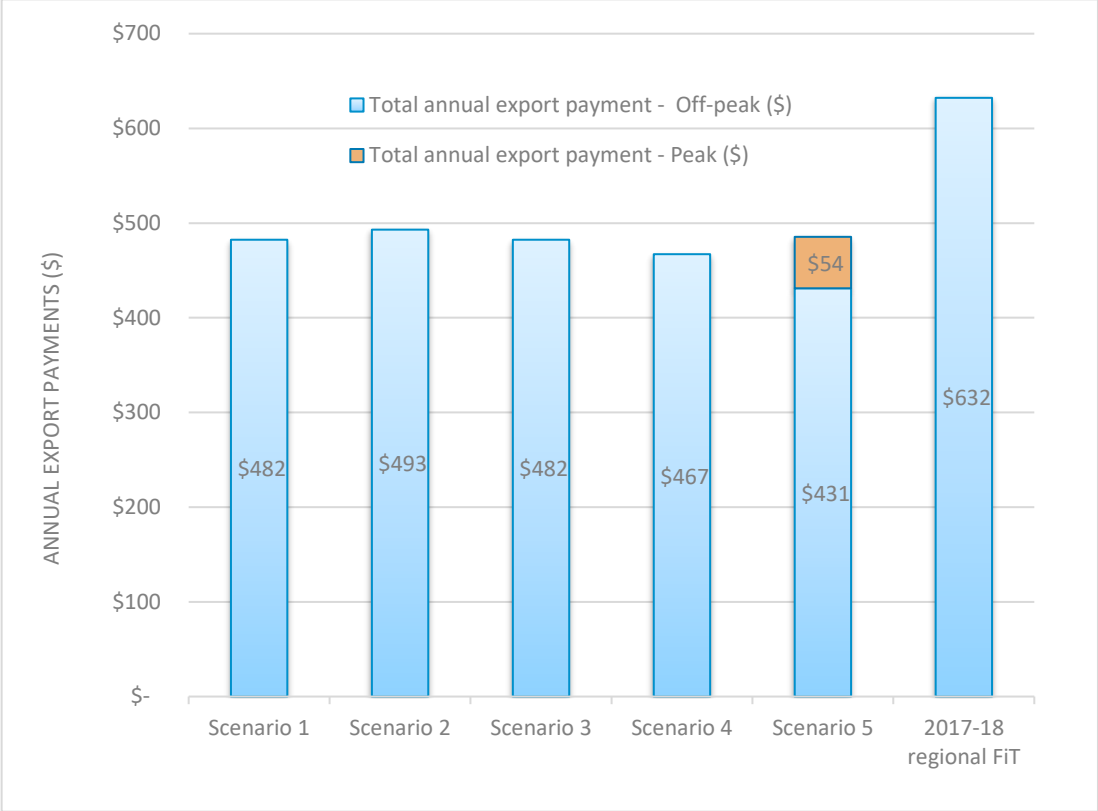


Figure 7 Scenario analysis—10 kW PV system

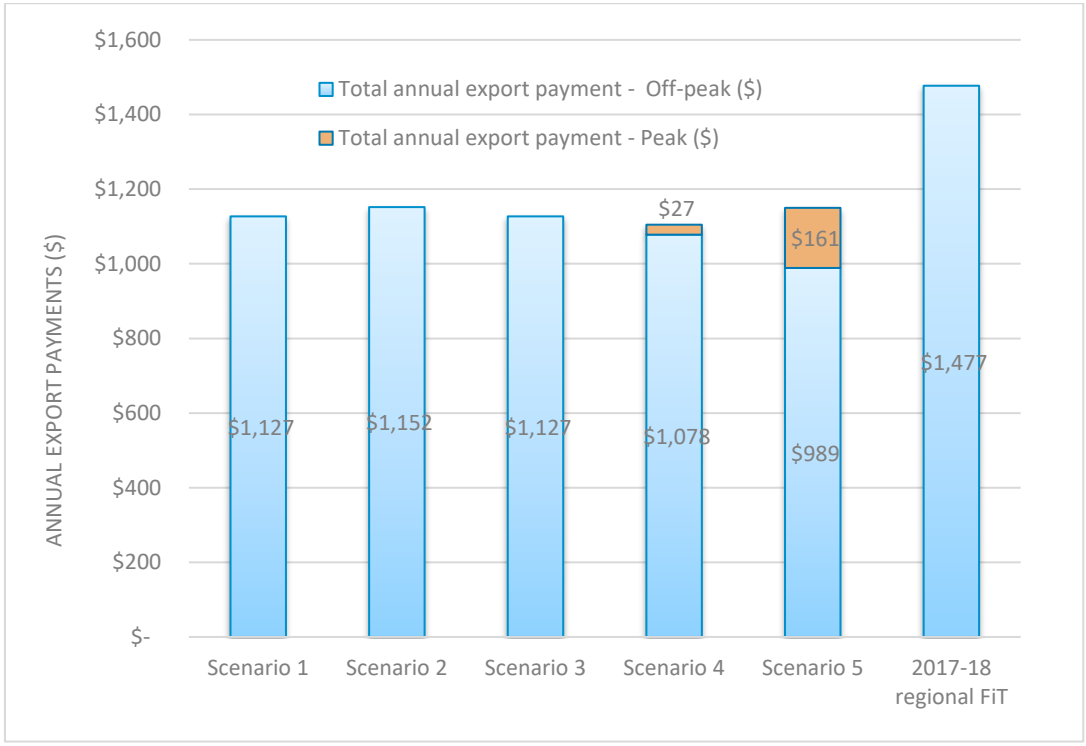


Figure 8 Scenario analysis—30 kW PV system

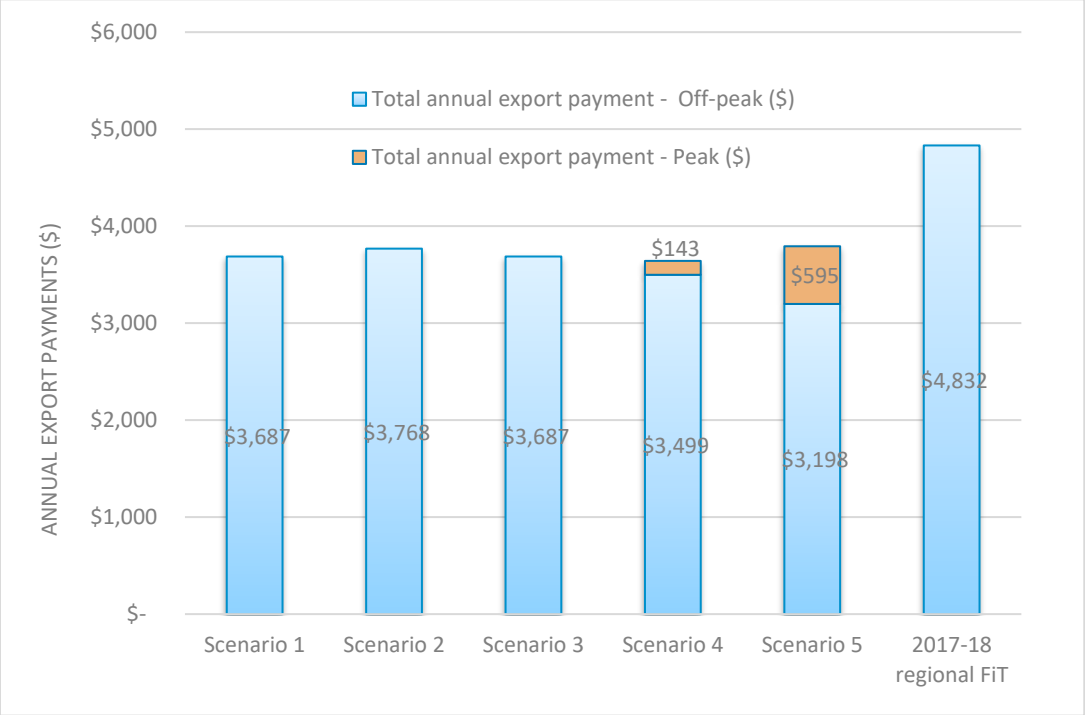


Table 10 summarises the indicative financial outcomes under each peak/off-peak pricing scenario.

Table 10 Summary of potential financial outcomes ($)

Assumed PV installation size	*Scenario 1*		*Scenario 2*		*Scenario 3*		*Scenario 4*		*Scenario 5*		*Regional Feed-in tariff 2017–18*	
	Peak revenue ($)	Off-peak revenue ($)	Peak revenue ($)	Off-peak revenue ($)	Peak revenue ($)	Off-peak revenue ($)	Peak revenue ($)	Off-peak revenue ($)	Peak revenue ($)	Off-peak revenue ($)	Peak revenue ($)	Off-peak revenue ($)
3.0 kW	$-	$239	$-	$244	$-	$239	$-	$231	$22	$216	$-	$313
4.0 kW	$-	$359	$-	$367	$-	$359	$-	$348	$38	$323	$-	$471
5.0 kW	$-	$482	$-	$493	$-	$482	$-	$467	$54	$431	$-	$632
10 kW	$-	$1,127	$-	$1,152	$-	$1,127	$27	$1,078	$161	$989	$-	$1,477
30 kW	$-	$3,687	$-	$3,768	$-	$3,687	$143	$3,499	$595	$3,198	$-	$4,832

4.4 Submission—timing of peak and off-peak periods

In its submission, the AEC said that:

> Dynamic price signals need to be seen so as consumers can respond accordingly, and further technology changes, and reductions in cost of consumer owned and operated storage, means that new approaches and incentives will be required to maintain stability. In the future time varying pricing may, in conjunction with other tools, play a role but their immediate introduction seems premature.[36]

More specifically, the AEC added that:

> The Energy Council supports a transition to flexible pricing regimes, but it is difficult to build a compelling customer benefit proposition exclusively upon the implementation of time varying solar pricing. Given that PV export isn't obtainable in many of the peak hours specified in the ACIL report it seems a marginal exercise.[37]

The AEC also noted that retail customers are already participating in the electricity market, by individually or collectively producing and consuming their own solar energy. However, it concluded that:

> At present, and without storage, people cannot change their sunlight generation outputs in response to time varying pricing. A number may be able to change their consumption patterns in response to maximize export during the proposed peak periods, but not many.[38]

4.4.1 QCA response

The QCA acknowledges the AEC's comments. The time periods considered in both the draft and final reports reflect the Direction notice, and a set of reasonable methodological assumptions (as described in Chapter 2 of this report). Should different time periods be applied, both the spot wholesale electricity pool price, and the impact on solar PV customers could be different, although it seems unlikely that estimated prices would increase.

The QCA also notes the AEC's reference to 'other tools'. Given changes in the capacity and cost of technology available to customers over the past 10 years, it seems likely that future developments will continue to change the ability of households to respond to electricity price signals. This possibility is discussed further in Section 4.5 below.

4.5 Concluding comments

As in the draft report, the QCA's impacts analysis suggests that typical solar PV customers in regional Queensland may be unlikely to benefit from accessing a time-varying solar price, in comparison to the flat rate feed-in tariff that is now available. However, we note this still allows for the possibility that there may be individual customers whose circumstances and particular consumption and generation profiles would allow them to benefit from accessing a time-varying solar price.

The impacts analysis also provides some evidence to suggest that the potential for an individual customer to benefit from accessing a time-varying solar price, under one or more of the scenarios modelled for this report, may increase as the capacity of solar PV installed increases. In that regard, we note the Queensland Government has indicated an intention to soon increase

[36] Australian Energy Council 2017, pp. 1–2.
[37] Australian Energy Council 2017, p. 2.
[38] Australian Energy Council 2017, p. 2.

the size of PV systems eligible to access regional feed-in tariffs from 5 kW to 30 kW[39], in order to help small businesses in regional Queensland take advantage of solar power.[40] This initiative may increase the likelihood for circumstances to arise whereby larger solar PV customers in regional Queensland, especially businesses, would benefit from having access to a time-varying solar price.

We also note that the impacts analysis shown here is static rather than dynamic—that is, the analysis is based on existing consumption and generation profiles for solar PV customers in regional Queensland. It may be that the introduction of a time-varying solar price in regional Queensland could lead to changes in consumers' consumption and generation patterns that would make it more likely that particular customers could benefit from accessing a time-varying solar price. In this regard, we note that the AEC said that a number of customers may be able to change their consumption patterns in order to maximise export during the peak periods (though its view was this would be 'not many').[41]

In addition, continued advances in battery technology, is one aspect of the potential dynamic development of the electricity supply system in regional Queensland that could allow more customers to benefit from access to a time-varying solar price. For example, battery storage systems allow electricity generated by solar PV (or other sources) to be stored for use at another time—which may allow for greater amounts of solar PV-generated electricity to be exported to the distribution network in periods like those associated with the scenarios examined in this final report. In this regard, we note that:

- DEWS advises that battery technology has developed rapidly in recent years and this is expected to continue[42]
- the AEC has commented on the reductions in the cost of customer-owned and operated storage.[43]

[39]Bailey, M 2016.
[40]Queensland Government 2016b, p. 1.
[41] Australian Energy Council 2017, p. 2.
[42] DEWS website, https://www.dews.qld.gov.au/electricity/solar/battery-energy-storage.
[43] Australian Energy Council 2017, pp. 1–2.

GLOSSARY

ACIL	ACIL Allen Consulting
AEC	Australian Energy Council
AEMO	Australian Energy Market Operator
c/kWh	cents per kilowatt hour
CLF	Combined loss factor
DEWS	Department of Energy and Water Supply
Electricity Act	*Electricity Act 1994*
kW	kilowatt
kWh	kilowatt hour
Minister	Minister for Energy, Biofuels and Water Supply
MW	megawatt
MWh	megawatt hour
NEM	National Electricity Market
NSLP	net system load profile
PV	photovoltaic
QCA	Queensland Competition Authority
QCA Act	*Queensland Competition Authority Act 1997*
RTI Act	*Right to Information Act 2009*

REFERENCES

ACIL Allen 2017c, *Wholesale electricity spot prices*, report prepared for the QCA, July.

—— 2017b, *Wholesale electricity spot prices*, report prepared for the QCA, June.

—— 2017a, *Estimated energy costs for 2017-18 retail tariffs*, report prepared for the QCA, May.

—— 2016, *Estimated energy costs for 2016–17 retail tariffs*, report prepared for the QCA, May.

—— 2015, *Estimated energy costs for 2015–16 retail tariffs*, report prepared for the QCA, June.

—— 2014, *Estimated energy costs for 2014–15 retail tariffs*, report prepared for the QCA, May.

Australian Energy Council 2017, *Draft Report - Request for advice: Time varying solar price for regional Queensland for 2017–18*, submission to the QCA, June.

Australian Energy Market Operator 2017, *Energy Supply Outlook*, June.

Bailey, M 2016, *Queensland powers towards becoming the solar state*, media release, Queensland Government, 19 December.

Clean Energy Regulator, *Postcode data for small-scale installations—SGU Solar.csv*, available at http://www.cleanenergyregulator.gov.au/RET/Forms-and-resources/postcode-data-for-small-scale-installations#Postcode-data-files.

DEWS website, https://www.dews.qld.gov.au/electricity/solar/battery-energy-storage.

Ergon Energy 2016, *Annual stakeholder report 2015–16*, https://www.ergon.com.au/__data/assets/pdf_file/0009/372492/Annual-Report-2015-16.pdf.

Geoscience Australia 2017, *Compute Sunrise, Sunset & Twilight Times*, Australian Government, accessed 26 May 2017, at http://www.ga.gov.au/geodesy/astro/sunrise.jsp.

QCA 2017c, *Request for advice: Time-varying solar price for regional Queensland for 2017–18*, draft report, June.

—— 2017b, *Solar feed-in tariff for regional Queensland for 2017–18*, final report, May.

—— 2017a, *Regulated retail electricity prices for 2017–18*, final determination (superseded), May.

—— 2013, *Estimating a fair and reasonable solar feed-in tariff for Queensland,* final report, March.

Queensland Government 2017, *Powering Queensland Plan*, June.

—— 2016b, *Queensland Government response to the Queensland Productivity Commission Solar Feed-in Pricing in Queensland Inquiry*, December.

—— 2016a, *Budget 2016–17 Budget Strategy and Outlook*, Budget Paper No. 2.

APPENDIX A: MINISTERIAL DIRECTION

Queensland Government

The Honourable Mark Bailey MP
Minister for Main Roads, Road Safety and Ports
Minister for Energy, Biofuels and Water Supply

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Our Reference: CTS 11270/17

22 MAY 2017

QLD COMPETITION AUTHORITY
26 MAY 2017
DATE RECEIVED

Professor Roy Green
Chair
Queensland Competition Authority
Level 27, 145 Ann Street
BRISBANE QLD 4000

Dear Professor Green Roy,

I am writing to direct the Queensland Competition Authority (the Authority) under section 253AA of the *Electricity Act 1994* (the Act) to provide advice on a time-varying feed-in tariff (FiT) for the 2017–18 tariff year. I attach my directions and the associated Terms of Reference (ToR) which impose conditions on the Authority when undertaking its investigation.

The Authority is to calculate spot wholesale electricity pool price values for different possible peak and off-peak combinations. For each combination the two periods are to cover the entirety of the day. These values are then to be used to create a cost build-up including the value of energy losses and avoided National Electricity Market fees.

After calculating the cost build-ups outlined in the ToR, the Authority is to undertake public consultation on public preferences for the timing of the peak and off peak periods.

Mr Tim Quirey, Director, Strategic Futures in my department will be pleased to assist with any questions about these directions and can be contacted on (07) 3199 4976.

Yours sincerely

Mark Bailey MP
Minister for Main Roads, Road Safety and Ports and
Minister for Energy, Biofuels and Water Supply

Encl: Section 253AA Direction and Terms of Reference

ELECTRICITY ACT 1994
Section 253AA

As the Minister for Main Roads, Road Safety and Ports and Minister for Energy, Biofuels and Water Supply, pursuant to section 253AA of the *Electricity Act 1994* (the Act), I hereby direct the Queensland Competition Authority (the Authority) to provide advice on the matters set out below to inform a time-varying solar price.

The Authority must publish this direction on its website.

The following are the Terms of Reference pertaining to this direction.

Terms of Reference

The Authority is to calculate and report on Queensland spot wholesale electricity pool price values under a range of different time periods. The values must be relevant for the 2017–18 tariff year.

1. Calculate Queensland spot wholesale electricity pool price values for each of the peak time periods below and a corresponding off-peak period covering the remaining hours throughout a day (i.e. the peak and off-peak periods are to cover 24 hours each day). The peak time periods to be calculated are:
    - a peak period not less than 2 hours which provides the highest wholesale energy value when solar PV is generating
    - a period not less than 2 hours which reflects the highest electricity demand on the Ergon Energy network
    - a peak period from 5pm – 7pm
    - a peak period from 4pm – 7pm
    - a peak period from 3pm – 7pm

2. Calculate a build-up (in cents per kilowatt hour) of peak and off-peak values which includes:
    a. the wholesale values calculated in (1) above;
    b. energy losses for Ergon Energy's east pricing zone; and
    c. National Electricity Market and ancillary service fees.

Consultation

The Authority must consult with Ergon Energy Queensland on the calculation of the wholesale values.

The Authority must undertake public consultation on the timing of the peak and off-peak periods and report to Government on which periods are preferred by stakeholders.

The Authority should illustrate the impacts and outcomes of different peak and off-peak periods to inform solar customers understanding. This must include presenting each of the potential peak and off-peak periods against a typical solar generation profile for a relevant location covered by the Ergon Energy network to allow solar customers to understand the timing of solar generation compared to the possible peak and off-peak periods.

Timing

1) Draft Report

The Authority must publish a draft report containing the calculated wholesale values and cost build-ups for the different peak/off-peak periods no later than 9 June 2017.

The Authority must publish a written notice inviting submissions about the timing of the peak and off-peak periods. The notice must state a period (the consultation period) during which anyone can make written submissions to the Authority about issues relevant to the timing of the peak and off-peak periods.

The Authority must make all submissions received within the consultation period available to the public, subject to normal confidentiality considerations.

2) Final Report

The Authority must include a summary of submissions including any stated preferences from submissions for particular timings for peak and off peak periods in its Final Report.

The Authority must provide me with a final report no later than 28 July 2017.

The Authority must publish its report on the Authority's website by 28 July 2017.

DATED this 21 day of May 2017

SIGNED by the Honourable)
Mark Bailey)
Minister for Main Roads, Road Safety and Ports and)
Minister for Energy, Biofuels and Water Supply) *(signature)*

Page **2** of **2**