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11 October 2011

Mr James Cox
Acting Chairman
Independent Pricing & Regulatory Tribunal
PO Box Q290,
QVB Post Office NSW 1230

Dear Mr Cox,

SOLAR FEED-IN TARIFFS

Setting a fair and reasonable value for electricity generated by small-scale solar PV units

Ausgrid welcomes the opportunity to provide input to the Solar Feed-In Tariff Review being undertaken by IPART. This letter and the attachments support the main points made in a meeting between officers of IPART and Ausgrid in August 2011. For completeness it is also noted that electronic files containing detailed metering data were issued to IPART subsequent to the above meeting, as follows:

- Residential data for FY10 and FY11;
- Business data for FY10 and FY11;
- Various Gross and Net summary profiles; and
- The distribution of solar PV systems connected to Ausgrid's network as at 30 June 2011, by system size.

The issue most relevant to a DNSP raised within the Issues Paper was Question 7:

"What impact does solar PV generation have on network costs? How can this impact be most accurately measured?"

Ausgrid conducted an analysis of the peak demand impact on its network due to solar PV. The analysis was based on a sample of interval meter data from connected solar systems for the period of the 2011 summer peak. The impact was assessed for three broad cases – system-wide; the top five zone substations (by penetration of solar connections); and the top five 11kV feeders (by penetration of solar connections).

The key points to emerge from this analysis (included as Attachment No.1) are summarised below.

1. Due to the time of day of system wide winter peaks (early evening), there is no peak demand benefit from solar for this season. All subsequent analysis focused on summer peaks.
2. The system wide reduction in demand due to solar on the summer peak day was estimated to be only 0.3% of total demand. The rated capacity of solar PV systems connected to the Ausgrid network at this time was 55.2MW. Even though the total rated capacity of small solar systems connected to the Ausgrid network will be approximately double that of summer 2010/2011 by 2011/2012 (108.8MW) the estimated peak demand reduction will equate to 0.6%.
3. For the top five zone substations (by penetration of solar), the reduction in demand due to solar during the summer peak period was in the range of 0.3% to 1.2%, with an average of 0.6%.
4. For the top five 11kV distribution feeders (by penetration of solar), the reduction in demand due to solar during the summer peak period was in the range of 0.1% to 2.9%, with an average of 1.2%.
5. An analysis of all 204 zone substations in the Ausgrid network area did not reveal any substations with a summer demand constraint in the next five years which also had sufficient connected solar generation to defer a network investment by one year.
6. For many zone substations the capacity investment driver is the winter peak, when there would be no benefit from solar PV in terms of deferral of investment.

Charmhaven zone substation presented as having the most potential for investment deferral, as it was in the top five zones by solar penetration and had a forecast constraint in the summer of 2016/17. In the hypothetical case that there is sufficient PV to defer the proposed capacity investment by one year, Ausgrid's analysis showed this would translate into a feed-in tariff value of approximately 1c/kWh, and specifically only for customers connected to this zone. This is a best case scenario.

Taking into consideration that a proportion of zones are winter-peaking (no solar impact on peak demand), that in most cases there will not be sufficient solar generation capacity connected to enable a capital deferral, and that many zones are not constrained in the foreseeable future, the solar buyback benefit is likely to be significantly lower than 1c/kWh when averaged across all zones. It should be further noted that such a value would only be available in that particular zone, and only at the particular time the peak demand is occurring. If averaged over the whole area (to provide equity of opportunity), and over time, this would translate to a generally available value of significantly less than one cent per kWh.

In short, there appears to be no case within Ausgrid's network where it is economically feasible to defer network investment due to the presence of embedded small-scale solar generation. This is the case even with the stimulus provided by the initial SBS rebate of 60c/kWh, which was subsequently reduced to 20c/kWh.

On the other hand, Ausgrid has incurred significant costs in implementing the NSW Solar Bonus Scheme. These costs – over and above the direct costs to the NSW distributors of the Scheme payments/rebate itself – were outlined in Ausgrid's cost pass-through application to the Australian Energy Regulator at the end of 2010. Although this application was rejected on the grounds that the total costs did not meet the AER's materiality threshold for a pass-through event under the National Electricity Rules, the costs were $40 million and were considered by Ausgrid as being significant, but have had to be absorbed by the business.

It is also relevant to highlight some other technical factors affecting the NSW distributors' LV networks. One is the impact on voltages in areas with high penetration levels of solar installations. Although only being noticed in isolated cases at this early stage, there are design and cost implications of maintaining appropriate voltage levels on networks so that solar customers' inverters do not switch off due to high network voltages. At the same time higher voltage levels produced by a concentrated presence of solar generation – particularly at lightly

loaded times of the day when the solar generation is at its maximum - can also have consequences for appliances and equipment in customers' homes.
It is difficult to accurately quantify the impact that concentrated solar generation may have on network costs, it is clear that their presence is likely to increase the cost to a distributor of operating the electricity network, rather than to accrue any benefits.

Ausgrid notes that the terms of reference include a requirement for IPART to investigate the impact on network businesses' costs of small-scale solar generation, and to make recommendations as to whether comprehensive network system modeling is warranted. Ausgrid's view, based on the foregoing, is that embarking on LV system modeling as a separate exercise should be carefully considered, particularly at current levels of small-scale solar penetration. The planning groups within the three DNSPs are already reviewing the issues which have been brought to the surface by the high stimulus provided by the NSW Solar Bonus Scheme. Further, it may be more appropriate for other participants within the National Electricity Market to become involved in such an exercise to encourage a national rather than jurisdictional approach. For instance, Ausgrid is already participating in an Electricity Networks Association (ENA) working group that is seeking to optimise network, installation and inverter equipment design and connection requirements to achieve the appropriate outcomes including management of increased penetration of embedded generation.

In summary there is no evidence to suggest that solar PV generation offsets the costs of operating and maintaining a distribution network However, there is a significant likelihood that it will result in an increase in costs for networks in the short-medium term.

If you would like to discuss any aspect of this submission please contact Mr John Thomson on 02 9269 2312.

Yours sincerely,

Peter Birk
Executive General Manager
System Planning & Regulation

Attach.

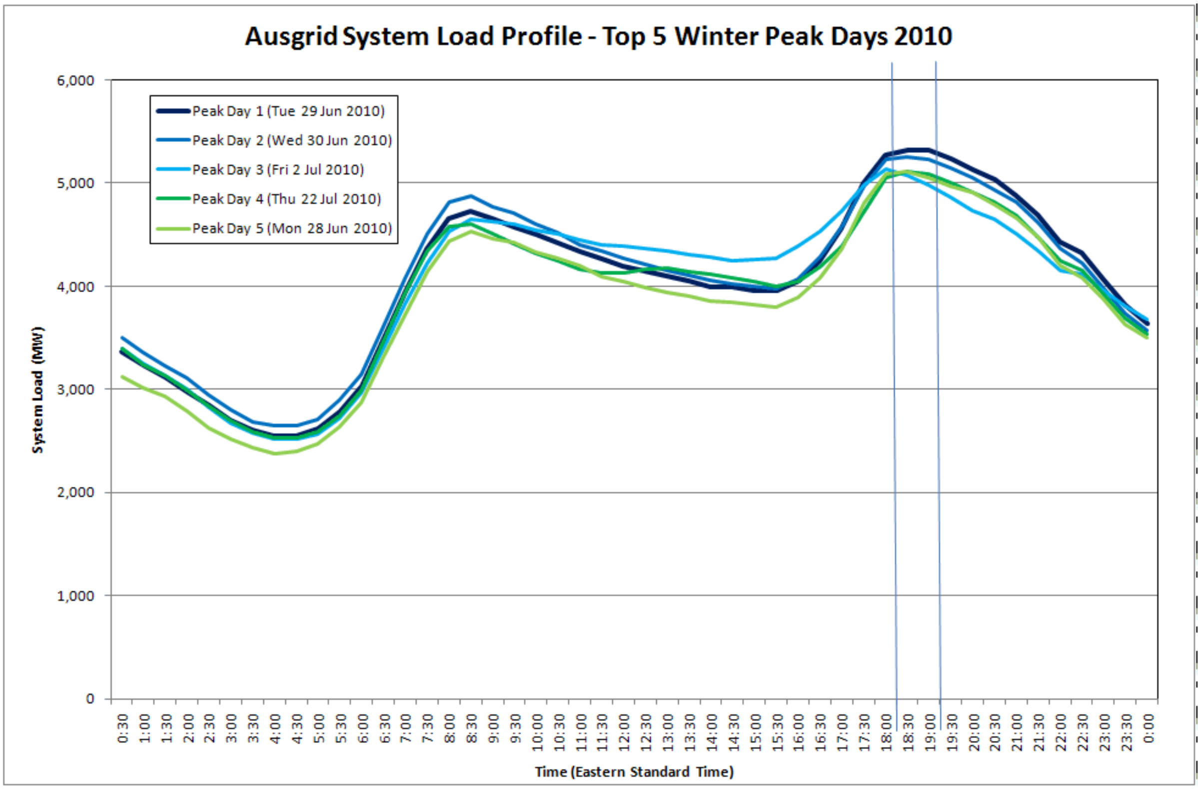
IPART Solar PV Feed-in Tariff Review

Ausgrid Network Peak Analysis

Effect of Solar PV on winter system peak 2010

The winter system peaks for 2010 were analysed and found to occur consistently between 6pm to 7pm, with four of the top five peaks in 2010 occurring between 6:00 to 6:30pm; the other was in the half hour between 5:30pm to 6:00pm (the 4th peak day). Nearly every other day in winter had a system peak occurring between 6pm to 7pm.

For Sydney, sunset is before 4:55pm in June, before 5:15pm in July, and before 5:36pm in August, so the contribution of solar to reducing winter peaks is highly unlikely. The remainder of this analysis focuses on analysing the effect of solar PV on summer peaks.

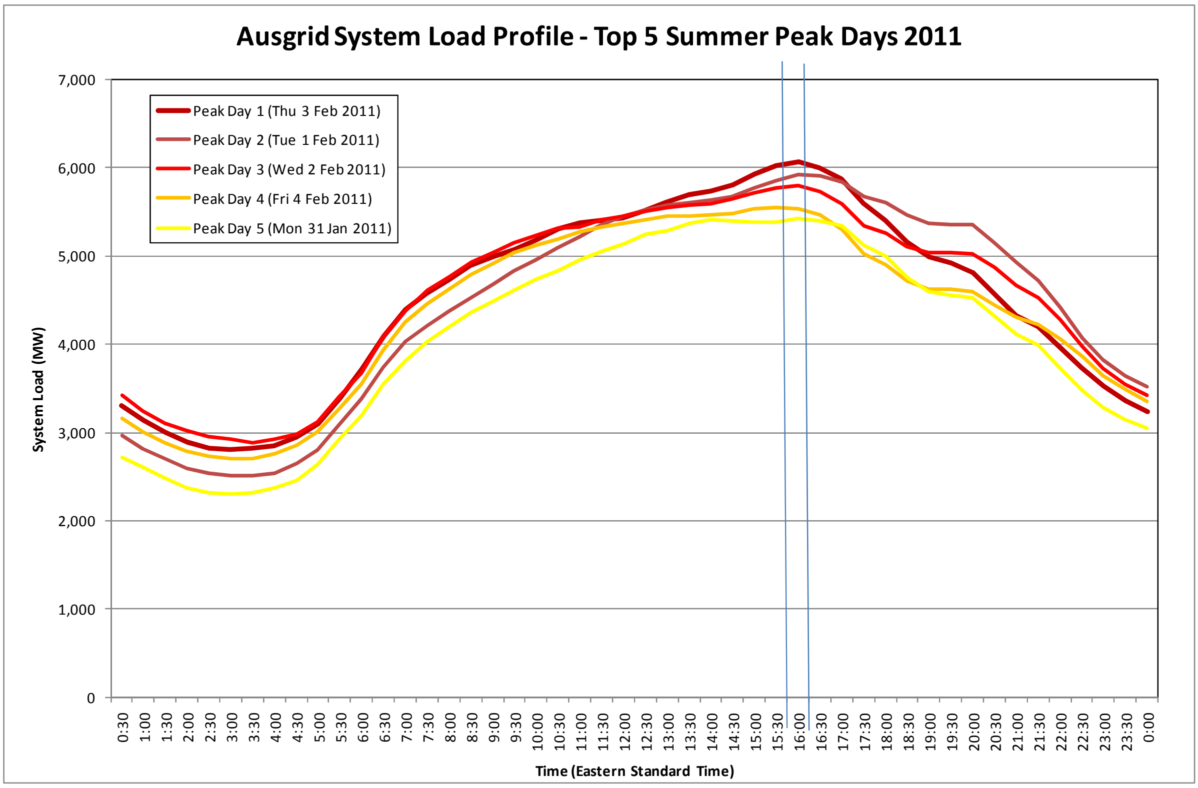


F*igure 1: Ausgrid network demand profile – top five system peak winter days in 2010*

Effect of Solar PV on summer system peak 2011

Ausgrid System Peak

The top five days on the Ausgrid network in 2011 all occurred during the working week of 31 Jan 2011 to 4 Feb 2001. Time of system peak occurred in the half hour between 3:30 to 4:00pm – EST, (or 4:30 to 5:00pm Eastern daylight savings time). See Figure 2 below showing system load profiles on each of the five days.



F*igure 2: Ausgrid network demand profile – top five system peak summer days in 2011*

Estimated contribution of small solar systems to reducing summer system peak

The total rated generation capacity of small solar systems (<10kW) connected to the Ausgrid network on 28/1/2011 was 55.2 MW, consisting of 29,061 connections. Interval data from a sample of 26,744 gross connected solar systems was analysed for the period of the summer peak (31 Jan 2011 to 4 Feb 2011). Figure 3 (next page) shows solar generation profiles for each of the five peak days. The total rated generation capacity of these systems (using panel sizes) was recorded as 51,594 kW.

Three of the summer system peak days had smooth solar profiles with a combined solar peak of around 36,600 kW at 12:00 to 12:30 AEST (or 13:00 to 13:30 daylight savings time). The capacity factor at this time was around 71% on these days or around 710 Watts per 1kW of installed solar panels based on panel rated capacity. The other two days had a diminished solar generation profile, with the peak day (on 3 Feb 2011), having noticeably less output throughout the day.

A preliminary check of Sydney weather data for 3 February showed that the amount of sun hours recorded for the 3 February was 5.7 hours, compared to 11, 12.3 and 12.8 hours for the previous three days (31 Jan to 2 Feb).

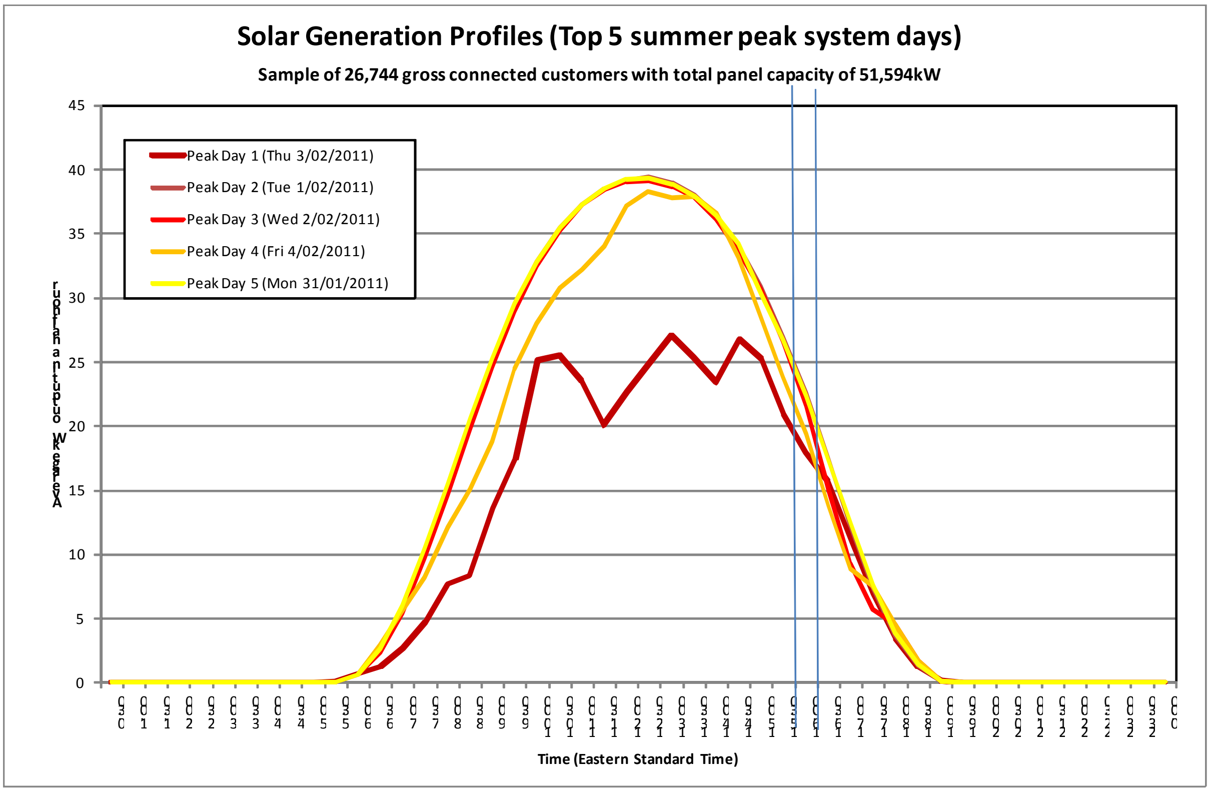


Figure 3: Ausgrid network total solar gross generation – top five summer days in 2011

The estimated impact of solar on reducing network summer peak is reduced due to the system peak time differing from the solar peak time. The estimated output of the gross connected sample of small solar systems at the time of system peak on 3 February was 16.7MW or 32% of the total solar rated capacity of 51.6MW of this sample set.

Below is a table showing the estimated impact of solar on the top five 2011 system summer peak days, using the sample profiles of the 26,744 units and scaling up by the total rated generation capacity installed as at 28/1/2011 (55.2 MW).

Table 1: Estimated solar impact on Ausgrid network summer peaks for Summer 2010/11

Summer Peak Day	Date	Day	Time of Peak (EST)	Actual System Peak (MW)	Estimated Solar impact (MW)	% Reduction
1	3/02/2011	Thu	4:00 PM	6,072	18.0	0.30%
2	1/02/2011	Tue	4:00 PM	5,922	22.5	0.38%
3	2/02/2011	Wed	4:00 PM	5,802	21.6	0.37%
4	4/02/2011	Fri	3:30 PM	5,553	23.9	0.43%
5	31/01/2011	Mon	4:00 PM	5,423	22.9	0.42%

As at 26 September 2011, Ausgrid had a total of 96.3 MW of small solar systems connected to the network, with a further 12.5 MW that is proposed to be connected. By summer 2011/2012, the total rated capacity of small solar systems connected to the Ausgrid network will be approximately double that of summer 2010/2011.

Analysis of zone substations with high penetration of solar connections

An analysis of connected and proposed solar system data was performed using all data across the network to identify the zone substations with the highest concentration of small solar system connections. The graph below shows that of the 204 zone substations in the Ausgrid network area, 25 had greater than 1.0 MW of small solar connected, with 5 zone substations having greater than 1.4 MW of solar connected.

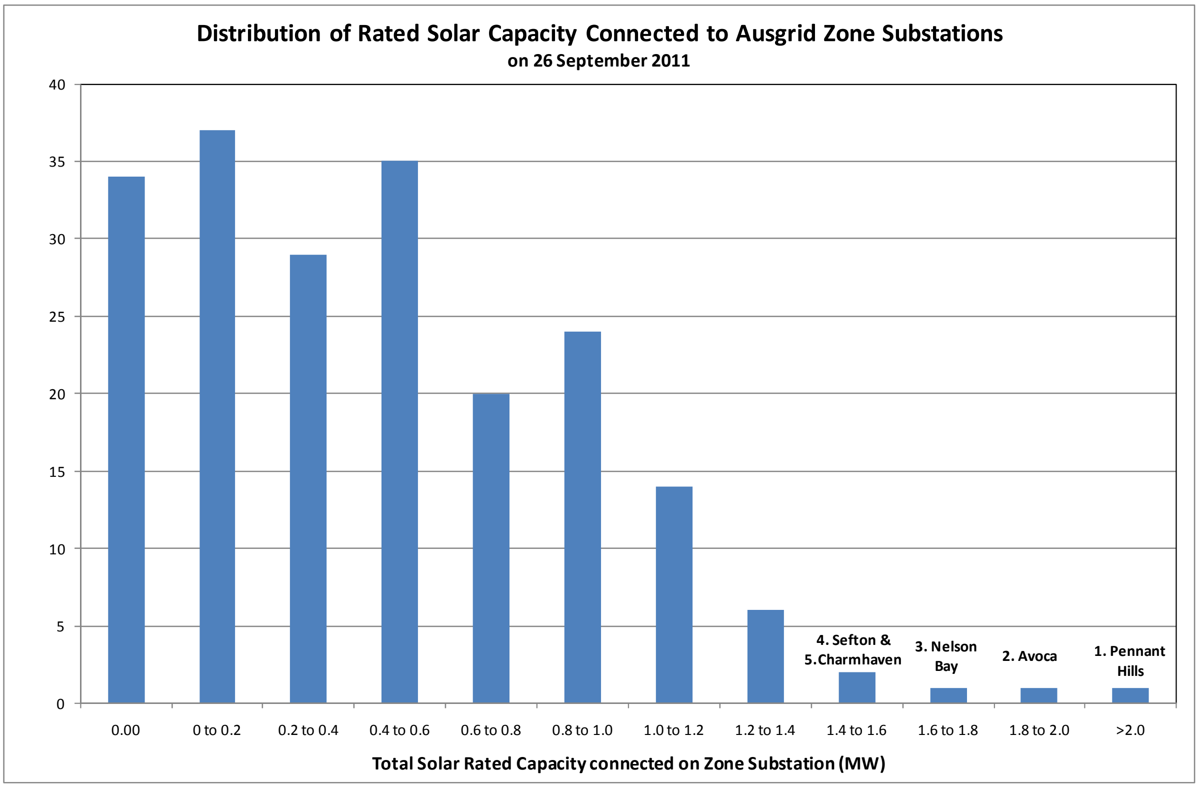


Figure 4: Rated solar capacity connected by Zone Substation

The top five zone substations with the highest penetration of solar connections (as at 26 September 2011) are listed below in more detail with some further comments about the characteristics of these zone substations.

1. **Pennant Hills** zone substation has 2.33 MW of small solar systems connected spread over many of the 11kV feeders. No individual feeder had above 200kW of currently connected solar, but many feeders are in the 100 to 200kW range. This zone has a typical residential summer zone profile with summer peak time around 4:30 to 5:30pm but also has summer and winter peaks of around the same magnitude. The summer peak in 2010/11 occurred on Saturday 5 February between 5pm to 5:30pm.
2. **Avoca** zone substation has 1.86 MW of small solar systems connected and has a residential type zone profile with summer peaks ranging between 4:00 to 6:30pm, indicating strong residential load (A/C). This zone substation is winter peaking, so any benefit of solar on summer peaks would not necessarily lead to a network benefit in winter. The summer peak in 2010/11 occurred on Saturday 5 February between 3:30pm to 4pm.
3. **Nelson Bay** zone substation currently has 1.79 MW of small solar systems connected with two of the 11kV feeders at this zone in the top ten list of 11kV feeders of connected solar capacity. The

summer peak occurs later in the day at around 5pm to 6pm. The summer peak in 2010/11 occurred on Thursday 3 February between 5pm to 5:30pm.

4. **Sefton** zone substation has 1.49 MW of small solar systems connected spread over twenty 11kV feeders, with not more than 130kW connected to a single 11kV feeder. Sefton also appears to be a summer peaking zone with peaks between 4pm to 5pm. The summer peak in 2010/11 occurred on Saturday 5 February between 4:30pm to 5pm.
5. **Charmhaven** zone substation has 1.45 MW of small solar systems connected, with summer peaks around 4pm to 6pm. The feeder with highest solar penetration on the Charmhaven zone substation has 195kW connected. The summer peak in 2010/11 occurred on Thursday 3 February between 4pm to 4:30pm.

We have conducted analysis of the estimated solar contribution to zone substation peak demand for the top four summer peak days in 2011 in each case. To understand the potential for solar to delay network investment, it is informative to compare these demand reductions to the annual demand growth rate at these zone substations. This information is presented in the table below.

Table 2: Summary of solar impact on summer peak 2011 at top five zone substations

Zone	Zone peak Date and Time	Zone peak MVA	Rated Capacity of Solar Connected at time of summer peak 2010/11 (MW)	Estimated solar impact at time of summer peak 2010/11 (MW)	Estimated % peak reduction	Zone demand rate of growth in MVA/yr	Solar impact as % of zone annual demand growth
Pennant Hills	5/02/2001 17:30	83.75	1.33	0.38	0.5%	1.20	32%
Pennant Hills	3/02/2011 17:30	79.84	1.33	0.33	0.4%	1.20	28%
Pennant Hills	2/02/2011 17:00	79.85	1.33	0.49	0.6%	1.20	41%
Pennant Hills	4/02/2011 17:00	75.64	1.33	0.54	0.7%	1.20	45%
Avoca	5/02/2011 16:00	43.27	0.93	0.50	1.2%	0.58	86%
Avoca	3/02/2011 18:00	40.50	0.93	0.18	0.4%	0.58	31%
Avoca	1/02/2011 18:30	39.71	0.93	0.11	0.3%	0.58	19%
Avoca	2/02/2011 18:30	36.70	0.93	0.11	0.3%	0.58	19%
Nelson Bay	3/02/2011 17:30	44.28	0.97	0.31	0.7%	0.66	47%
Nelson Bay	5/02/2011 18:00	42.64	0.97	0.26	0.6%	0.66	39%
Nelson Bay	2/02/2011 17:30	38.76	0.97	0.35	0.9%	0.66	53%
Nelson Bay	1/02/2011 17:30	37.73	0.97	0.34	0.9%	0.66	52%
Sefton	1/02/2011 17:00	76.06	0.68	0.27	0.4%	1.53	18%
Sefton	2/02/2011 16:30	72.95	0.68	0.33	0.5%	1.53	22%
Sefton	3/02/2011 17:00	72.40	0.68	0.27	0.4%	1.53	18%
Sefton	31/01/2011 16:30	70.39	0.68	0.33	0.5%	1.53	22%
Charmhaven[1]	3/02/2011 16:30	44.24	0.93	0.24	0.5%	1.51	16%
Charmhaven[1]	1/02/2011 17:30	43.73	0.93	0.31	0.7%	1.51	21%
Charmhaven[1]	5/02/2011 17:30	43.50	0.93	0.31	0.7%	1.51	21%
Charmhaven[1]	2/02/2011 18:00	39.77	0.93	0.24	0.6%	1.51	16%

[1]The current forecast for Charmhaven Zone Substation, is that it will become constrained in summer 2016/17. The proposed supply side investment is a transformer upgrade at an estimated cost of $6.9m.

The above data shows that the estimated demand reduction on these zone substations due to solar installations ranges from 0.3% to 1.2% of peak demand for the peak days analysed, with an average of 0.6%.

When the solar impact is calculated in terms of the annual summer demand growth, the impact of solar ranges between 14% to 86% of the annual summer demand growth, with an average of 32%.

The total rated solar capacity connected across the network and at these five zone substations will have increased by about double by summer 2011/12, so it could be expected that the solar impact will be around twice as effective by summer 2011/12.

Analysis of 11kV distribution feeders with high penetration of solar connections

A detailed analysis was performed of the five 11kV distribution feeders with the highest penetration of solar connections (as at 26 September 2011). Feeder analysis showed that based on connected solar, sixty 11kV feeders had above 200kW of solar connected to them. Data was sorted based upon connected generation capacity due to the possibility of speculative proposals still being present on the proposed connections, due to the 60c cut-off date.

The top five 11kV distribution feeders with solar connected are supplied from Homebush Bay, Flemington, Lake Munmorah, Raymond Terrace & Lisarow zone substations. Solar contribution to peak demand for each of these feeders is summarised below:

Table 3: Summary of solar impact on summer peak at top five 11kV feeders

Zone	11kV Feeder No.	Feeder Peak (MVA)	Peak Date	Time	Rated Capacity of Solar Connected at time of summer peak 2010/11 (MW)	Estimated solar impact at time of summer peak 2010/11 (MW)	% peak reduction	Demand rate of growth in MVA/yr	Solar impact as % of annual demand growth
Homebush[1]	19	4.88	31/01/2011	14:30	0.54	0.15	2.9%	0.22	67%
Flemington[1]	25	4.80	3/02/2011	15:30	0.42	0.07	1.5%	0.08	95%
Lake Munmorah	7	6.84	5/02/2011	19:00	0.29	0.01	0.1%	0.17	6%
Raymond Terrace	2005	6.98	3/02/2011	18:00	0.19	0.03	0.4%	0.13	23%
Lisarow	9	4.14	5/02/2011	18:00	0.28	0.04	0.8%	0.03	122%

[1]The high penetration of solar on Homebush Bay and Flemington is due to the Newington Olympic Village solar systems being supplied by these zone substations.

The above data shows that the estimated demand reduction on these 11kV feeders due to solar installations ranges from 0.10% to 2.90% of peak demand for the peak days analysed, with an average of 1.20%. The estimated solar impact as a % of annual demand growth ranged between 6% and 122%.

Discussion of potential of solar to defer network capital expenditure

An analysis was performed of all 204 zone substations in the Ausgrid network area, to identify locations where solar PV could potentially defer the need for a network investment by a year or more. Only a small numbers of cases were found where zone substations with emerging capacity constraints due to growth in summer peak demand also had significant solar penetration.

Notwithstanding the recent very high uptake of solar PV due to the NSW Solar Bonus Scheme, we have not identified any zone substations with a summer demand constraint within the next five years where there is also sufficient connected solar PV generation to defer a network capacity investment, even by as little as one year.

The Zone substation with the most potential to benefit from a deferment of investment was Charmhaven zone, where summer demand is forecast to reach capacity limits in 2016/17. The proposed network investment to address this constraint is a transformer upgrade at an estimated cost of $6.9m. However with an annual summer demand growth rate of 1.5 MVA per year for this zone, there is insufficient reduction in peak demand due to solar PV to defer this investment by a year.

In the hypothetical case that there was sufficient solar PV installed at Charmhaven zone to reduce demand by 1.5MVA and defer this investment by a year (i.e. approximately 4.5MW or three times the amount to be installed by summer 2011/12 under the Solar Bonus Scheme), the potential savings due to capital deferment would be around $600,000 (i.e. $6.9m at 7.47% real discount rate plus some savings in operating expenditure). To translate this into a c/kWh contribution to a buyback tariff, we need to divide this deferment saving by the kWh production of the installed PV systems over the likely timeframe of a solar bonus scheme (nominally assumed to be ten years). Assuming average solar production of 1300 kWh/kWp installed, the total solar energy production is 58,500,000 kWh. This translates into a solar buyback benefit of around 1c/kWh, specifically for customers connected to this zone.

It is important to understand that this analysis has been made for a zone substation with a best case scenario for solar to achieve network cost savings. For some zone substations the capacity investment driver is the winter peak, when there would be no benefit from solar PV. Also, our data indicates that in every case analysed there is insufficient solar PV installed at any zone substation to enable deferral of network investment, even for only one year. In addition there are many zone substations that are not forecast to be constrained in the foreseeable future. Taking these things into consideration, when averaged across all zone substations the solar buyback benefit is likely to be significantly lower than the 1c/kWh derived for Charmhaven zone.

This consideration of network cost savings has focused specifically on zone substations. Potential savings on other levels of distribution network infrastructure, such as the 11kV distribution feeders, have not been considered. However, given that we have observed peak reductions at the 11kV feeder level at similar levels to those at zone substations, it is reasonable to expect that the potential benefits at other levels of the network would at best only be comparable to those for zone substations.

On balance therefore it is likely that, averaged over the whole distribution network, the investment savings due to solar PV would translate into a solar buyback benefit of significantly less than 1c/kWh.