OSBORNE PARK

Summary of characteristics

Osborne Park has three 132/11kV transformers. Load in the area consists of a mixture of residential, retail/commercial (ie. Westfield Innaloo, Centro Innaloo and surrounding areas) and industrial (ie. Osborne Park Industrial Area), however supplies predominantly commercial/industrial type loads. In 2009 the Joondanna substation will be established with one 33MVA 132/11kV transformer, one section of 11kV switchboard, two 5MVAr capacitor banks and other associated works at an estimated cost of $13 million.

Annual profile

The July 2003 to June 2004 load profile for Osborne Park TX1 is shown in Figure 1. It is characterised by a constant baseload of 5 to 9MW with daily maxima about three times the size of the baseload and increasing during summer, especially February. It also has a clear weekly cycle, with weekend loads barely above baseload and Saturday nights dropping below average baseload – see Figure 2 (which also includes the study period's peak load day) and Figure 3. There are a number of days of extreme demand peaks, which are discussed in more detail below. In both October 2003 and May/June 2004 there were large gaps in the data provided. Figure 4 shows the simulated north-facing 2MW PV output for ACDB site 'Perth', which increases in summer as expected, particularly late Feb and early March.

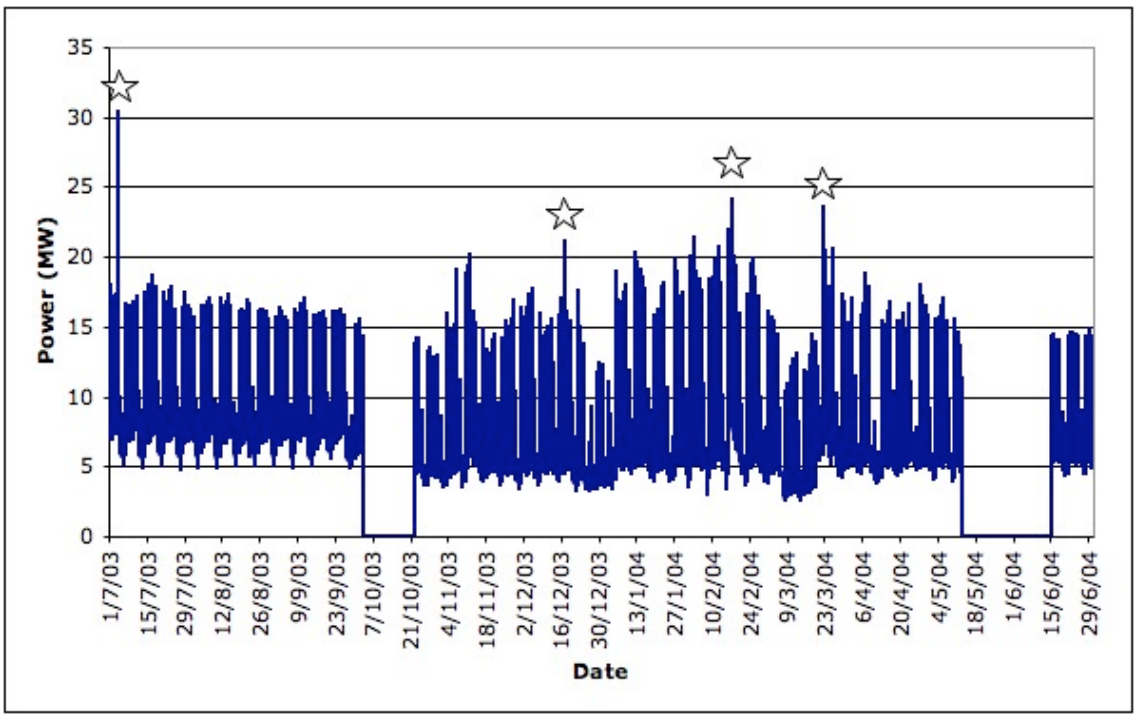

Figure 1: Osborne Park TX1 Load
July 2003 to June 2004
(the stars indicate the peak days analysed in detail below)

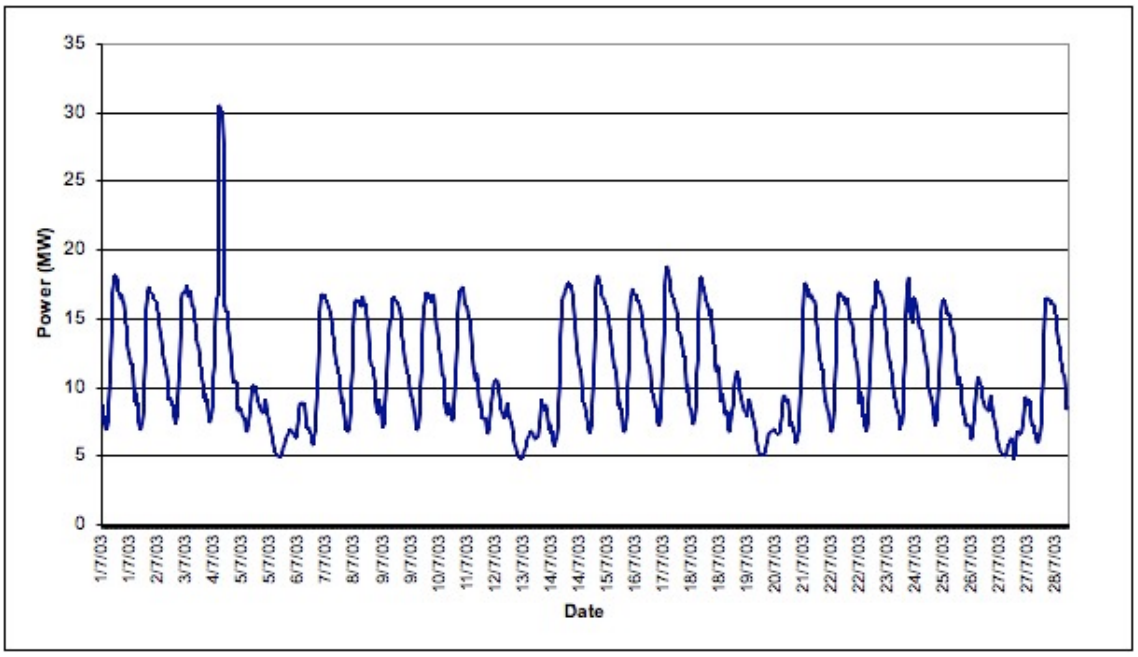

Figure 2: Osborne Park TX1 Load - July
The first 28 days of July 2003

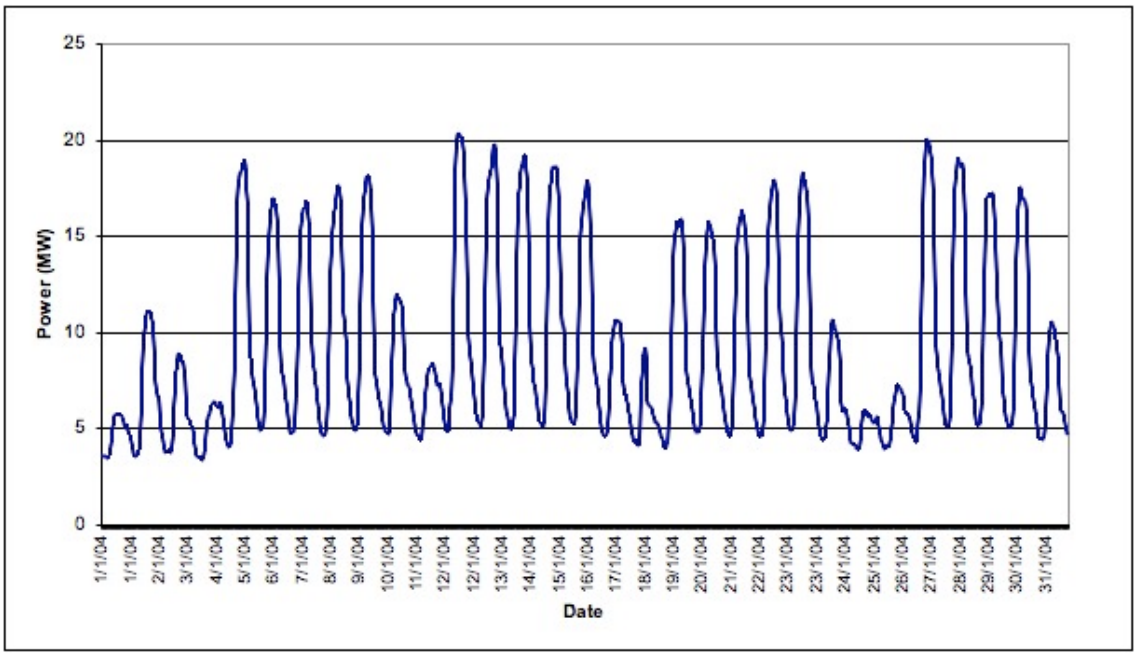

Figure 3: Osborne Park TX1 Load - Jan
The first 28 days of Jan 2004

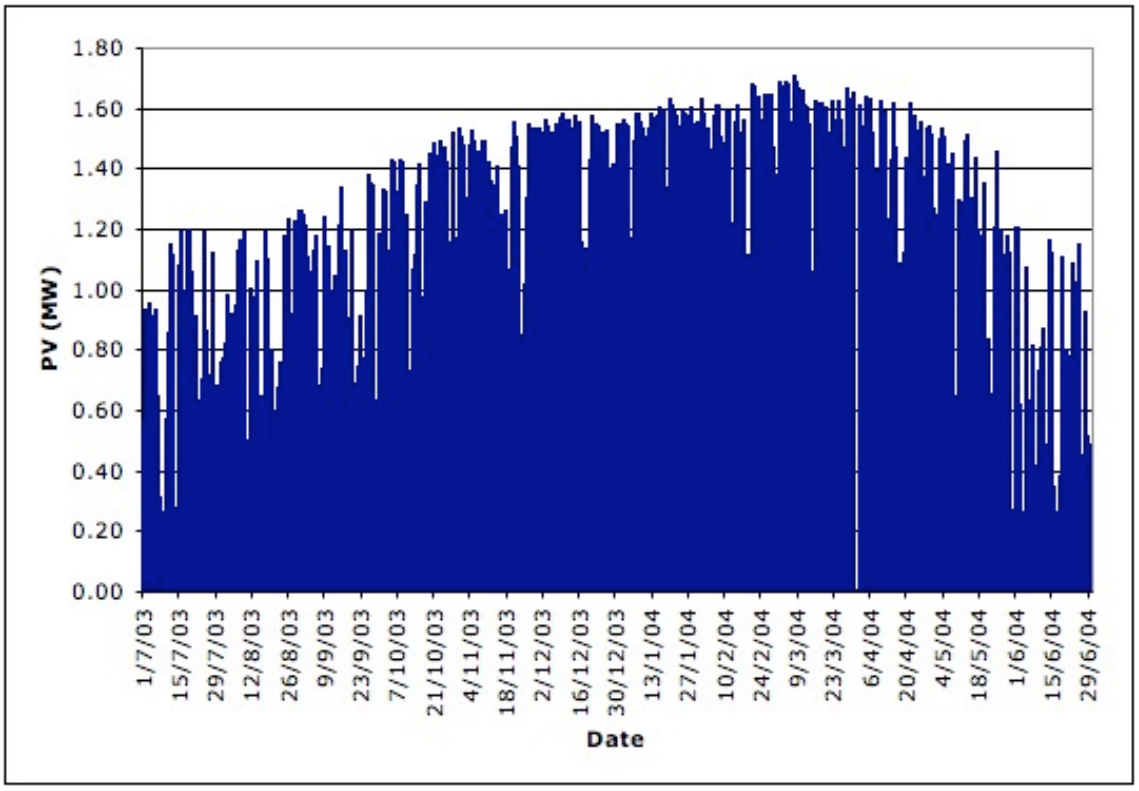

Figure 4: Osborne Park Simulated North-facing PV Output (2MW)
July 2003 to June 2004

Daily profiles

Figure 5 shows the daily annual average load for Osborne Park TX1, the simulated north-facing 2MW PV output, and the net load assuming it is reduced by PV. Both the annual average load and simulated north-facing PV peak at around 12:30pm. As can be seen from Figure 6 to Figure 9, although the spring loads also peak at this time, the summer and autumn peaks occur about an hour later and the winter peak occurs much earlier, at around 11am.

The highest seasonal peak occurs in summer and correlates well with the simulated north-facing PV. Both the spring and autumn peaks are also reduced, however because the winter peak occurs earlier in the day, simulated north-facing PV has a smaller impact – with the result that the reduced winter peak is higher than the reduced summer peak. The impact of simulated west-facing PV is discussed below.

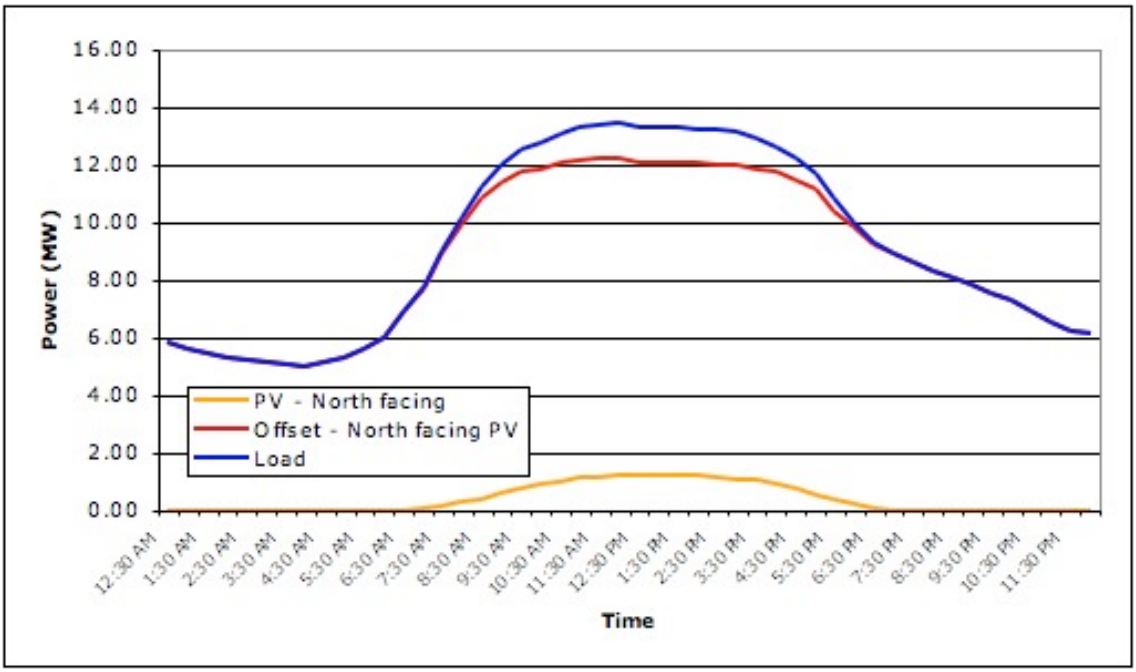

Figure 5: Daily Annual Average
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset
July 2003 to June 2004

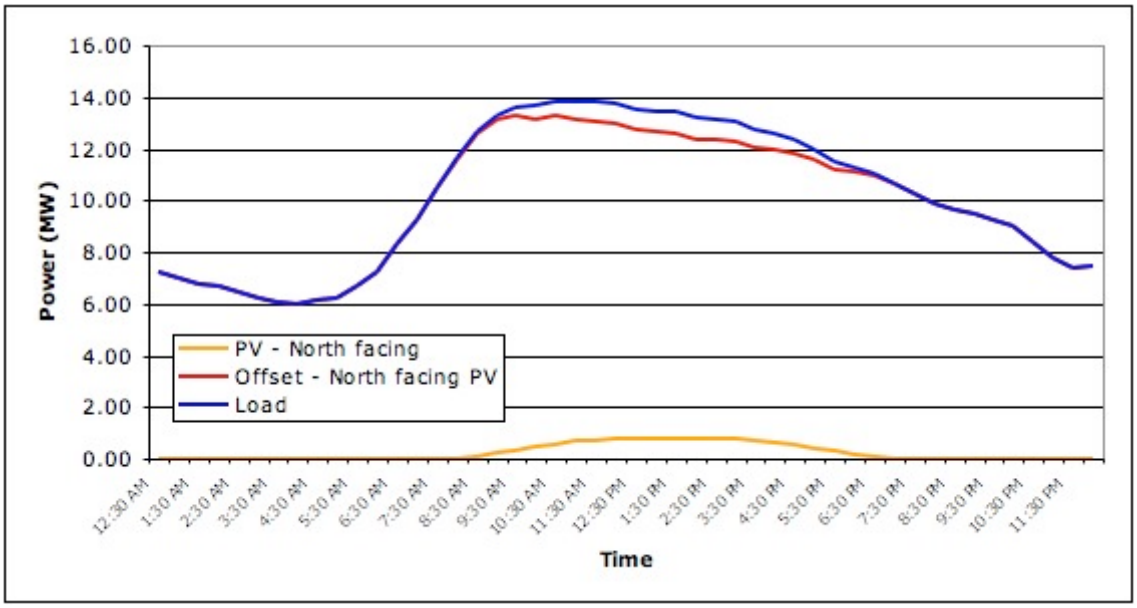

Figure 6: Daily Winter Average
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset
June 2004 and July/Aug 2003

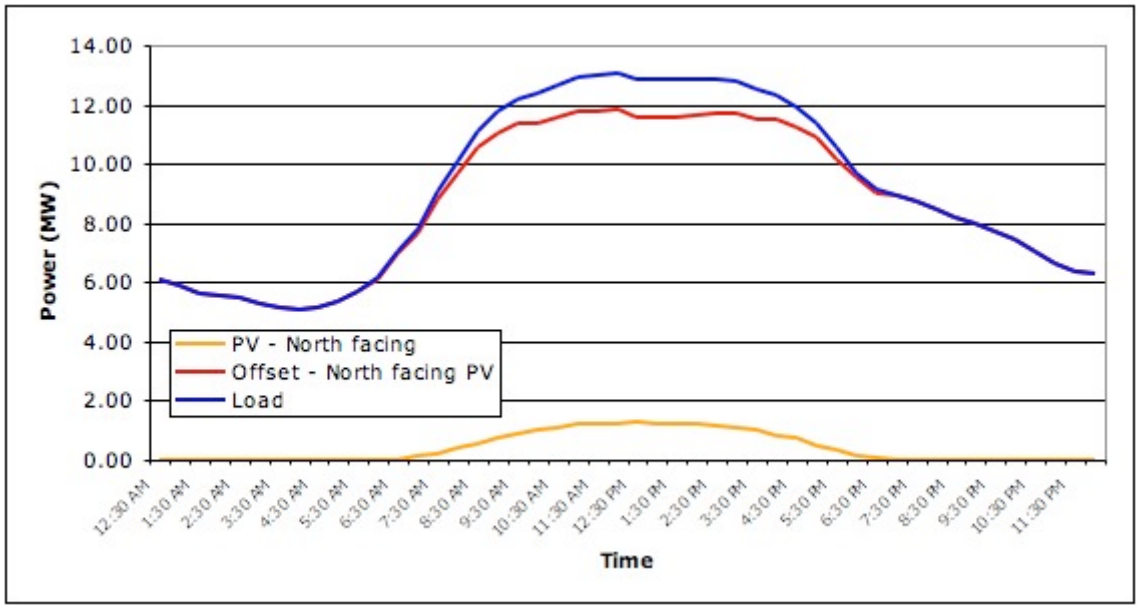

Figure 7: Daily Spring Average
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset
Sept 2003 to Nov 2003

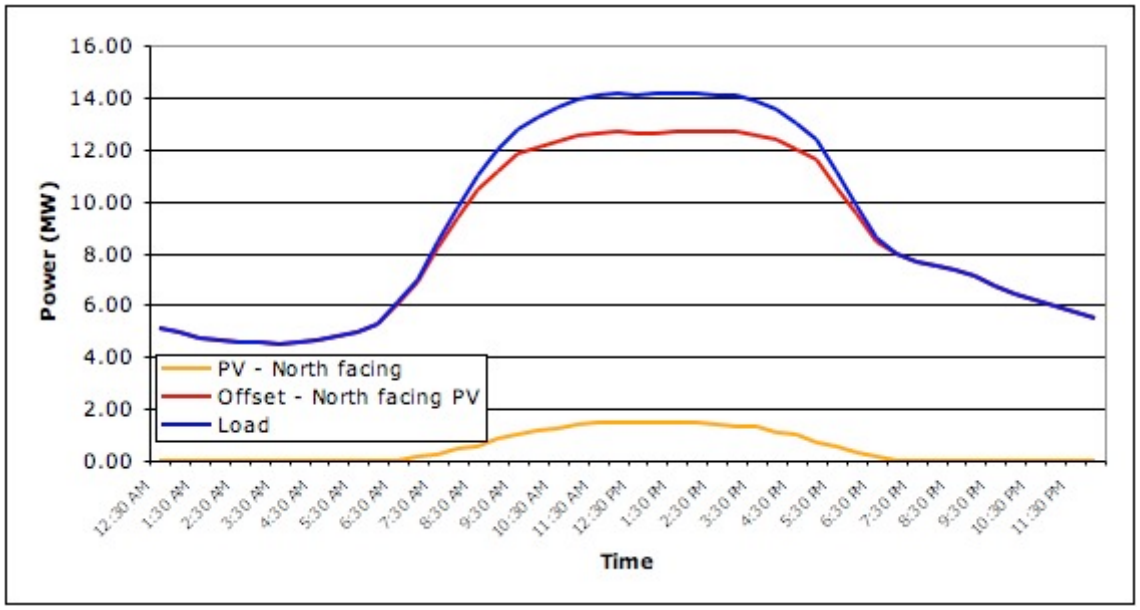

Figure 8: Daily Summer Average
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset
Dec 2003 to Feb 2004

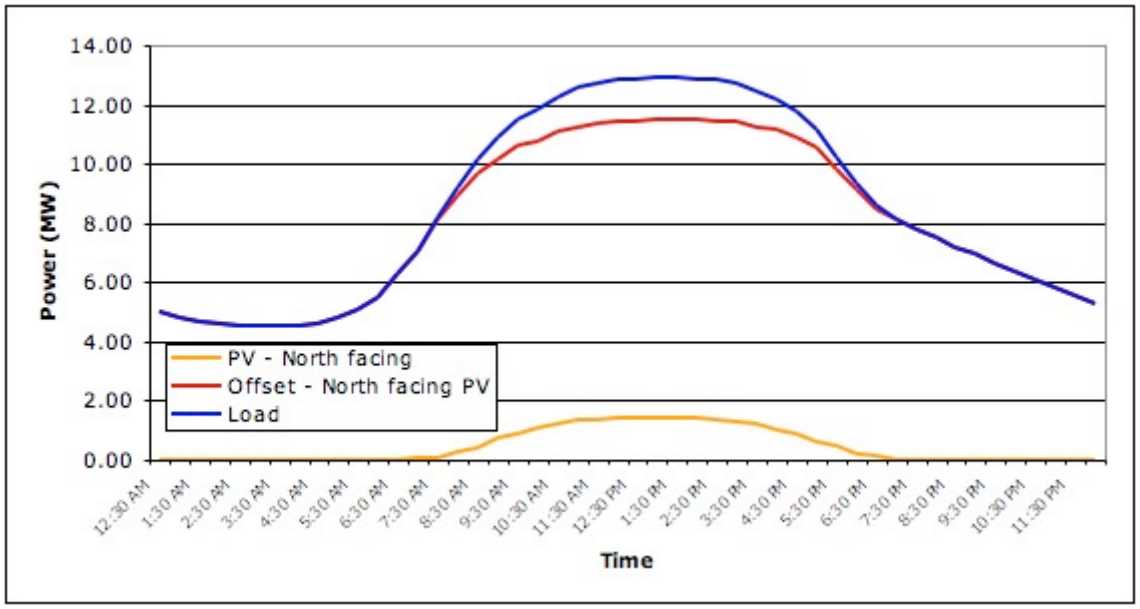

Figure 9: Daily Autumn Average
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset
March 2004 to May 2004

The impact of simulated west-facing PV is illustrated in Figure 10 to Figure 14 and Table 1. Use of simulated west-facing PV with a tilt of 25 degrees shifts the peak PV output by about 1.5 hours later in the day, and a tilt of 45 degrees brings the shift to a total of about 3 hours. However, because the load and simulated north-facing PV output match so well, use of simulated west-facing PV has reduced ability to offset load.

Table 1: Annual Energy Output from Simulated 960W PV at Osborne Park[1]

Orientation	Tilt (degrees)	2003 (kWh/yr)	2004 (kWh/yr)
North	25	1,528	1,695
North west	25	1,585	1,757
West	25	1,476	1,614
West	45	1,409	1,546
West	90	1,015	1,116

[1] Note that these are identical to those for Forrest Ave as they are based on the same ACDB site.

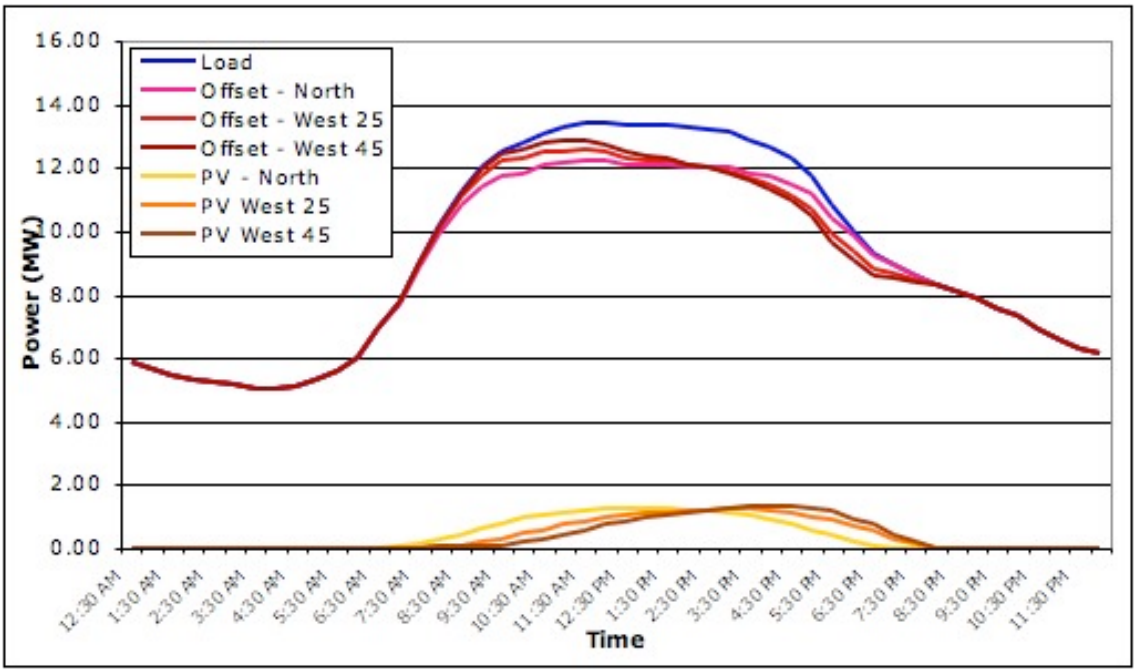

Figure 10: Daily Annual Average
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load, Osborne Park PV (2MW) and Net Load after PV Offset
July 2003 to June 2004

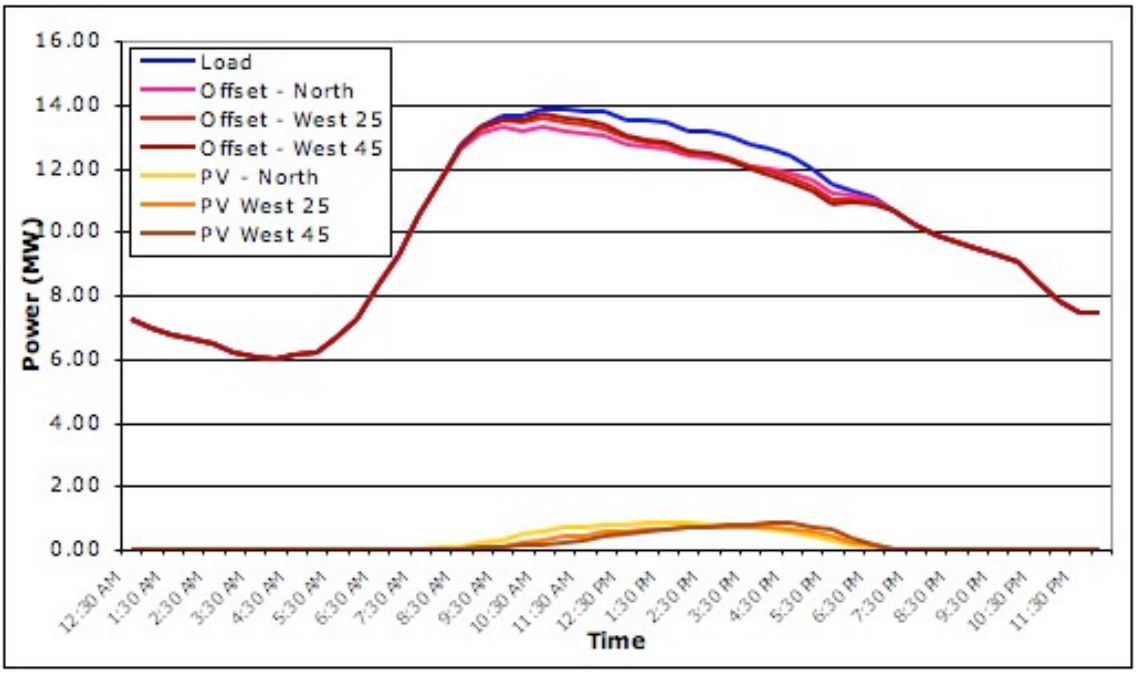

Figure 11: Daily Winter Average
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load, Osborne Park PV (2MW) and Net Load after PV Offset
June 2004 and July/Aug 2003

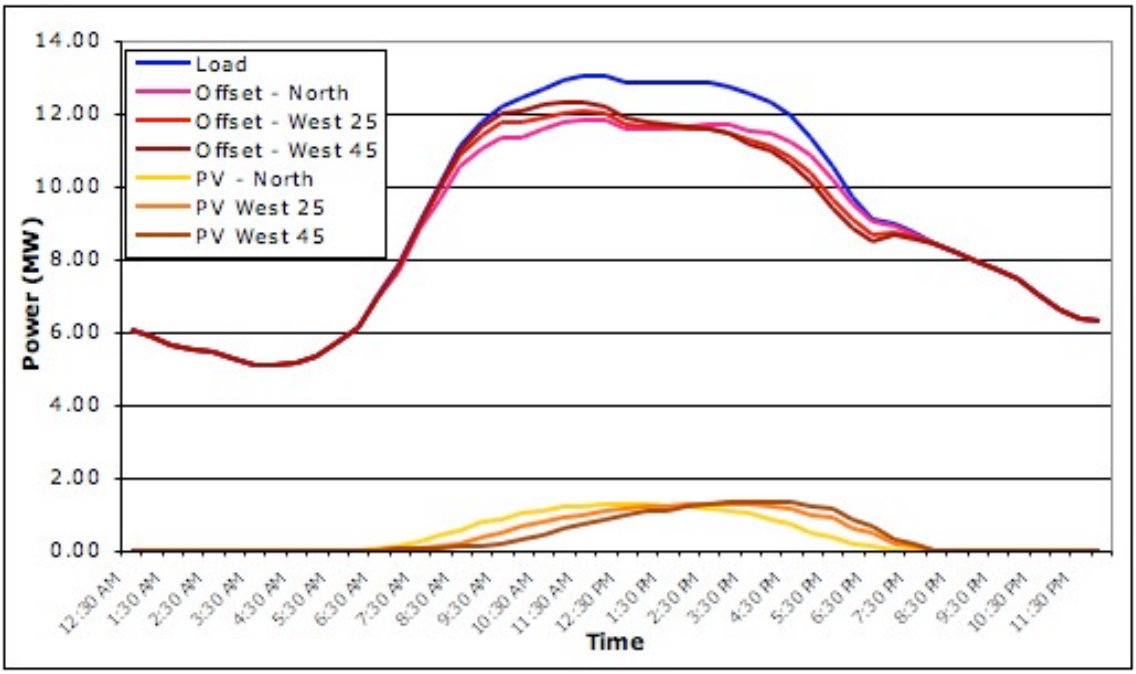

Figure 12: Daily Spring Average
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load, Osborne Park PV (2MW) and Net Load after PV Offset
Sept 2003 to Nov 2003

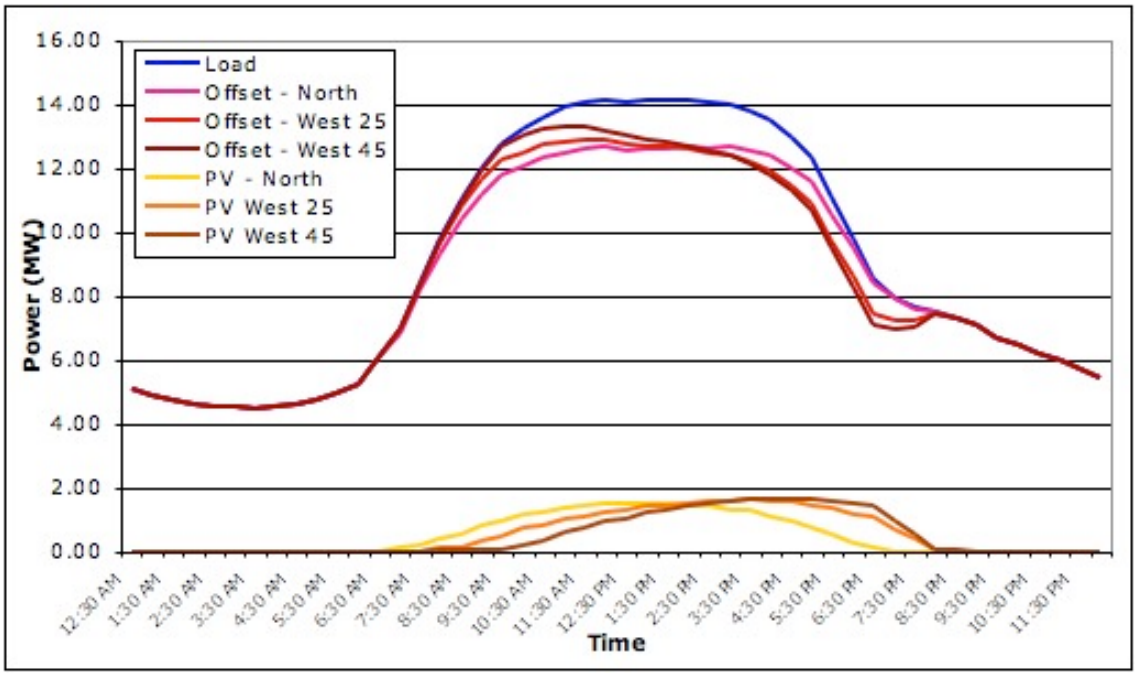

Figure 13: Daily Summer Average
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load, Osborne Park PV (2MW) and Net Load after PV Offset
Dec 2003 to Feb 2004

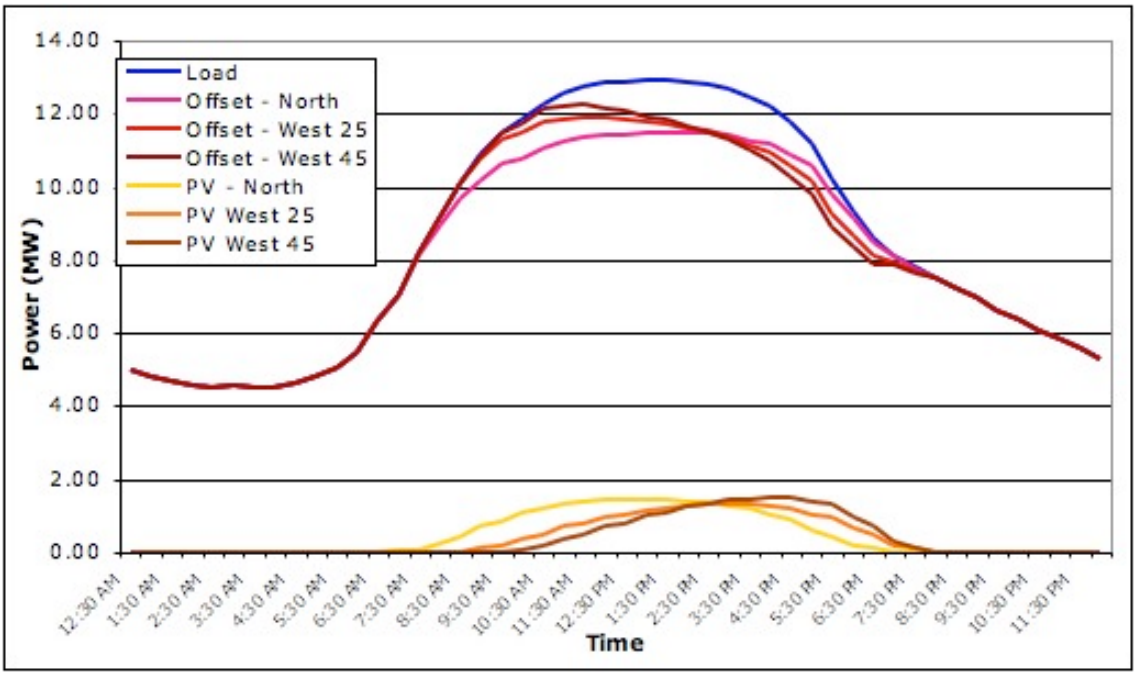

Figure 14: Daily Autumn Average
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load, Osborne Park PV (2MW) and Net Load after PV Offset
March 2004 to May 2004

Times of peak demand

The ten top half-hour demand periods at Osborne Park TX1 are shown in Table 2. All occur on the 4th July 2003 and the 17th Feb 2004, and are the ten highest points in the load duration curves in Figure 19 to Figure 21.

The highest peak load day for the study period occurred in winter (4th July 2003) and is illustrated in Figure 15, where the load rapidly increased from around 6MW to around 17MW, peaking at around 10:30am. The low temperature (less than 20°C) together with the rapid increase and decline indicates this peak is probably due to operational changes by Western Power. The simulated north-facing PV had a good match to load however output was quite low, and so, as can be seen from the load duration curves in Figure 20 and Figure 21, reduced the peak half hour periods by only between 0.7 and 0.9MW.

The second highest cluster of peak load days assessed here (16th -17th Feb 2004; Figure 16), were driven by high temperatures – over 38°C on day 1 then over 40°C on day 2. Again there was generally a good match to simulated north-facing PV output, however because the peak occurred relatively early in the day (11am) it was reduced by only 0.9 to 1.1MW.

The third highest cluster of peak load days assessed here (22nd-25th March 2004; Figure 17) and had a classic commercial profile likely driven by high temperatures (over 41°C), and again had a good match to simulated north-facing PV.

The fourth highest cluster of peak load days assessed here (16th-17th Dec 2003; Figure 18) and was most likely driven by high temperatures (reaching over 33°C), and sudden

changes in the profile indicate large loads going on and off line. Again there was a good match to simulated north-facing PV output.

Table 2: Ten Top Half-hour Demand Peaks at Osborne Park TX1

Demand (MW)	Date	Day	Time
30.50	4-July-03	Fri	10:30
30.33	4-July-03	Fri	11:00
30.07	4-July-03	Fri	12:00
29.92	4-July-03	Fri	11:30
29.82	4-July-03	Fri	12:30
29.57	4-July-03	Fri	13:00
27.75	4-July-03	Fri	13:30
24.18	17-Feb-04	Tues	11:30
23.87	17-Feb-04	Tues	10:30
23.82	17-Feb-04	Tues	10:00

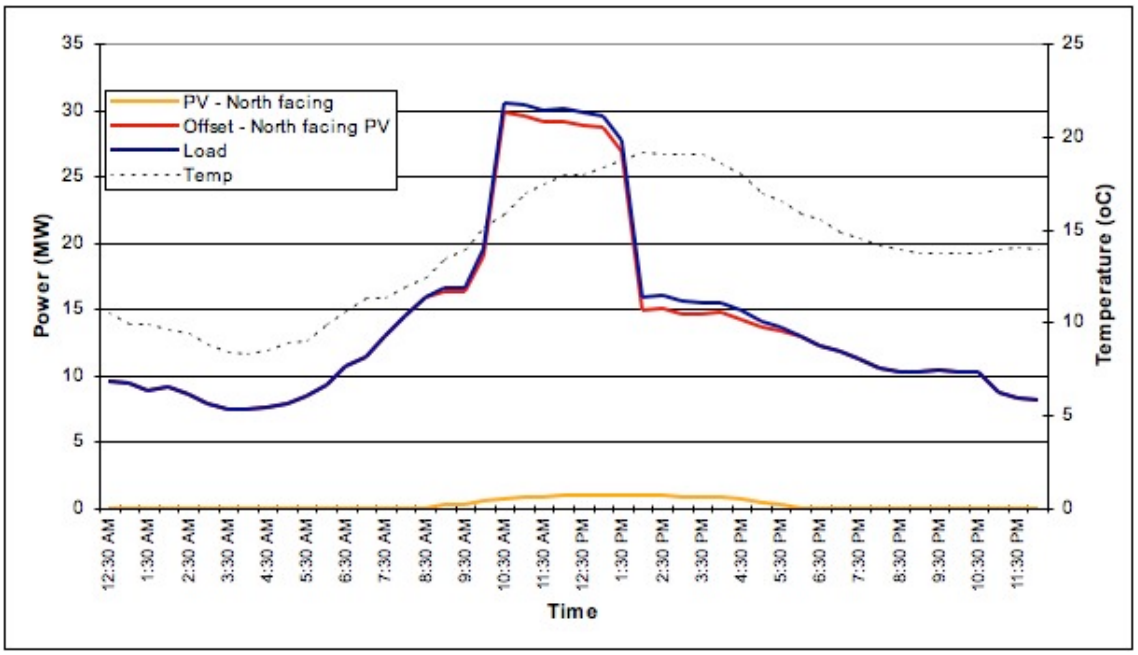

Figure 15: Winter peak day
4th July 2003
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset

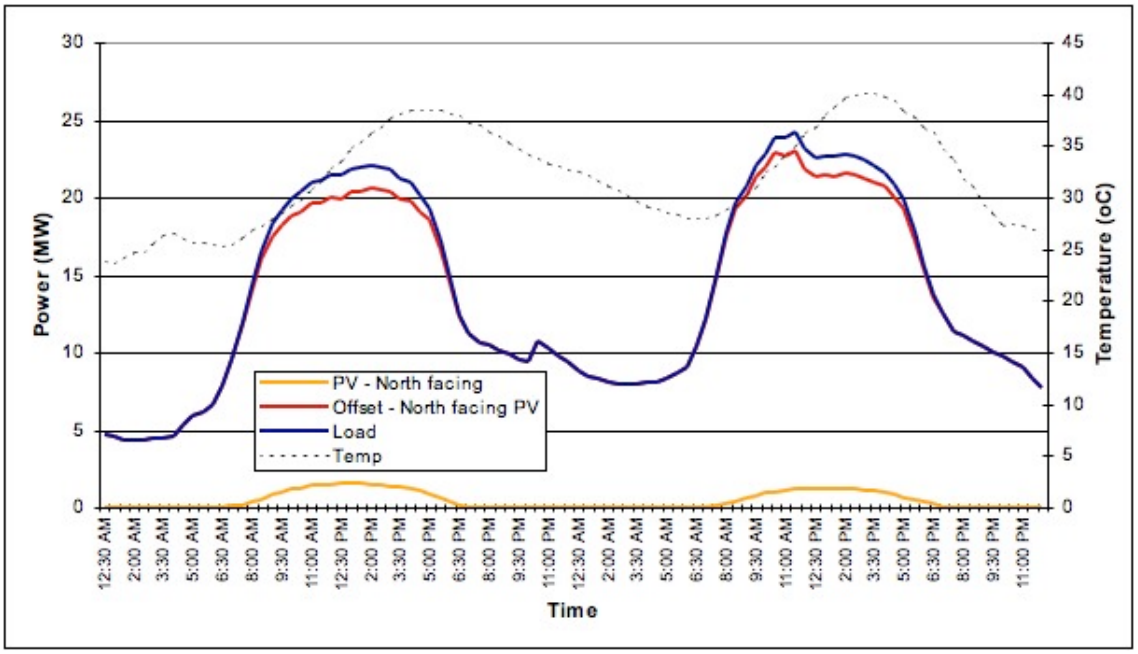

Figure 16: Summer peak days
16th and 17th Feb 2004
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset

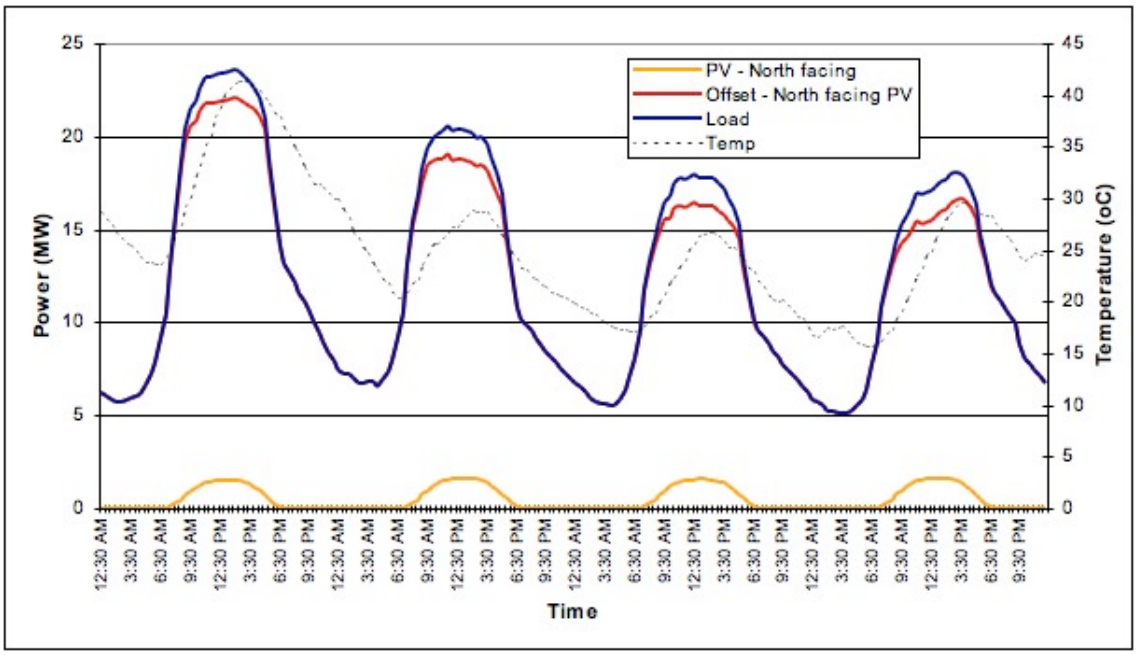

Figure 17: Autumn peak days
22nd-25th March 2004
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset

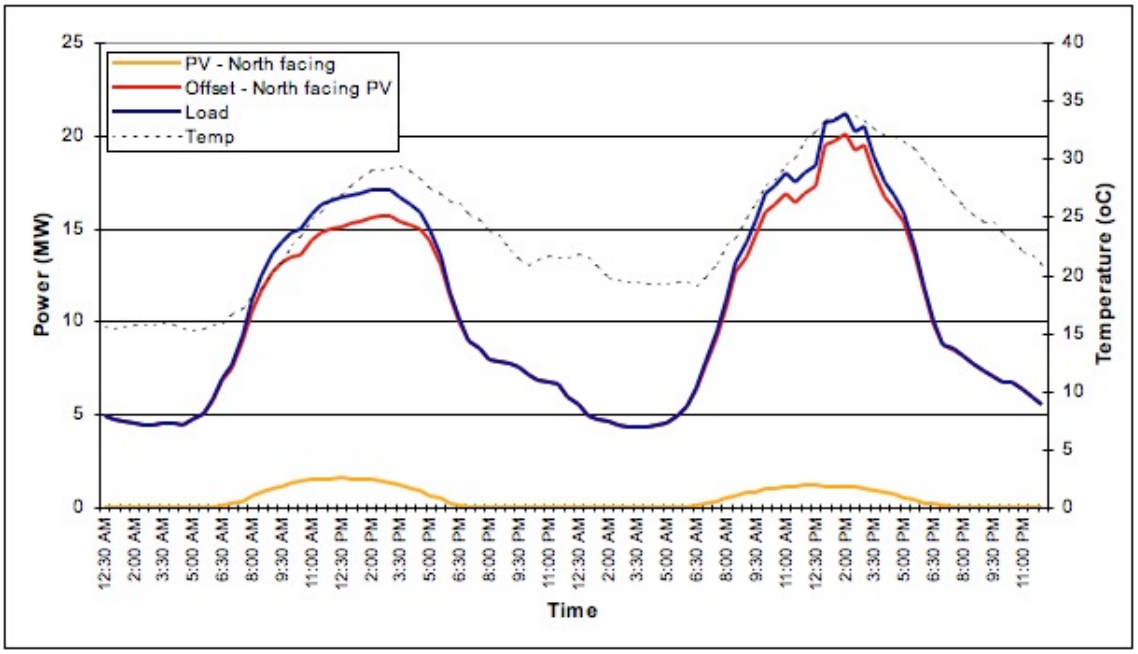

Figure 18: Summer peak days
16th-17th Dec 2003
Osborne Park TX1 Load, Osborne Park Simulated North-facing PV (2MW) and Net Load after PV Offset

Load duration curves

The load duration curve for Osborne Park TX1 is in Figure 19 and displays a pattern that indicates two distinct load levels – around 7MW and around 15MW. The top 50% of the load occurred for 13% of the study period, while the top 10% occurred for 0.04% of the time.

Figure 20 shows the top 50 half hour load periods, together with the offset load duration curve assuming reduction by simulated north-facing PV or simulated west-facing PV at either of two tilt angles (25° and 45°). It can be seen that the simulated north-facing PV resulted in the lowest offset load duration curve, followed by west-25 then west-45. 2MW of simulated north-facing PV changed the highest load period from 30.50MW to 29.84MW (a reduction of 0.66MW, meaning that only 33% of the PV was contributing to load reduction at this time) and resulted in the top 10 offset load periods being lower by an average 0.94MW. PV's contribution was so low because the top 7 load periods occurred on a winter day due to what appear to be operational changes by Western Power.

Figure 21 shows the same load duration curves except that the offset periods now correspond to the load periods directly above them on the chart, and it can be seen that the 10 highest load periods are in the same order as in Figure 20.

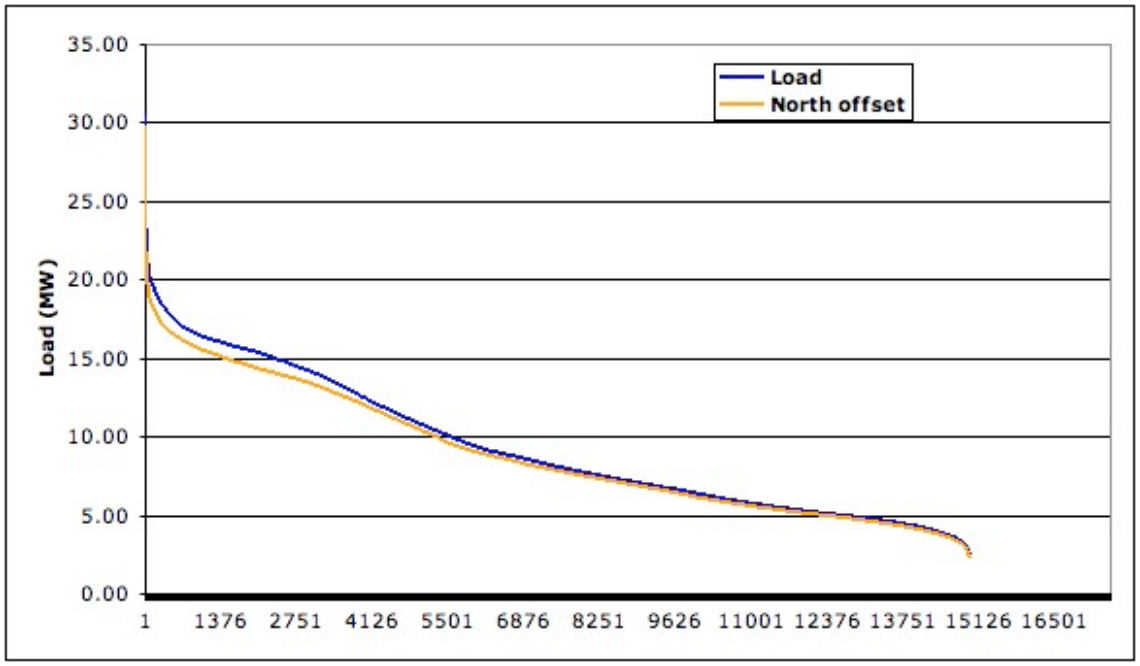

Figure 19: Load Duration Curve - July 2003 to June 2004
Osborne Park TX1 Load and Osborne Park TX1 Net Load after PV Offset (2MW)

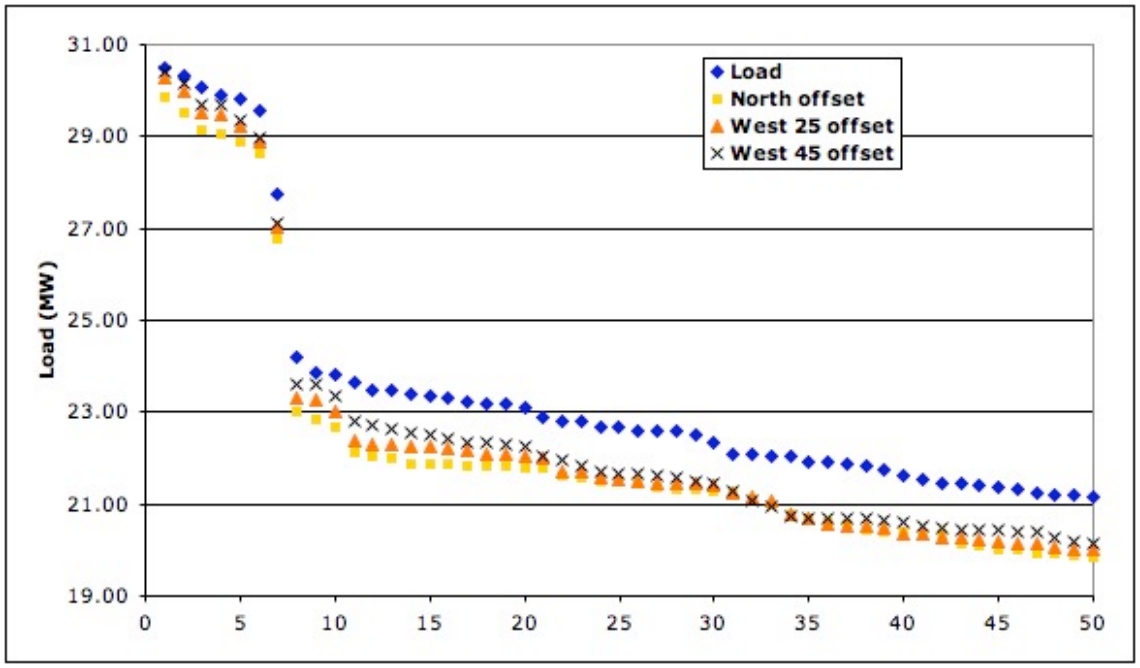

Figure 20: Load Duration Curve - top 50 load periods
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load and Osborne Park TX1 Net Load after PV Offset (2MW)
July 2003 to June 2004

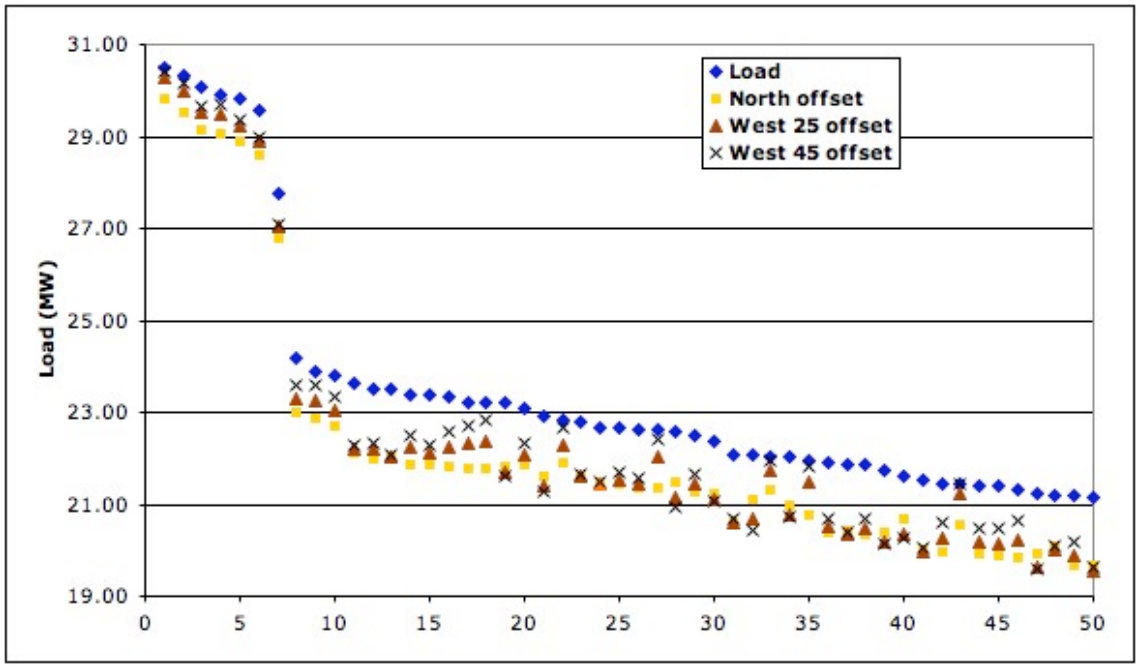

Figure 21: Load Duration Curve - top 50 load periods (linked)
North, and West (25° and 45° inclinations)
Osborne Park TX1 Load and Osborne Park TX1 Net Load after PV Offset (2MW)
July 2003 to June 2004

General correlation between PV Output and Load

Figure 22 shows the relationship between north-facing simulated PV output and the Osborne Park TX1 load at any one time, and shows some correlation. The load is split into two distinct regions - though not so distinct as occurred for Forrest Jnct - corresponding to the baseload periods and the daytime peaks – where the latter displays some correlation with PV output, extending up and to the right. When the PV output is plotted against the offset load (ie. reduced load because of PV), the PV shifts the load points at the top of the chart, to the left – see Figure 23. The cluster of data points at about 30MW load correspond to the high load points on the 4th July 2003 that are only moderately reduced by PV (Figure 15). Avoiding these peaks through other means such as demand side management or rerouting through a different transformer would significantly increase PV's ability to reduce peak loads through TX1.

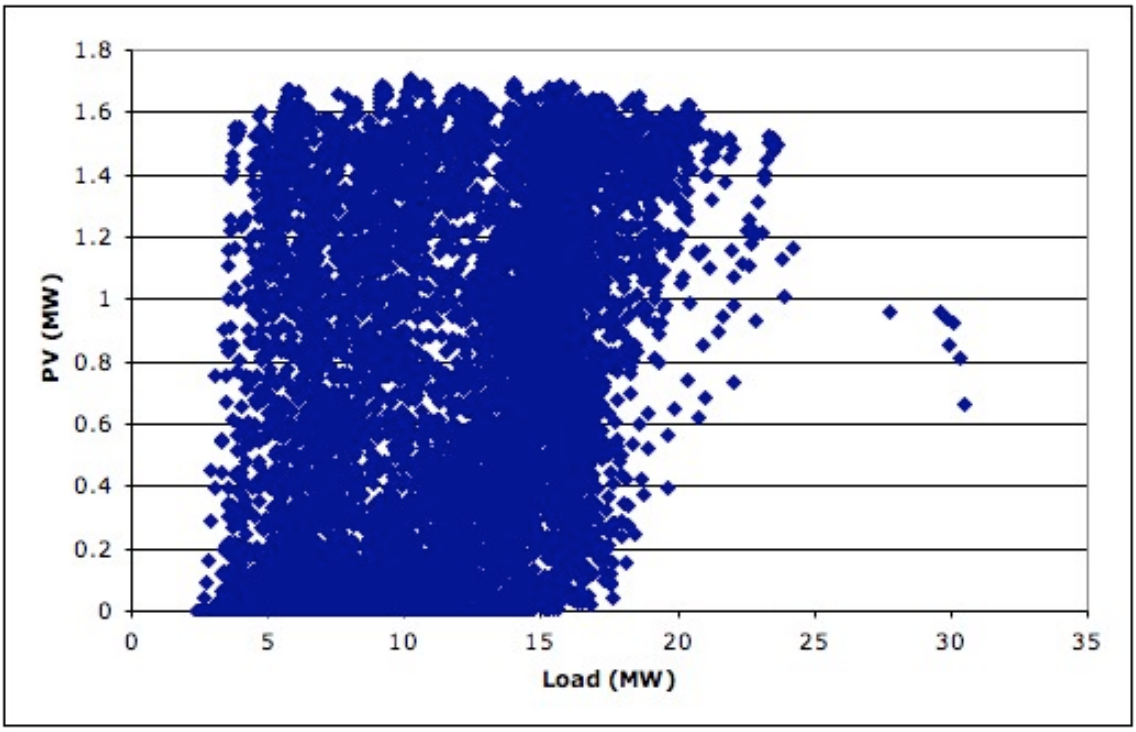

Figure 22: Osborne Park Simulated North-facing PV (2MW) vs Osborne Park TX1 Load
July 2003 to June 2004

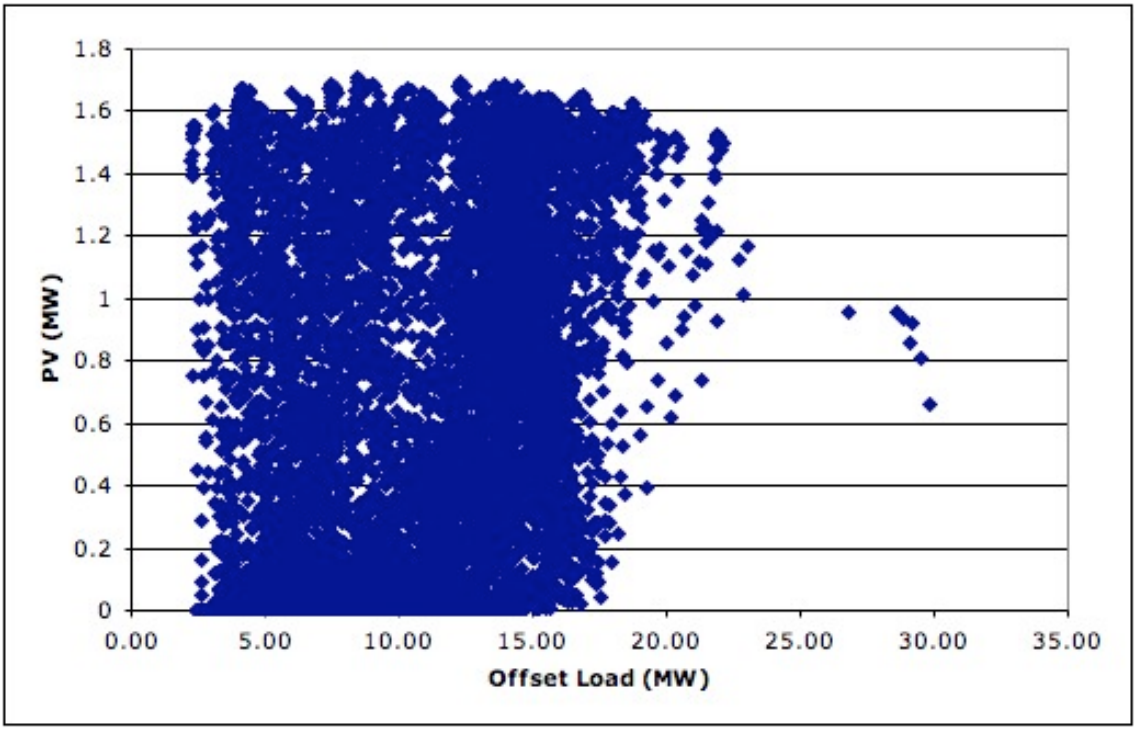

Figure 23: Osborne Park Simulated North-facing PV (2MW) vs Osborne Park TX1 Net Load after PV Offset
July 2003 to June 2004

Correlation with temperature

Figure 24 shows the relationship between the Osborne Park TX1 load and temperature, and shows fair correlation, with load tending to increase with temperature. The cluster of detached data points around 30MW correspond to the high load points on the 4th July 2003.

Figure 25 shows the relationship between simulated north-facing PV output and temperature, and shows some correlation, where PV tends to increase at higher temperatures, which would normally occur during the middle of the day – although note there are instances of zero PV output at high temperatures, presumably on hot summer evenings. The sudden cutoff around 1.6 to 1.7MW is likely an artefact of the PV simulation.

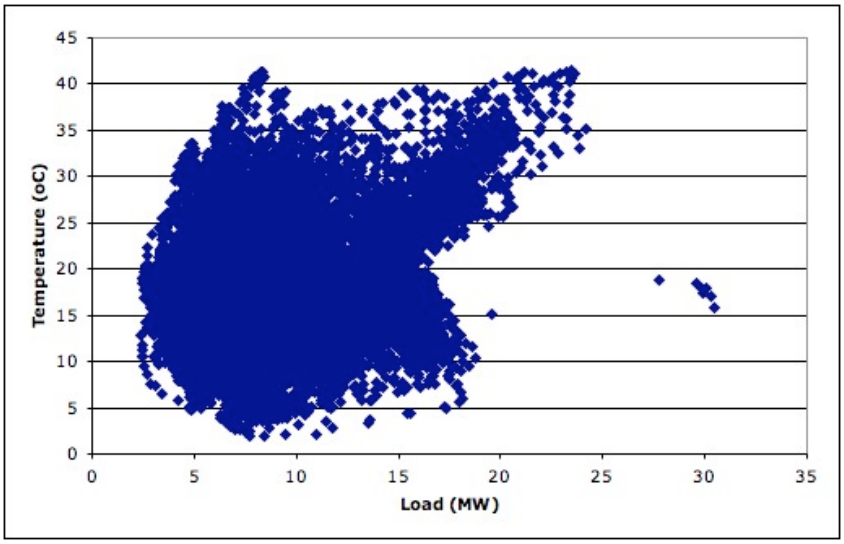

Figure 24: Osborne Park TX1 Load vs Temperature
July 2003 to June 2004

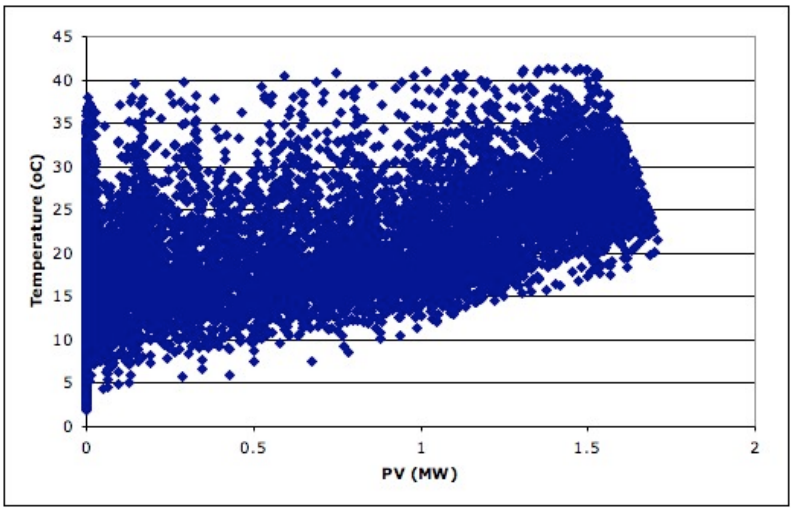

Figure 25: Osborne Park Simulated North-facing PV (2MW) vs Temperature
July 2003 to June 2004