KATANNING

Summary of characteristics

Katanning substation presently has 3 transformers and the substation firm capacity is 13.0 MVA in summer and 14.4 MVA in winter. Katanning is usually a winter peaking substation, however summer loads are now close to winter loads and due to the reduced transformer rating in summer, both summer and winter peak loads are critical with respect to substation capacity. Note that the following analysis is based on 2003/04 data, at a time when the winter peak was significantly greater than the summer peak.

Annual profile

The July 2003 to June 2004 load profile for Katanning TX2 is shown in Figure 1. It is characterised by a constant baseload around 1.5MW, with daily maxima about double the size of the baseload and increasing during winter, especially July/August. It also has a clear weekly cycle, with reduced weekend loads – see Figure 2 (which also includes some of the peak load days assessed here) and Figure 3. There are a number of days of extreme demand peaks, which are discussed in more detail below. Figure 4 shows the 400kW simulated north-facing PV output for ACDB site 'Katanning', which increases in summer as expected, particularly Feb to April, before dropping sharply in the winter months.

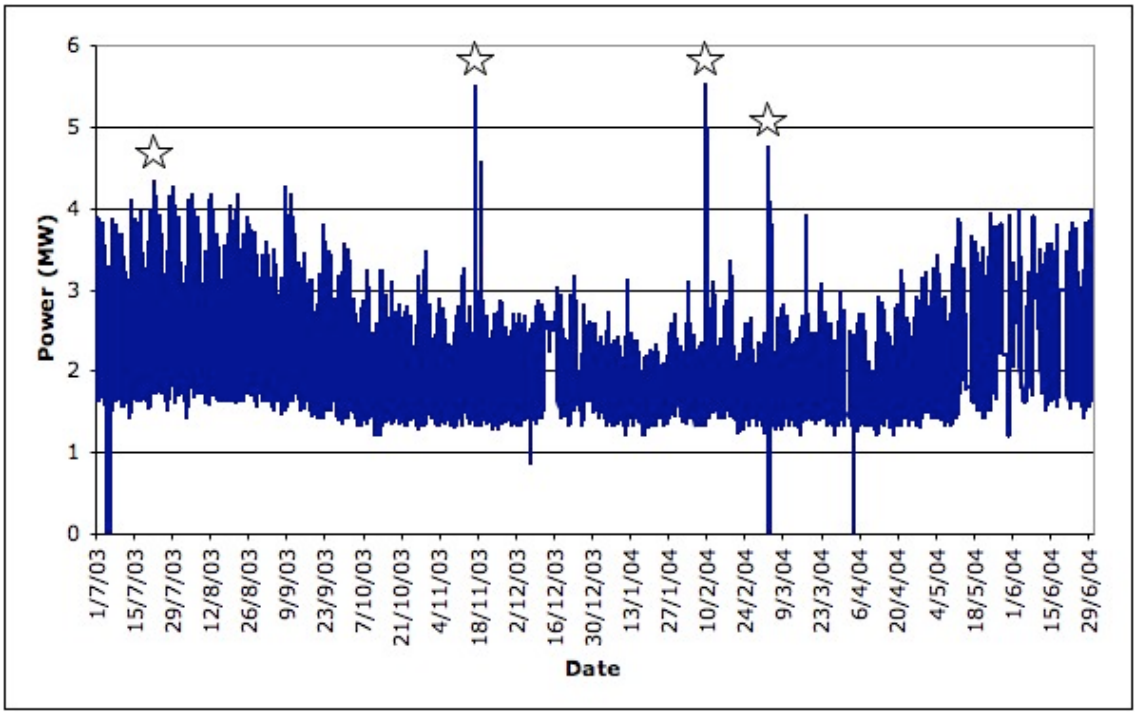

Figure 1: Katanning TX2 Load
July 2003 to June 2004
(the stars indicate the peak days analysed in detail below)

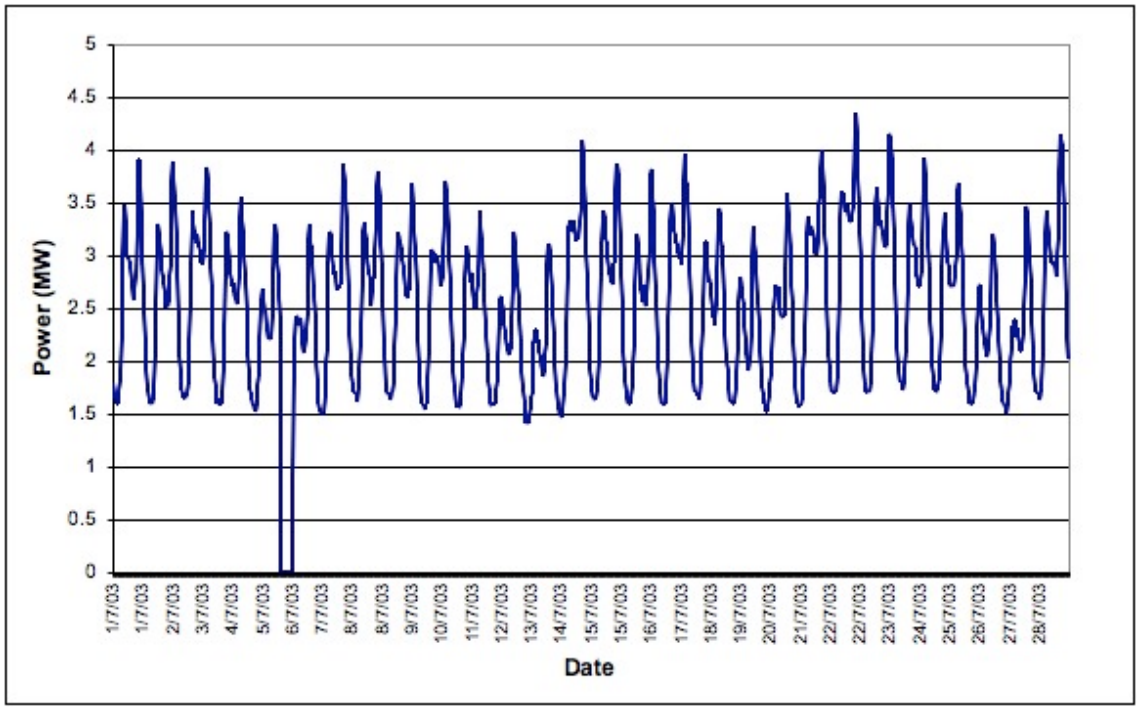

Figure 2: Katanning TX2 Load - July
The first 28 days of July 2003

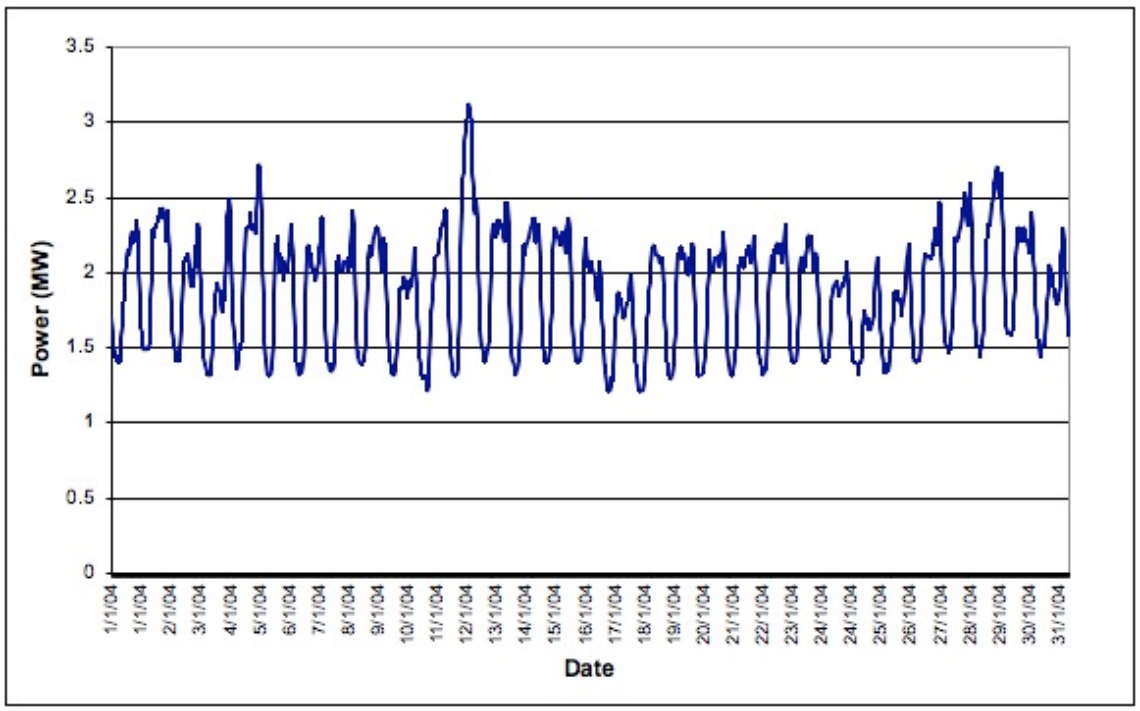

Figure 3: Katanning TX2 Load - Jan
The first 28 days of Jan 2004

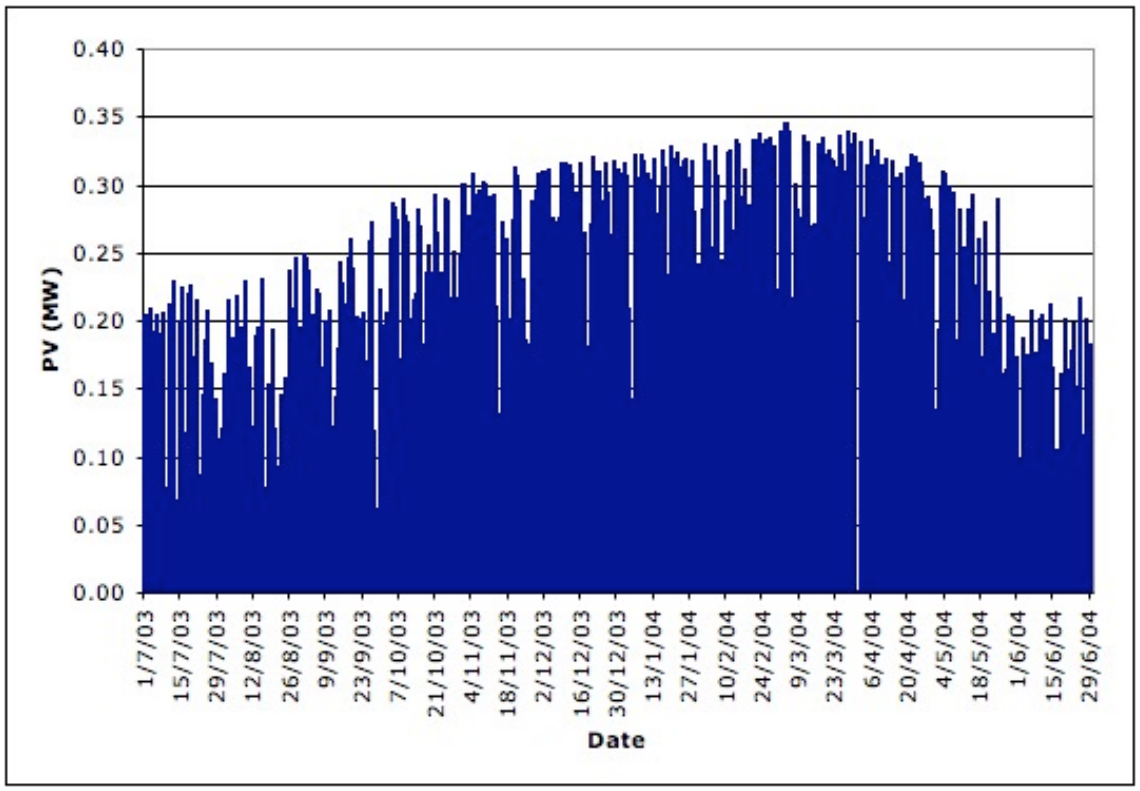

Figure 4: Katanning Simulated North-facing PV Output (400kW)
July 2003 to June 2004

Daily profiles

Figure 5 shows the daily annual average load for Katanning TX2, the simulated north-facing 400kW PV output, and the net load assuming it is reduced by PV. The annual average load peaks at 7pm while the simulated north-facing PV peaks at around 1pm. As can be seen from Figure 6 to Figure 9, the winter peak is the highest and all seasons peak around 7pm – a time where the simulated north-facing PV has no impact.

The impact of west-facing simulated PV on energy output is illustrated in Table 1. It would have an insignificant impact on the seasonal profiles and so they are not shown here.

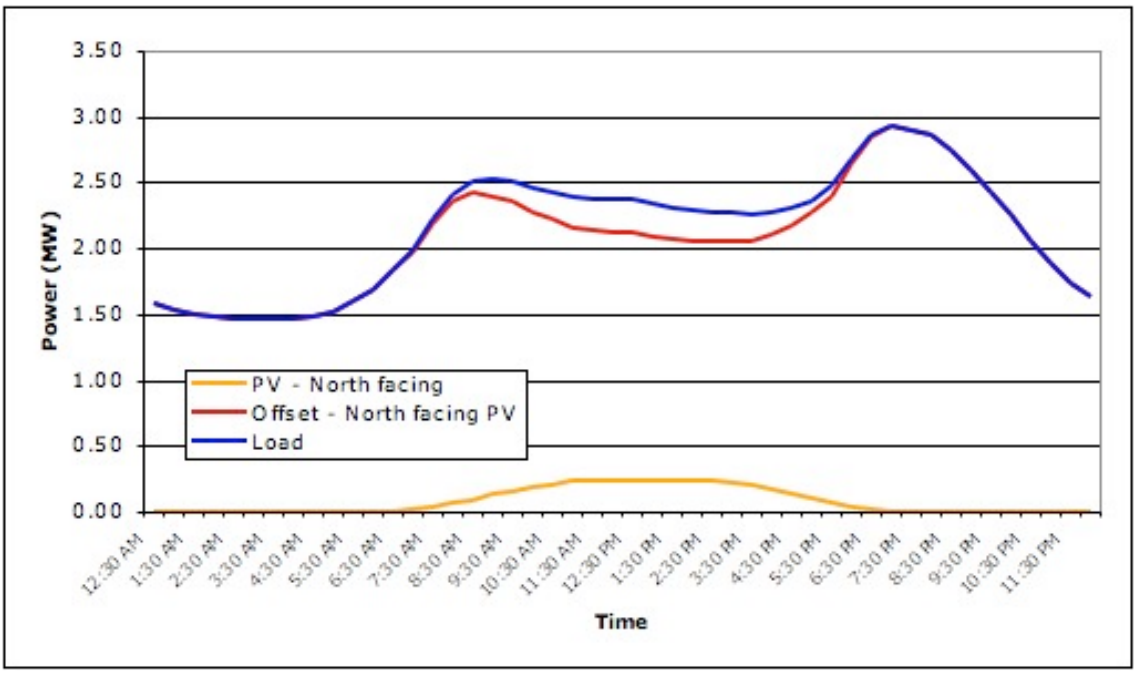

Figure 5: Daily Annual Average
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset
July 2003 to June 2004

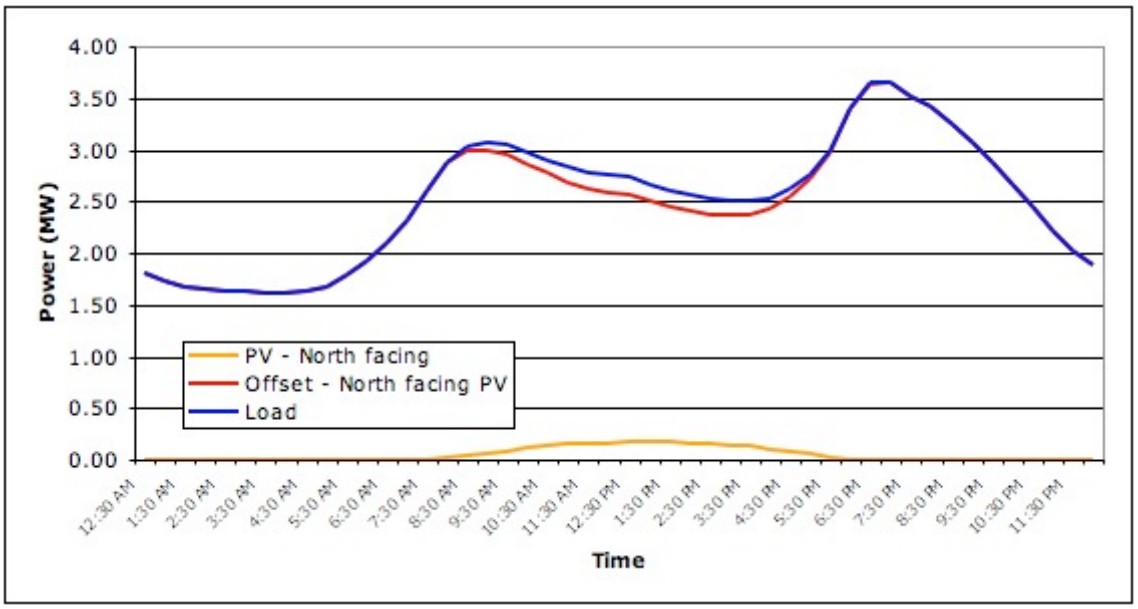

Figure 6: Daily Winter Average
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset
June 2004 and July/Aug 2003

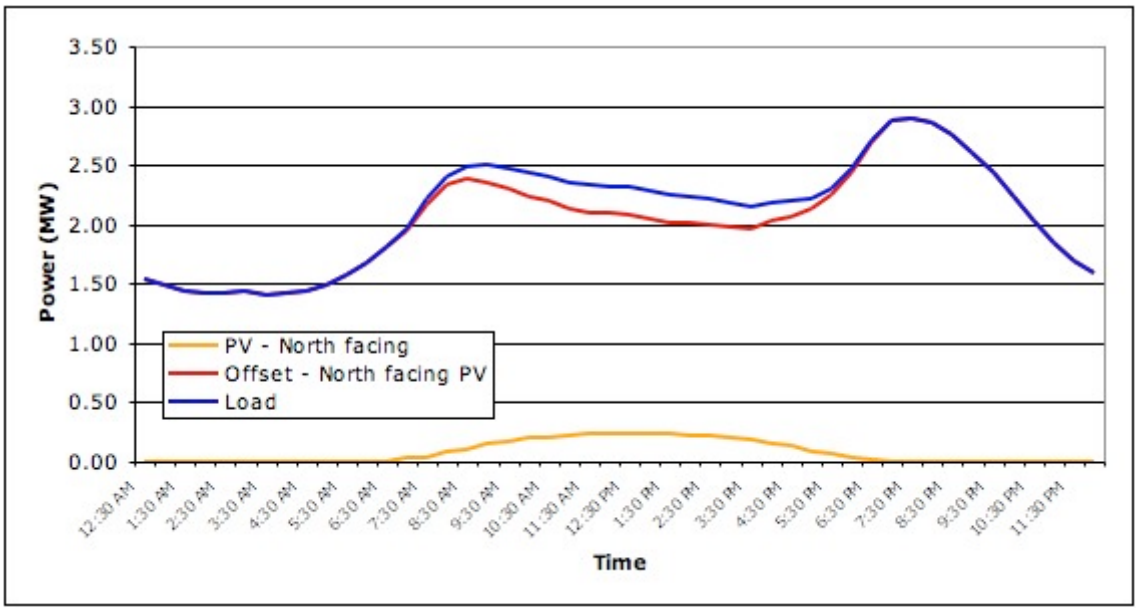

Figure 7: Daily Spring Average
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset
Sept 2003 to Nov 2003

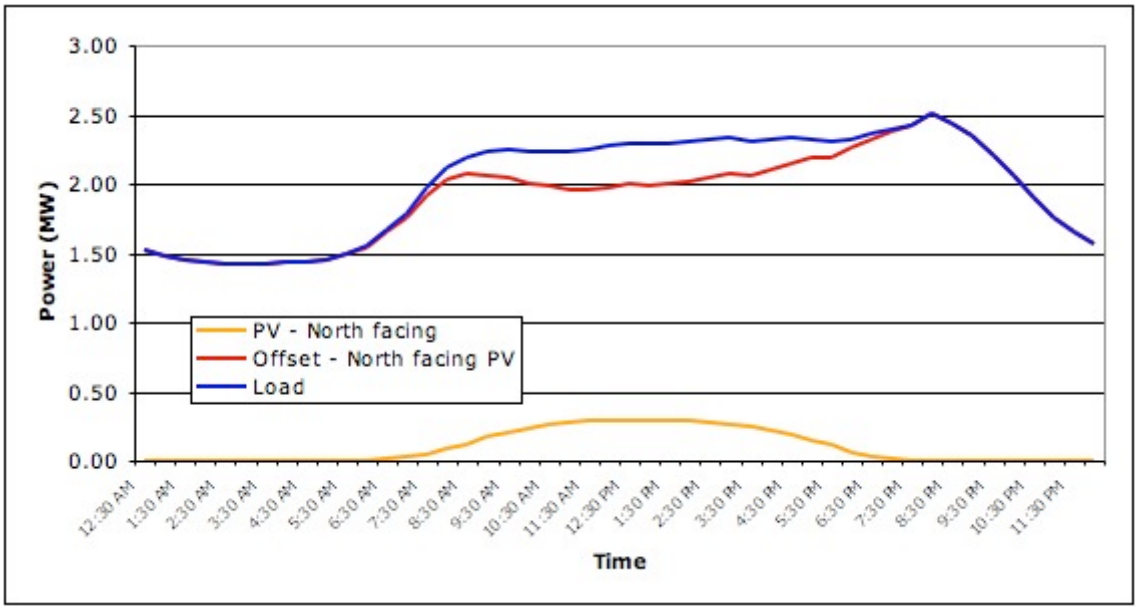

Figure 8: Daily Summer Average
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset
Dec 2003 to Feb 2004

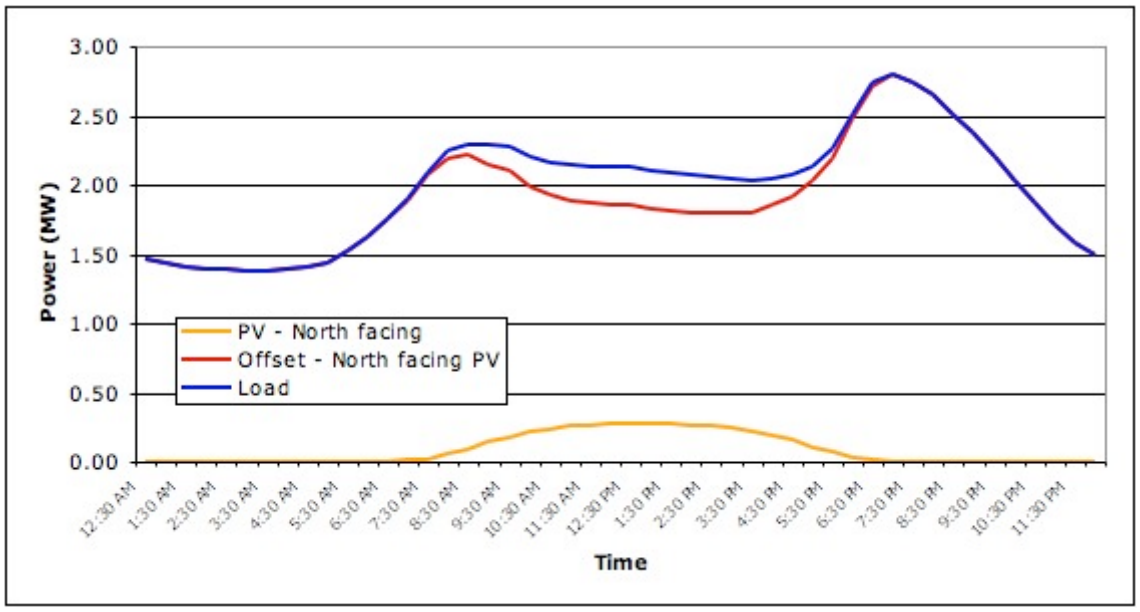

Figure 9: Daily Autumn Average
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset
March 2004 to May 2004

Table 1: Annual Energy Output from Simulated 960W PV at Katanning

Orientation	Tilt (degrees)	2003 (kWh/yr)	2004 (kWh/yr)
North	25	1,489	1,657
North west	25	1,522	1,695
West	25	1,408	1,549
West	45	1,332	1,466
West	90	948	1,048

Times of peak demand

The ten top half-hour demand periods at Katanning TX2 are shown in Table 2. All occur on the 9th Feb 2004 and the 17th Nov 2003, which are illustrated in Figure 10 and Figure 11 respectively, and are the ten highest points in the load duration curves in Figure 14 to Figure 16.

The highest peak load day for the study period (9th Feb 2004; Figure 10) and the following day were not particularly hot and have very unusual load profiles that reflect either operational changes by Western Power or large loads going on and off-line. The load peaked in the evening, at a time when even simulated west-facing PV would make little significant contribution.

The second highest peak load day (17th Nov 2003; Figure 11) again was not hot and appears to be due to operational changes or sudden large loads. The peak occurred in the middle of the day as so was well matched to simulated north-facing PV, which was quite low due to low insolation levels.

The third highest cluster of peak load days assessed here (3rd-5th March; Figure 12), again appears due to operational changes or sudden large loads, and includes a complete loss of load for 20hrs. The peak occurred at 8:30am and so was not well matched to simulated north-facing PV.

The fourth highest of the peak load days assessed here (22nd July 2004; Figure 13) has a classic residential winter profile, peaking between 6:30 and 7pm, and so was not at all matched to even west-facing simulated PV.

Table 2: Ten Top Half-hour Demand Peaks at Katanning TX2

Demand (MW)	Date	Day	Time
5.53	9-Feb-04	Mon	19:30
5.50	17-Nov-03	Tues	12:30
5.43	17-Nov-03	Tues	14:30
5.40	9-Feb-04	Mon	19:00
5.37	9-Feb-04	Mon	20:00
5.37	17-Nov-03	Tues	13:00
5.35	17-Nov-03	Tues	15:00
5.32	17-Nov-03	Tues	13:30
5.32	9-Feb-04	Mon	16:00
5.32	9-Feb-04	Mon	18:30

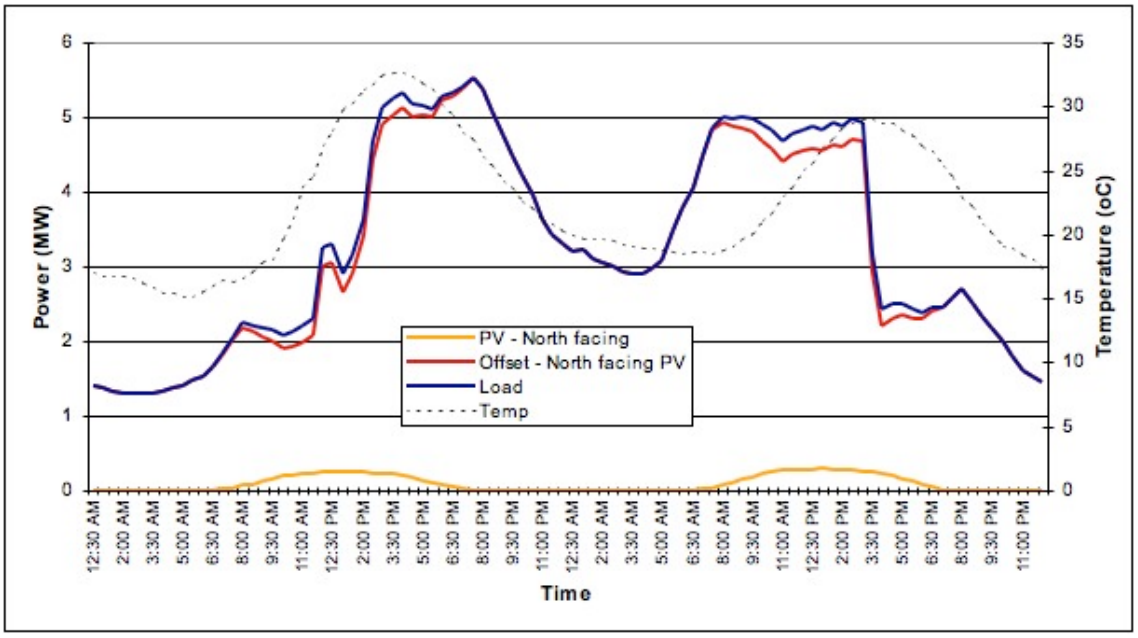

Figure 10: Summer peak days
9th-10th Feb 2004
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset

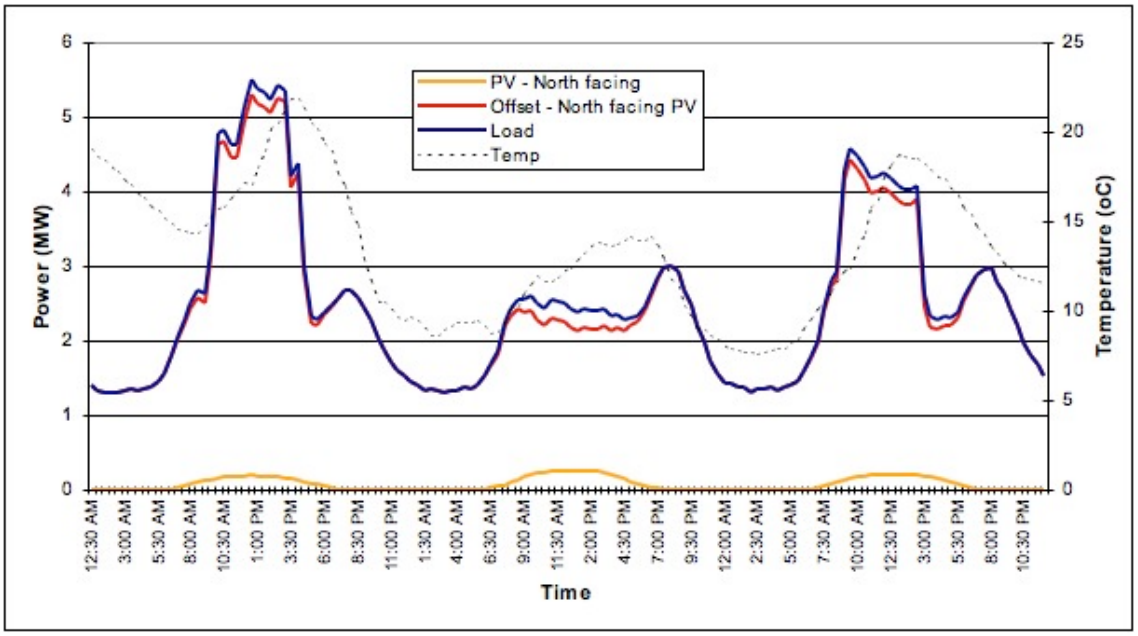

Figure 11: Spring peak days
17th-19th Nov 2003
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset

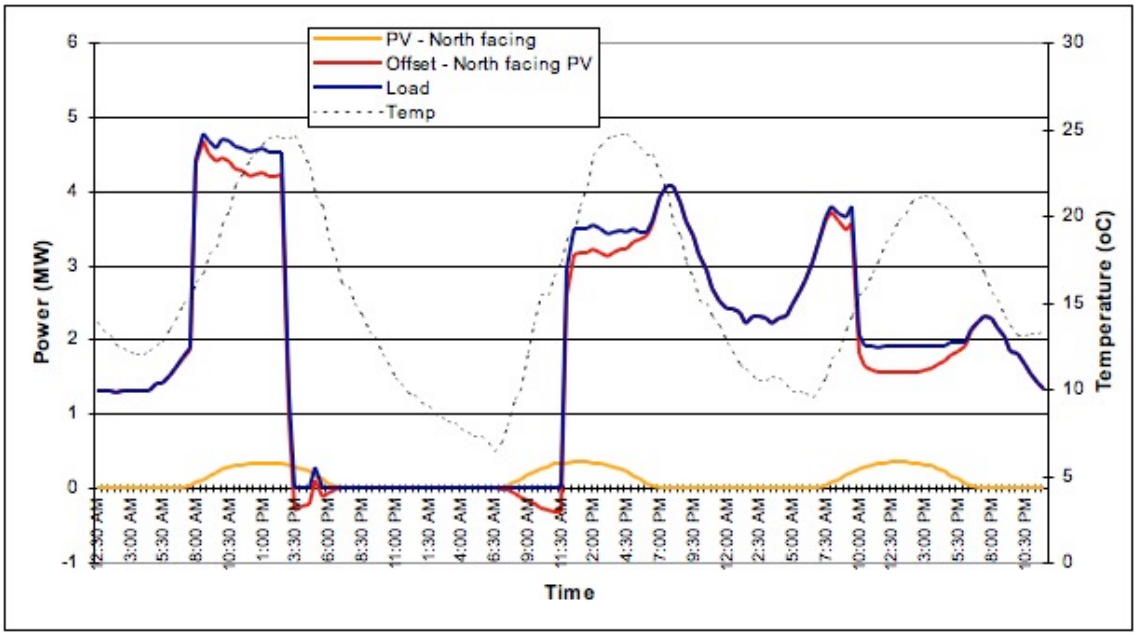

Figure 12: Autumn peak days
3rd-5th March 2004
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset

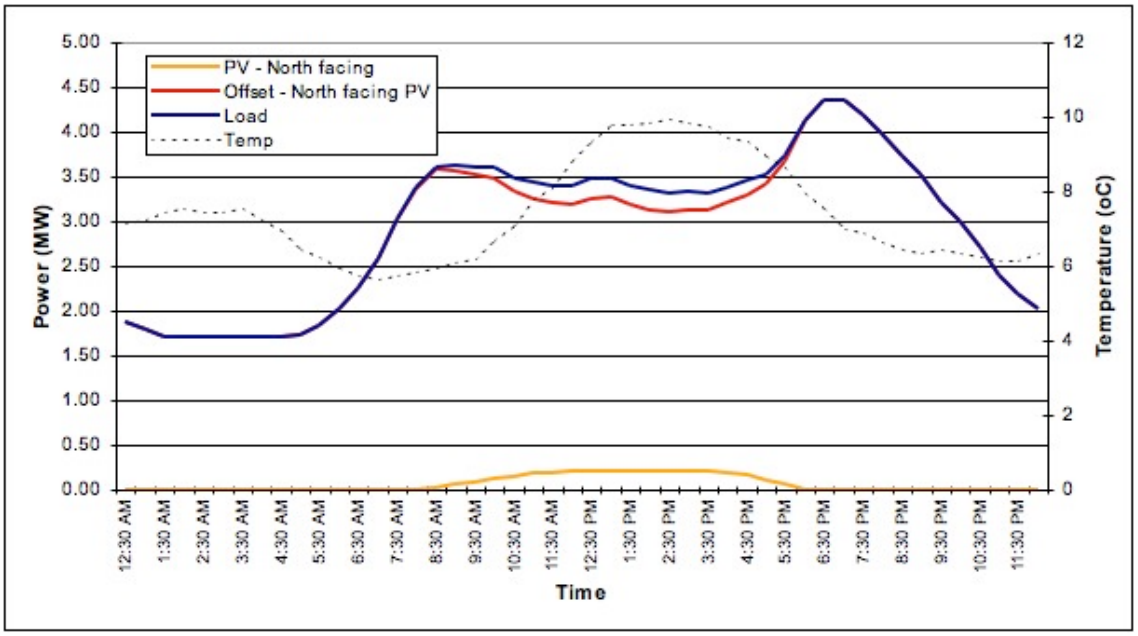

Figure 13: Winter peak days
22nd July 2003
Katanning TX2 Load, Katanning Simulated North-facing PV (400kW) and Net Load after PV Offset

Load duration curves

The load duration curve for Katanning TX2 is in Figure 14. The top 50% of the load occurred for just under 33% of the study period, while the top 10% occurred for 0.13% of the time.

Figure 15 shows the top 50 half hour load periods, together with the offset load duration curve assuming reduction by north-facing simulated PV or west-facing simulated PV at either of two tilt angles (25° and 45°). It can be seen that none of the simulated PV options reduced these load periods significantly. 400kW of simulated west-facing-45 PV resulted in the highest offset load period being 50kW lower than the highest original load period, and resulted in the top 10 offset load periods being lower by an average of 140kW.

Figure 16 shows the same load duration curves except that the offset periods now correspond to the load periods directly above them on the chart. This shows that during the highest load period, only 12.5% of the 400kW simulated PV would have contributed to load reduction, reducing it from 5.53MW to 5.48MW. On average during the 10 highest load periods, 14% the 400kW simulated PV was contributing to reducing peak load.

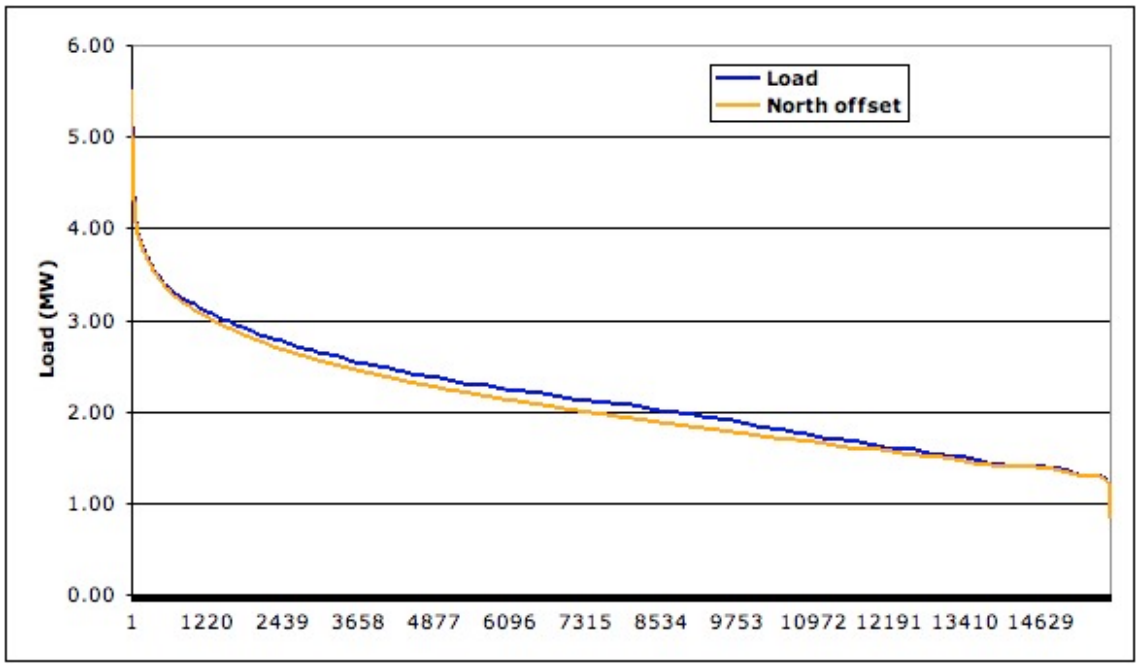

Figure 14: Load Duration Curve - July 2003 to June 2004
Katanning TX2 Load and Katanning TX2 Net Load after PV Offset (400kW)

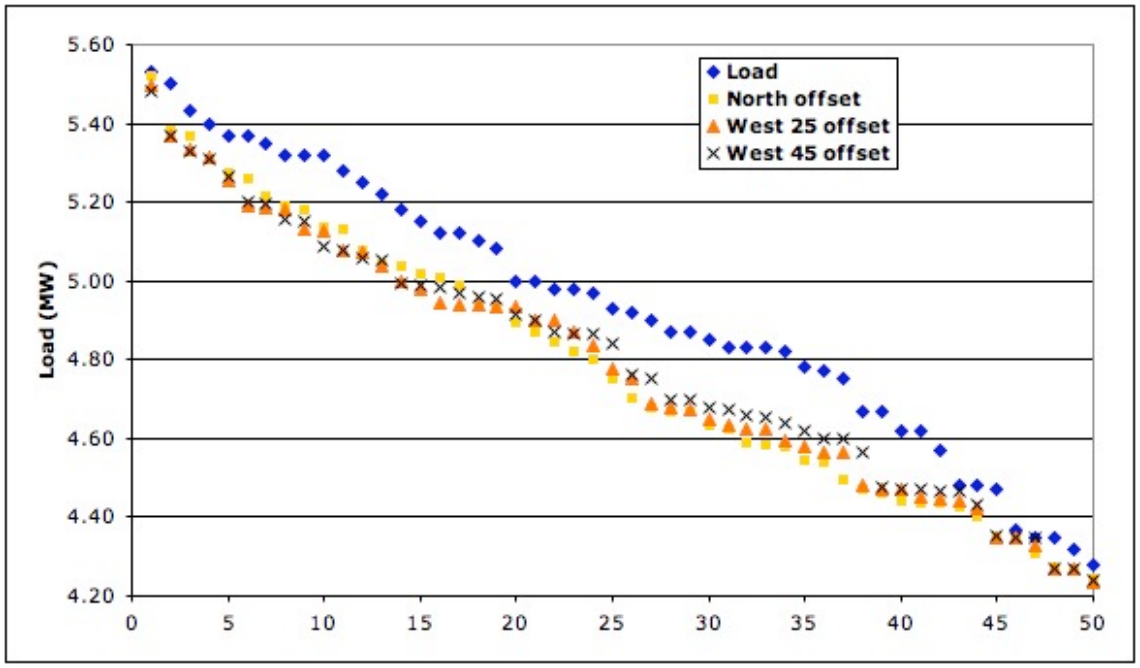

Figure 15: Load Duration Curve - top 50 load periods
North, and West (25° and 45° inclinations)
Katanning TX2 Load and Katanning TX2 Net Load after PV Offset (400kW)
July 2003 to June 2004

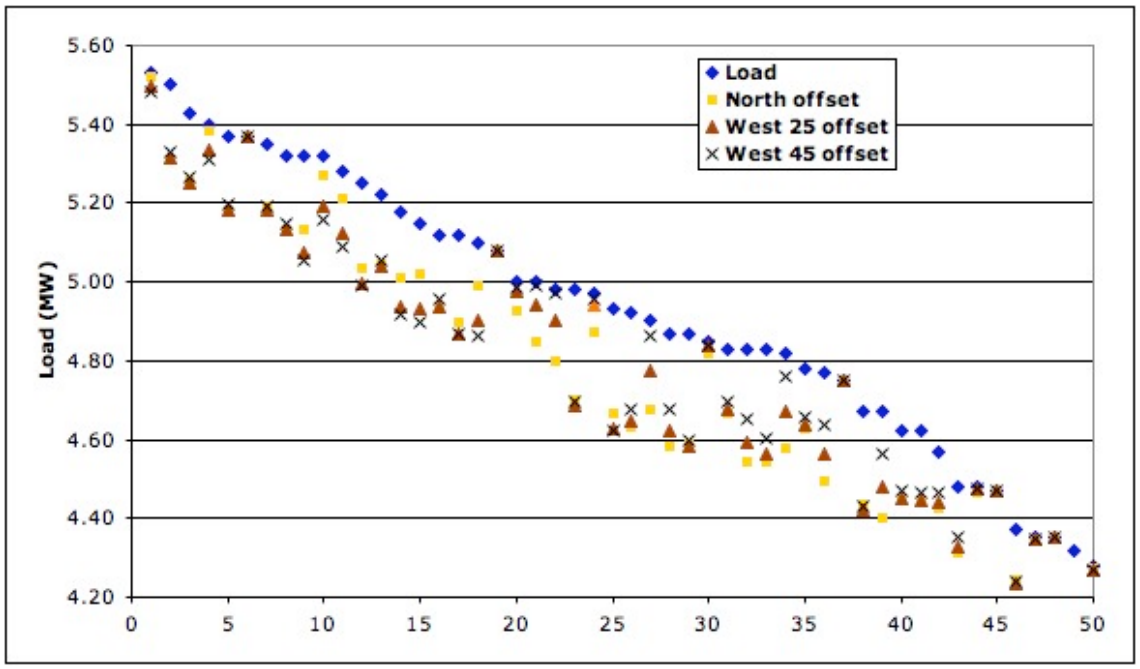

Figure 16: Load Duration Curve - top 50 load periods (linked)
North, and West (25° and 45° inclinations)
Katanning TX2 Load and Katanning TX2 Net Load after PV Offset (400kW)
July 2003 to June 2004

General correlation between PV Output and Load

Figure 17 shows the relationship between north-facing simulated PV output and the Katanning TX2 load at any one time, and shows no correlation. A high correlation would result in the data points being distributed from the bottom left to the top right of the chart. Instead, the load is essentially vertical. The scattered points to the right correspond to the peak load periods identified earlier. 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, which do not include the peak load periods, to the left – see Figure 18.

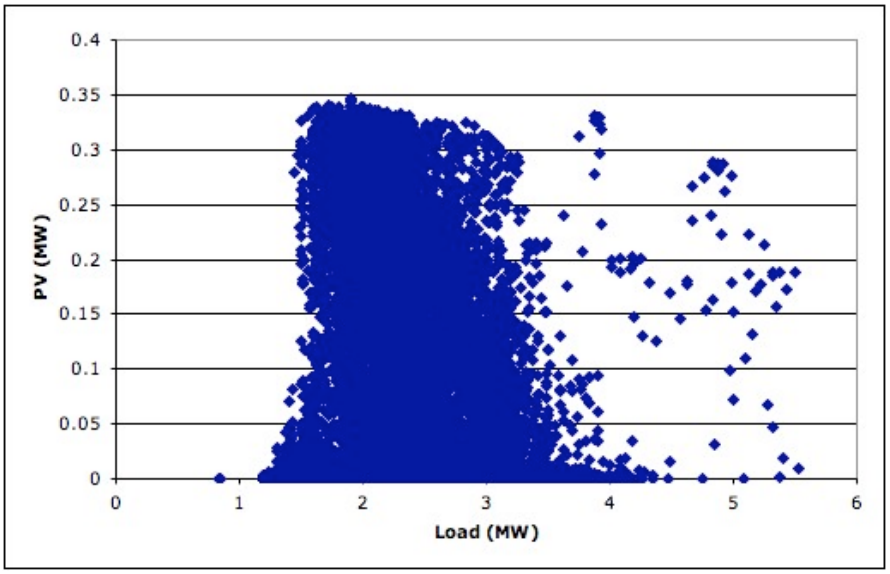

Figure 17: Katanning Simulated North-facing PV (400kW) vs Katanning TX2 Load
July 2003 to June 2004

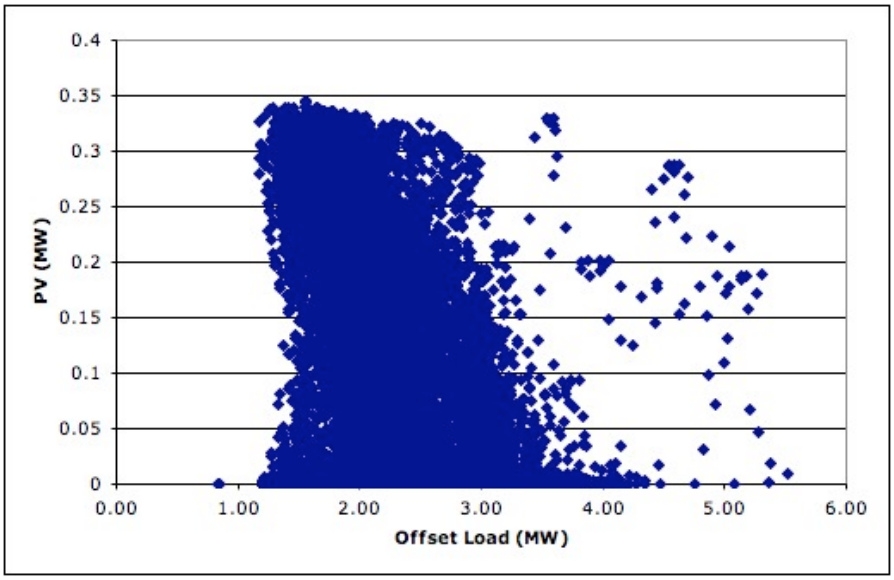

Figure 18: Katanning Simulated North-facing PV (400kW) vs Katanning TX2 Net Load after PV Offset
July 2003 to June 2004

Correlation with temperature

Figure 19 shows the relationship between the Katanning TX2 load and temperature, and shows a classic residential profile, where load increases due to high temperatures in summer and low temperatures in winter. Again, the scattered points to the right correspond to the peak load periods identified earlier, which seem not to be temperature related. Figure 20 shows the relationship between simulated north-facing PV output and temperature, and shows a fair 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 0.3 to 0.35 is likely an artefact of the PV simulation.

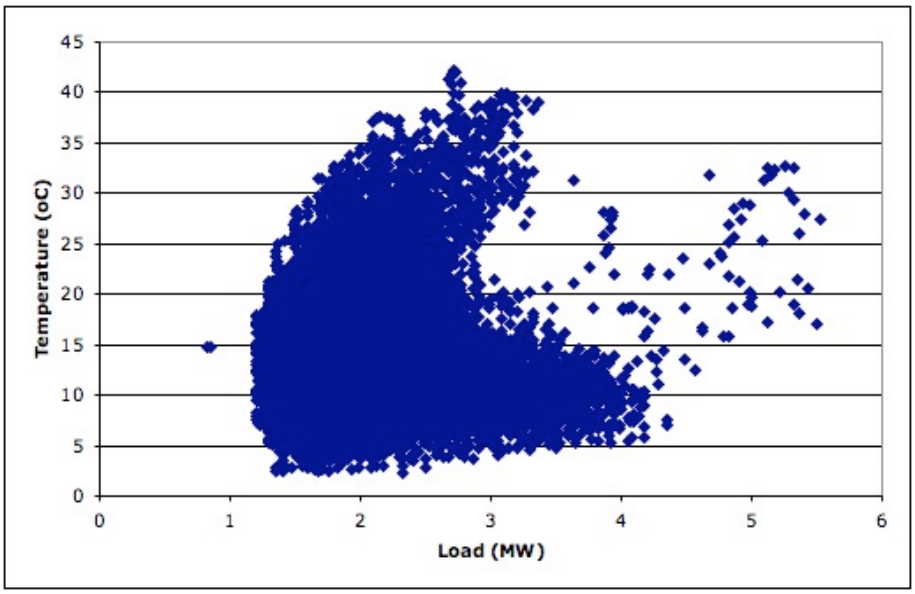

Figure 19: Katanning TX2 Load vs Temperature
July 2003 to June 2004

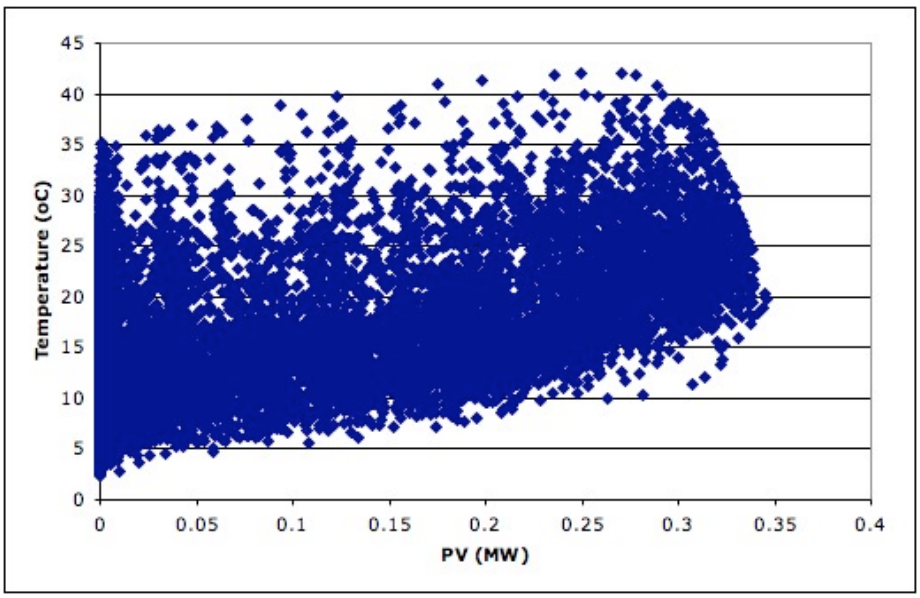

Figure 20: Katanning Simulated North-facing PV (400kW) vs Temperature
July 2003 to June 2004