MARBLE BAR

Annual profile

The July 2005 to June 2006 load profile for Marble Bar is shown in Figure 1. It is characterised by a winter baseload around 100kW, with daily maxima about double the size of the baseload. Both baseload and daily maxima more than double during the hotter months, when there is also significant variability with load decreasing for some weeks. There is no real evidence of a weekly cycle in either summer or winter – see Figure 2 and Figure 3. There are a number of days of extreme demand peaks, which are discussed in more detail below. Figure 4 shows the 40kW simulated north-facing PV output for ACDB site 'Newman', which is highest in spring and lowest during Jan to March, presumably because of cloud cover.

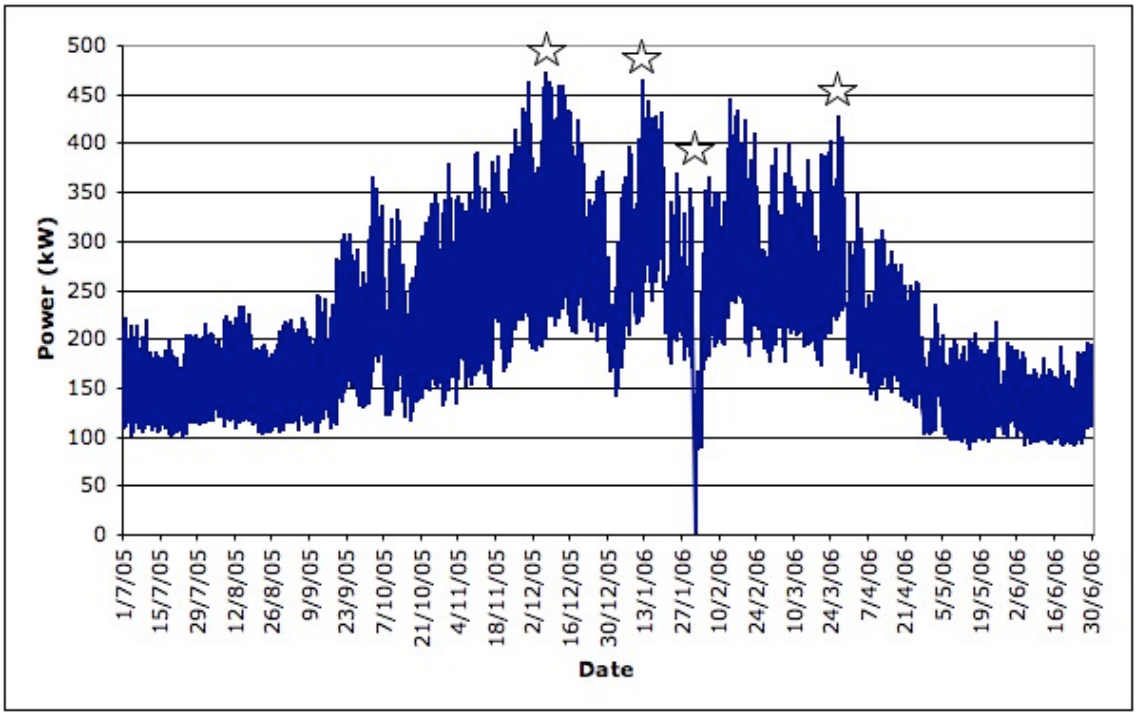

Figure 1: Marble Bar Load
July 2005 to June 2006
(the stars indicate the peak days analysed in detail below)

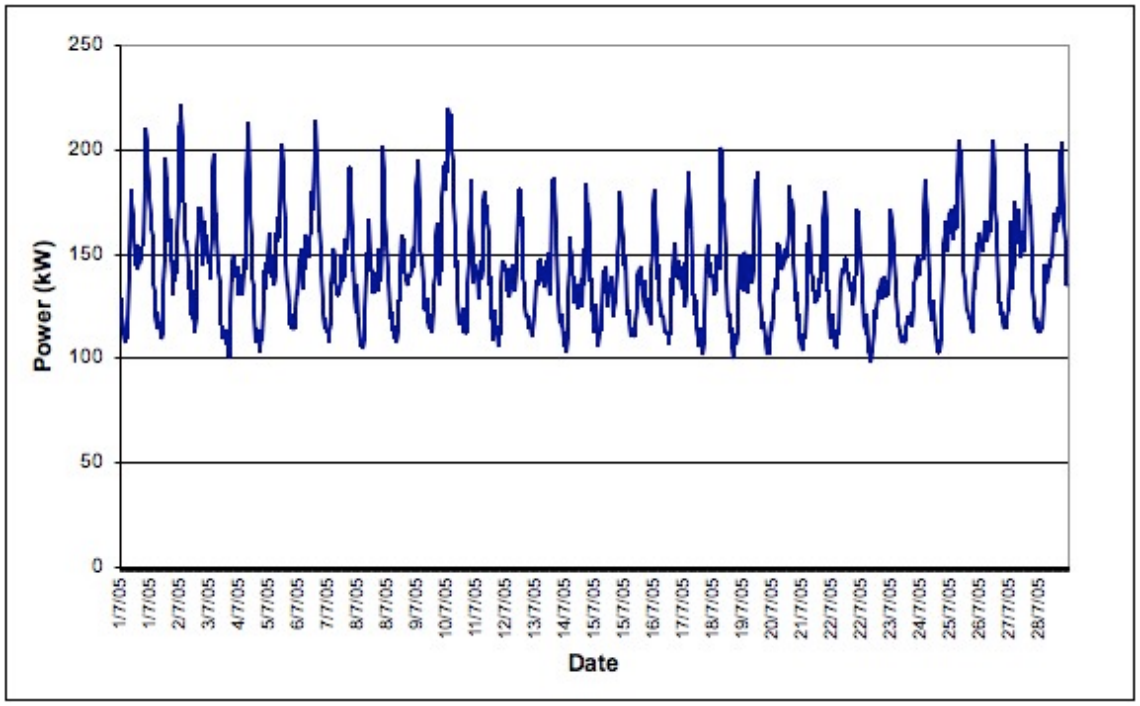

Figure 2: Marble Bar Load - July
The first 28 days of July 2005

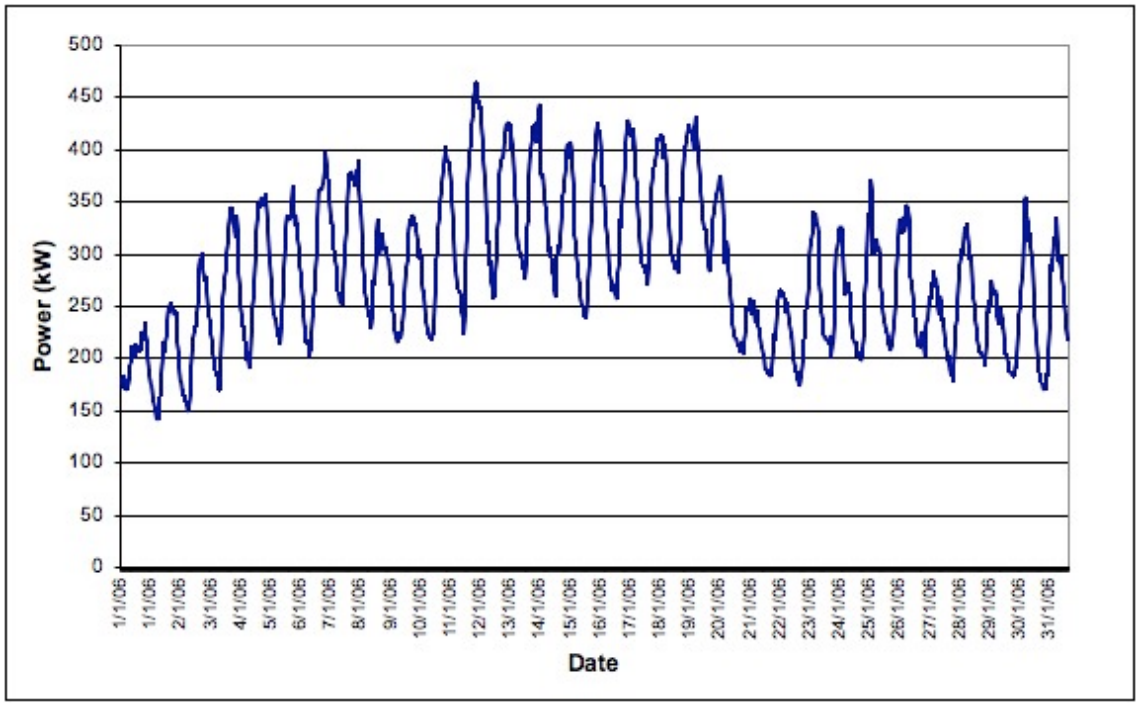

Figure 3: Marble Bar Load - Jan
The first 28 days of Jan 2006

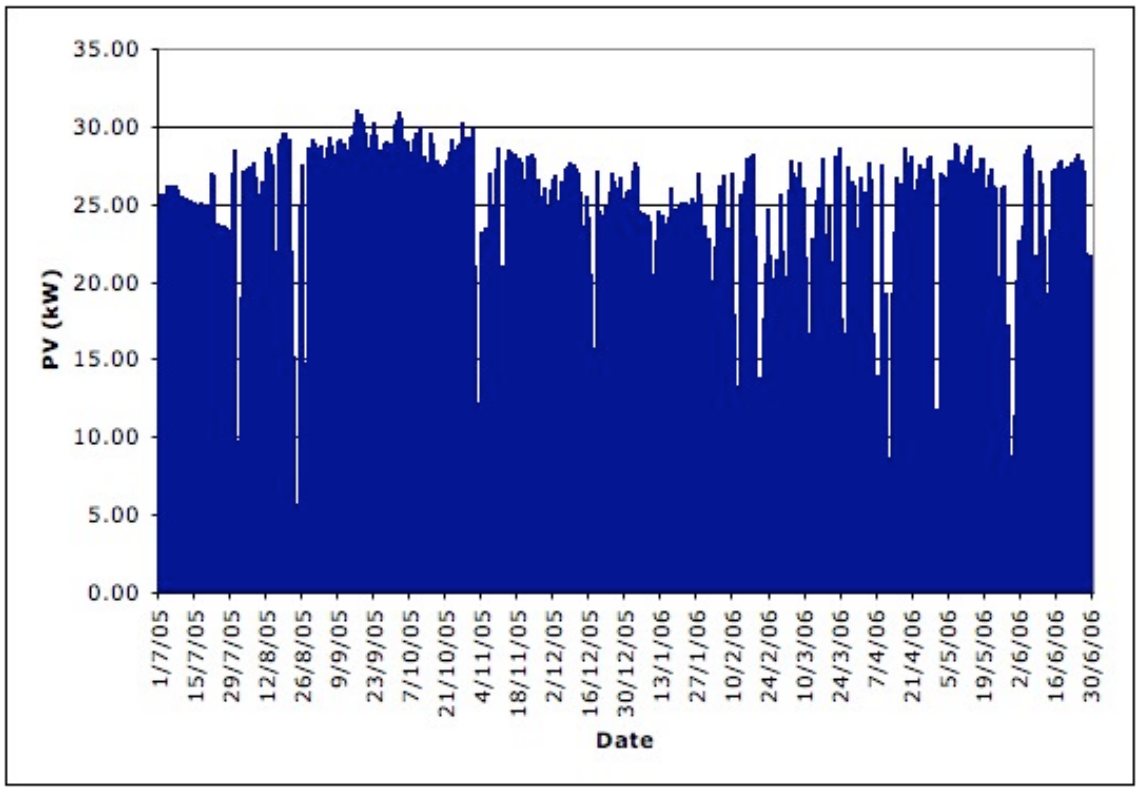

Figure 4: Marble Bar Simulated North-facing PV Output (40kW)
July 2005 to June 2006

Daily profiles

Figure 5 shows the daily annual average load for Marble Bar, the simulated north-facing 40kW PV output, and the net load assuming it is reduced by PV. The annual average load peaks at around 7:30pm while the average simulated north-facing PV peaks at around 12:30pm. As can be seen from Figure 6 to Figure 9, the highest seasonal peak occurs in summer at about 3pm and is reduced by the simulated north-facing PV and shifted to later in the day, to around 7pm. The next highest seasonal peak occurs in spring at about 7pm and is not reduced by the simulated north-facing PV but is still less than the PV-reduced summer peak. The autumn peak occurs at about 3pm and is shifted by simulated north-facing PV to 7pm, while the winter peak occurs at about 7:30pm. The impact of simulated west-facing PV is discussed below.

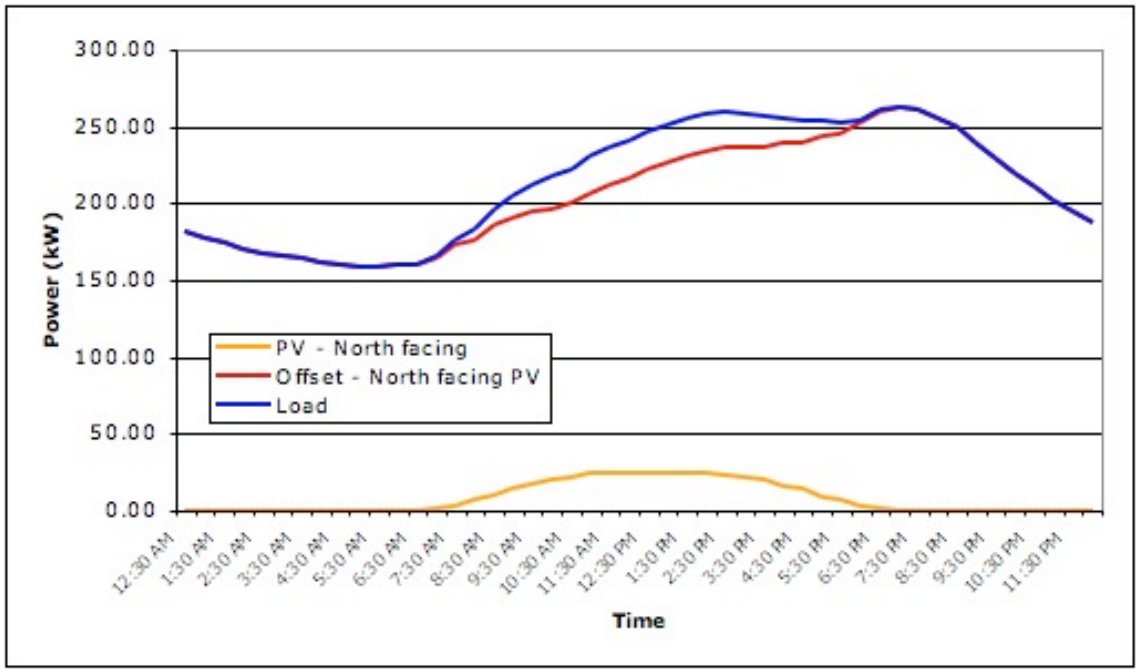

Figure 5: Daily Annual Average
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset
July 2005 to June 2006

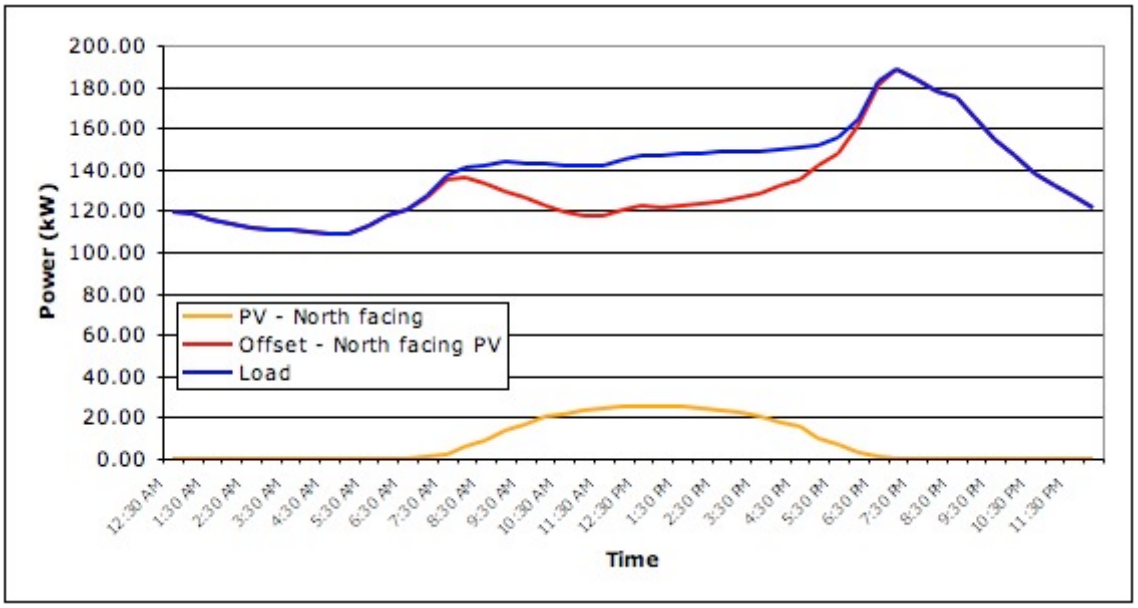

Figure 6: Daily Winter Average
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset
June 2006 and July/Aug 2005

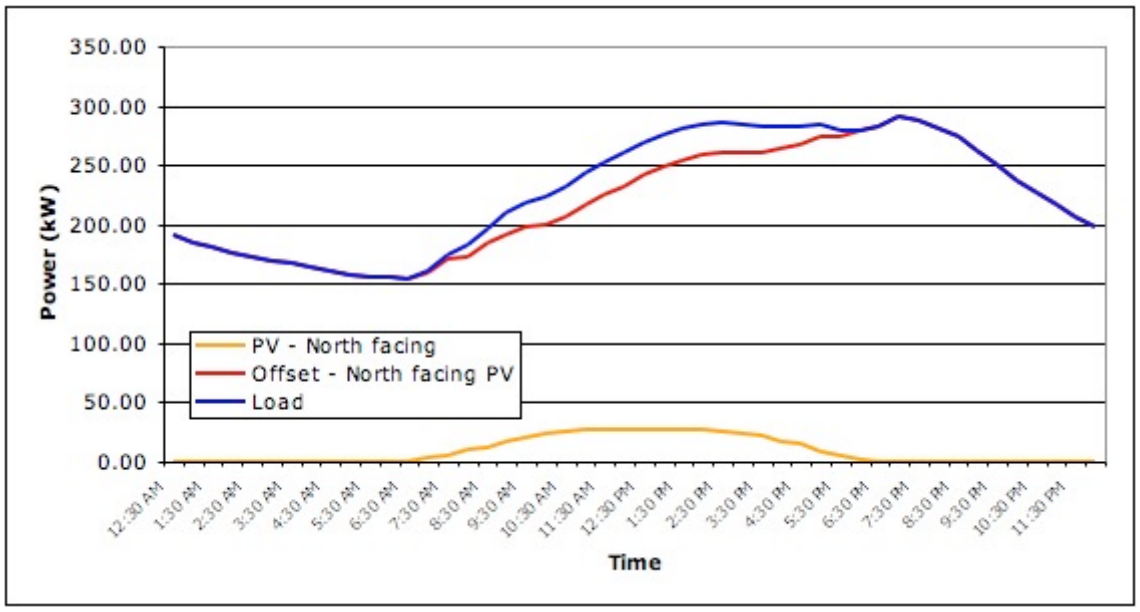

Figure 7: Daily Spring Average
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset
Sept 2005 to Nov 2005

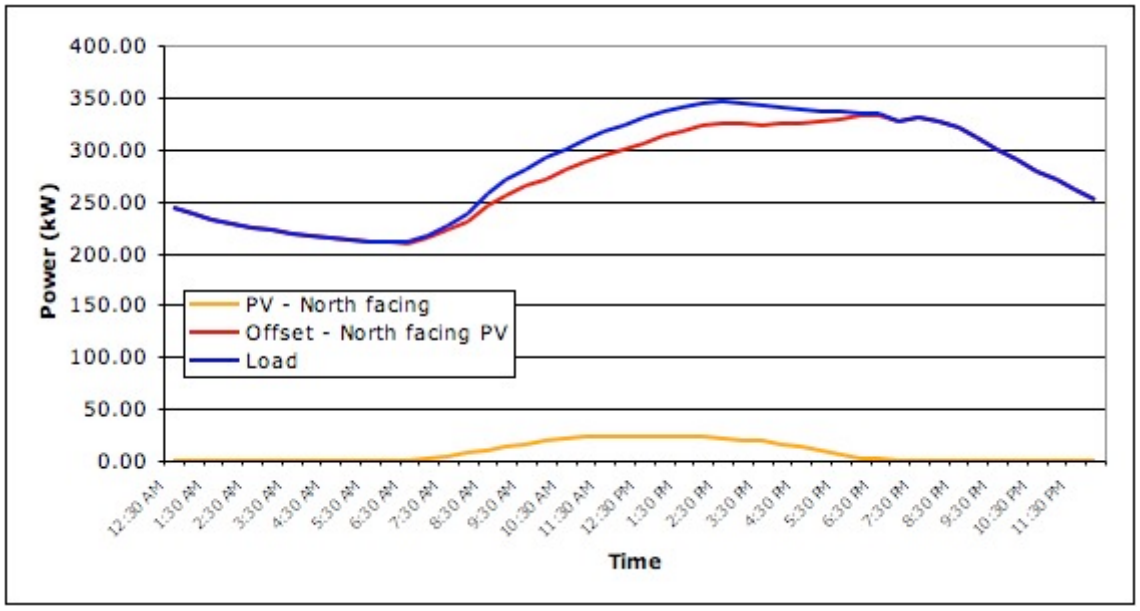

Figure 8: Daily Summer Average
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset
Dec 2005 to Feb 2006

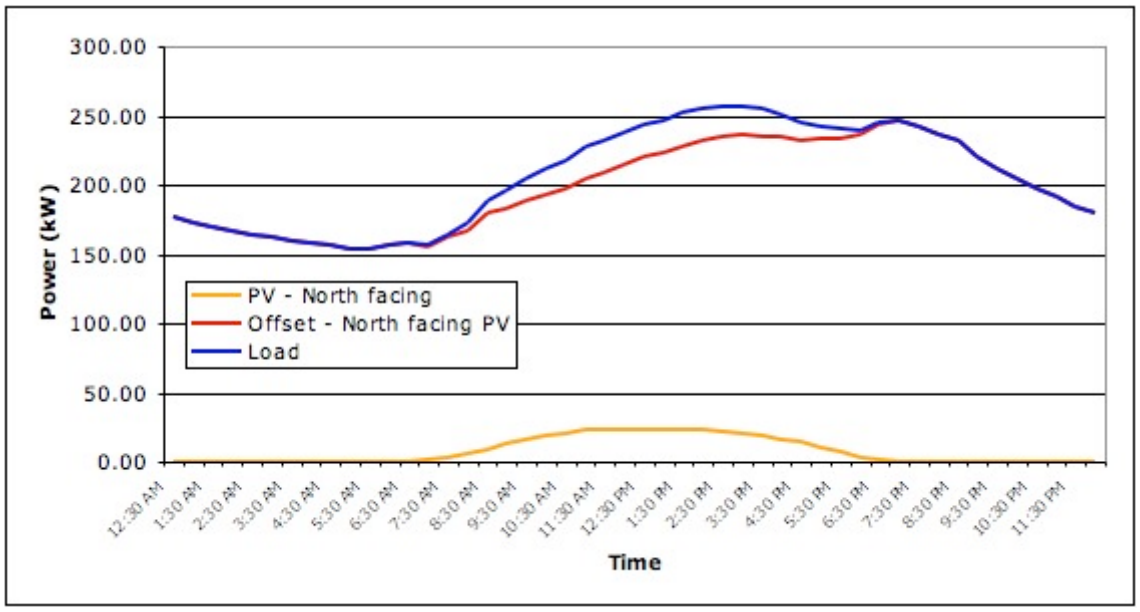

Figure 9: Daily Autumn Average
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset
March 2006 to May 2006

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. The summer peak is shifted by 1 to 1.5 hours to even later in the day by simulated west-facing PV. The other seasons' peak are not affected.

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

Orientation	Tilt (degrees)	RMY (kWh/yr)
North	25	1,689
North west	25	1,747
West	25	1,685
West	45	1,624
West	90	1,176

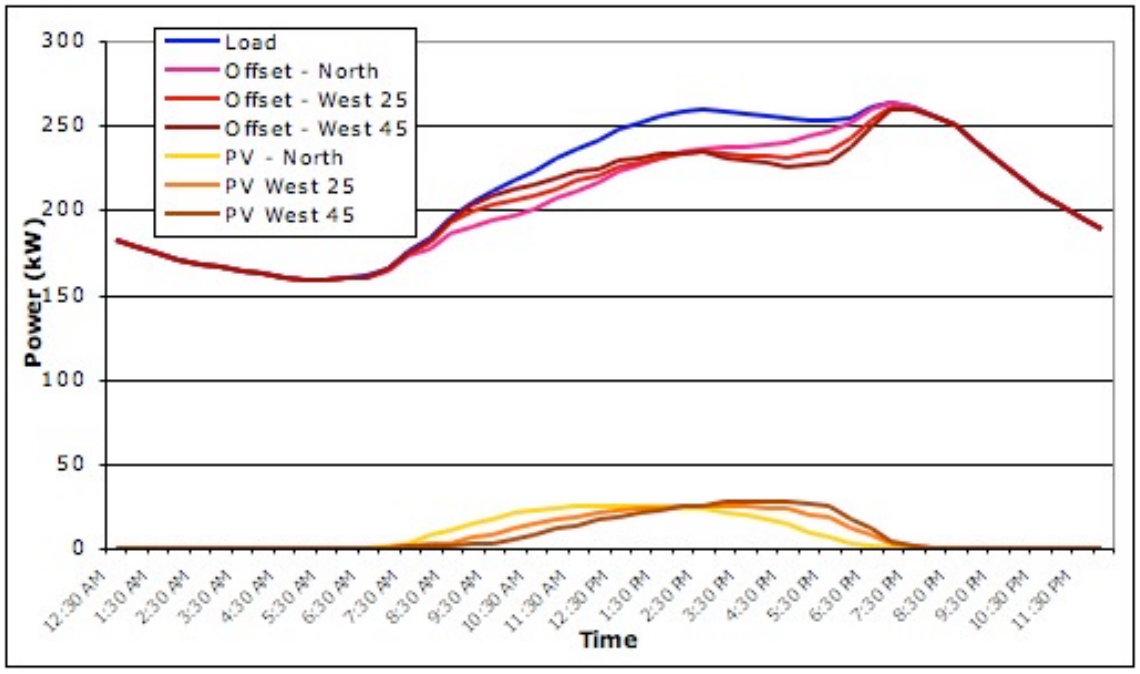

Figure 10: Daily Annual Average
North, and West (25° and 45° inclinations)
Marble Bar Load, Marble Bar PV (40kW) and Net Load after PV Offset
July 2005 to June 2006

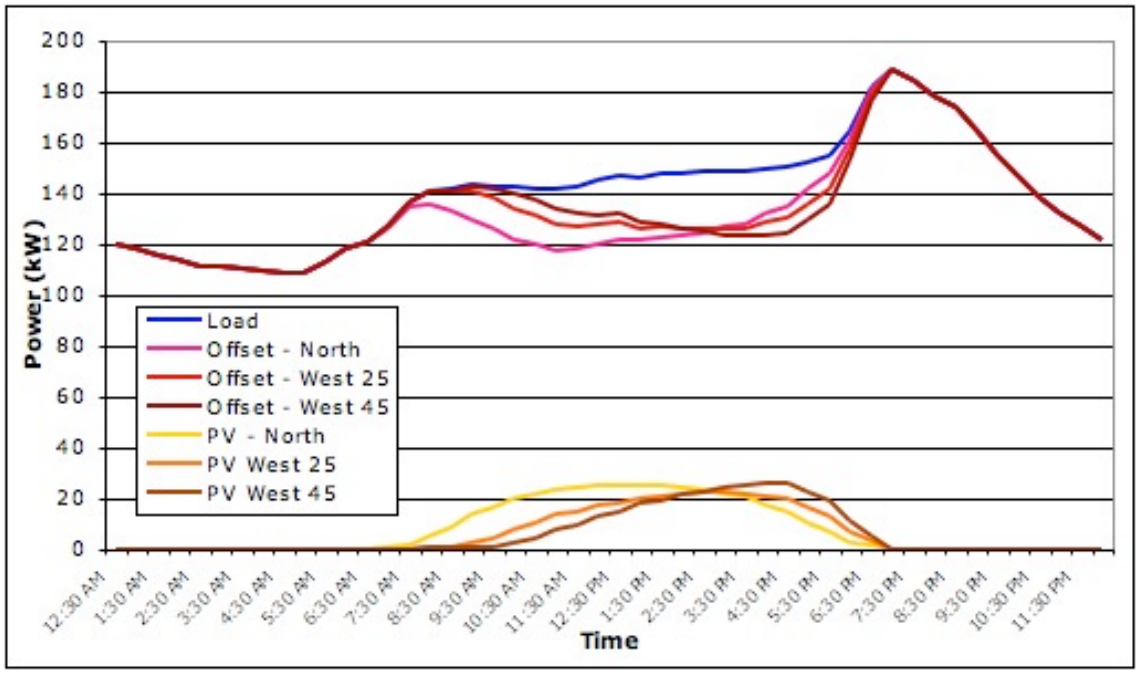

Figure 11: Daily Winter Average
North, and West (25° and 45° inclinations)
Marble Bar Load, Marble Bar PV (40kW) and Net Load after PV Offset
June 2006 and July/Aug 2005

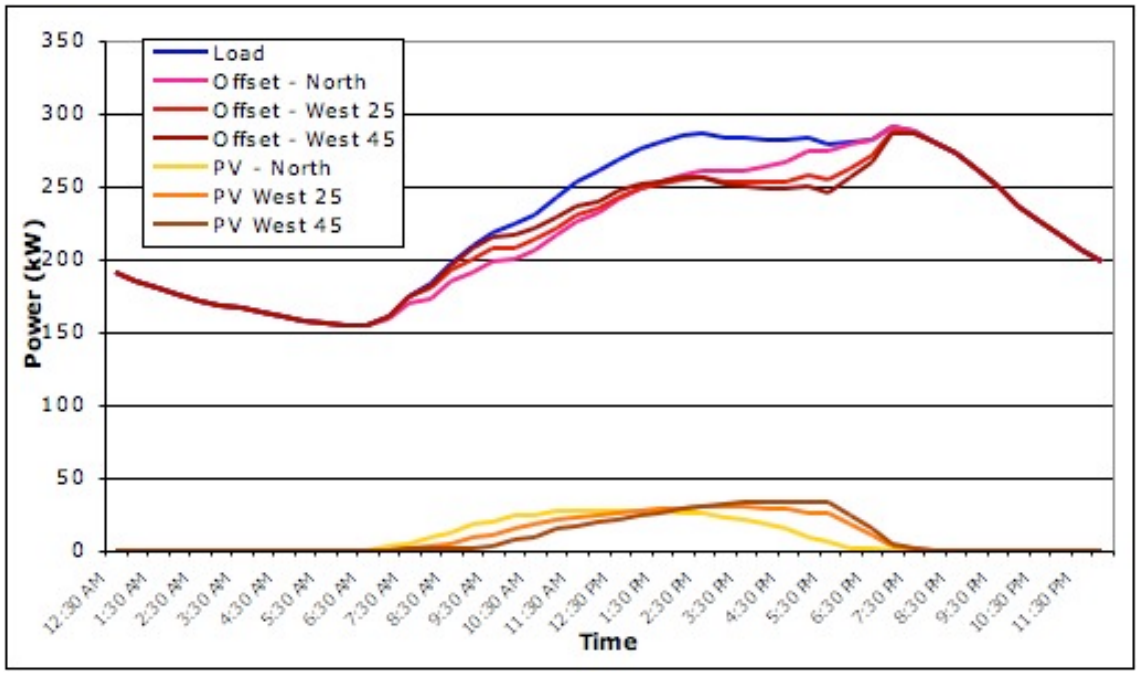

Figure 12: Daily Spring Average
North, and West (25° and 45° inclinations)
Marble Bar Load, Marble Bar PV (40kW) and Net Load after PV Offset
Sept 2005 to Nov 2005

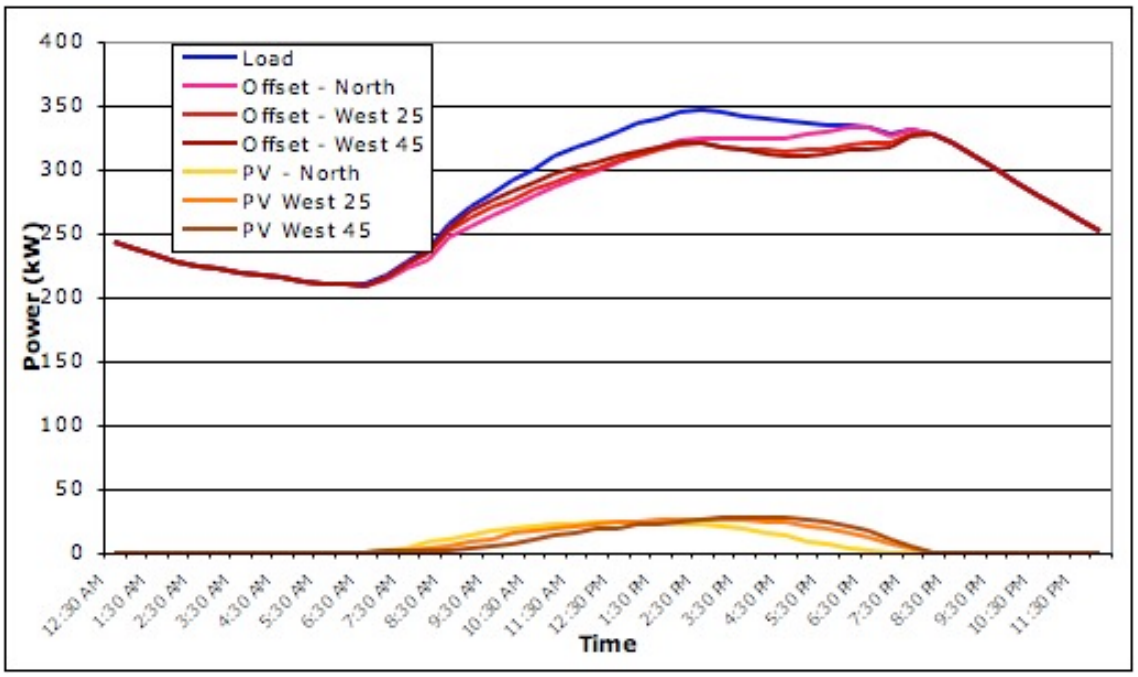

Figure 13: Daily Summer Average
North, and West (25° and 45° inclinations)
Marble Bar Load, Marble Bar PV (40kW) and Net Load after PV Offset
Dec 2005 to Feb 2006

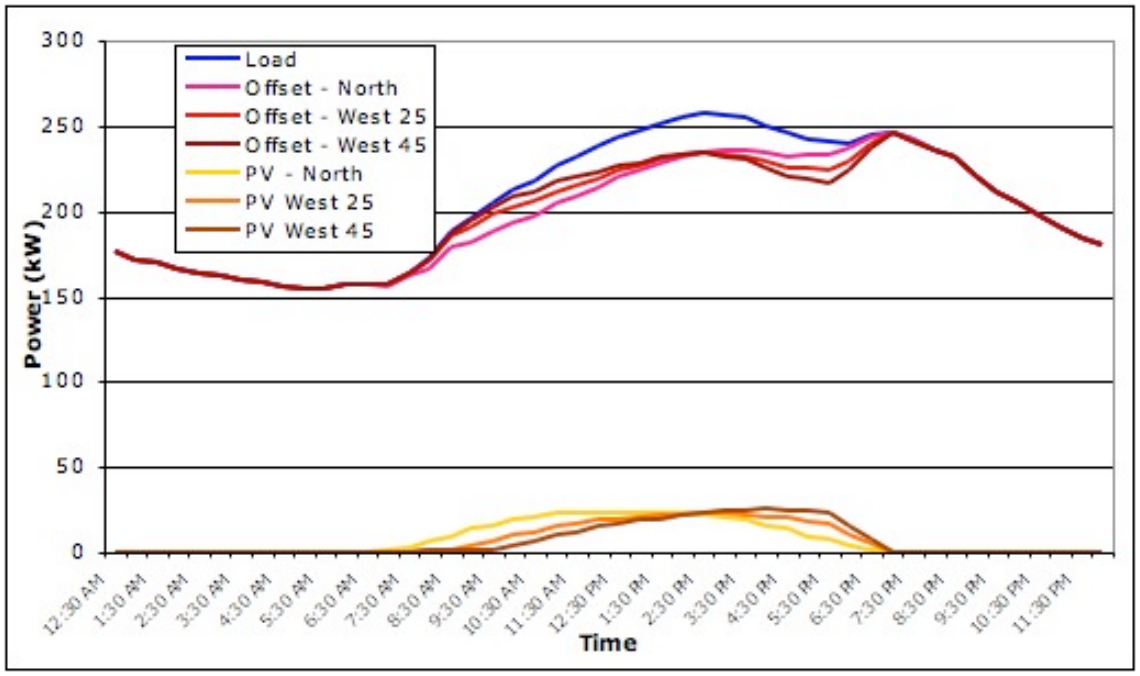

Figure 14: Daily Autumn Average
North, and West (25° and 45° inclinations)
Marble Bar Load, Marble Bar PV (40kW) and Net Load after PV Offset
March 2006 to May 2006

Times of peak demand

The ten top half-hour demand periods at Marble Bar are shown in Table 2. All occur on the 30th Nov and 7th-8th Dec 2005, and on the 12th Jan 2006, and are the ten hig hest points in the load duration curves in Figure 20 to Figure 22.

The highest peak load days for the study period (7th - 8th Dec 2005; Figure 15) occurred within a cluster of hot days (between 35 and 40°C). The 40kW simulated north-facing PV was a good match for the load on the two peak days, and, as can be seen from the load duration curves in Figure 22, reduced the peak half hour periods for those days by between 25 and 27kW. However, on the fourth day in that series, the peak occurred quite late in the day, around 6pm, when the simulated north-facing PV made almost no contribution.

The second highest peak load day (12th Jan 2006; Figure 16) was also hot (over 40°C), and because the peak occurred late in the day, around 4 to 4:30pm, was only moderately well matched to PV. The impact of simulated west-facing PV at 45 degrees tilt is shown in Figure 17. The peaks on all three days are reduced more than by simulated north-facing PV. These days include the periods most reduced by simulated west-facing PV in the 'linked' load duration curve – see 4th, 5th, 8th and 10th highest points in Figure 22.

The third highest cluster of peak load days assessed here occurred in autumn (27th - 28th March; Figure 18), peaked around 3pm and were relatively well matched to simulated north-facing PV.

The days spanning the 1st Feb 2006 are assessed here because of the loss of load at that time – see Figure 19. It occurred during a time of fairly high temperatures (between 35 and 45°C) but not particularly high load. That time of the year was characterised by large changes to the load presumably reflecting changing operational conditions.

Table 2: Ten Top Half-hour Demand Peaks at Marble Bar

Demand (kW)	Date	Day	Time
472.5	7-Dec-05	Wed	14:00
467.5	7-Dec-05	Wed	14:30
464.5	7-Dec-05	Wed	13:30
464.5	12-Jan-06	Thurs	16:00
464.5	12-Jan-06	Thurs	16:30
463.5	8-Dec-05	Thurs	13:30
462.5	30-Nov-05	Wed	15:00
462	12-Jan-06	Thurs	15:00
461.5	8-Dec-05	Thurs	14:30
461.5	12-Jan-06	Thurs	15:30

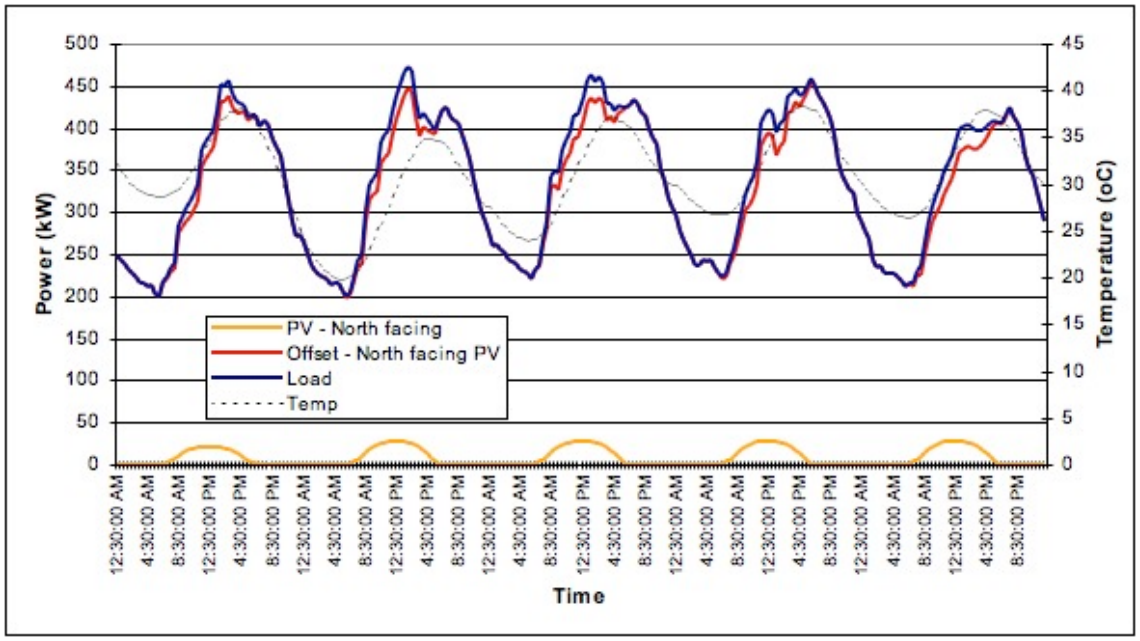

Figure 15: Summer peak days
6th – 10th Dec 2005
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset

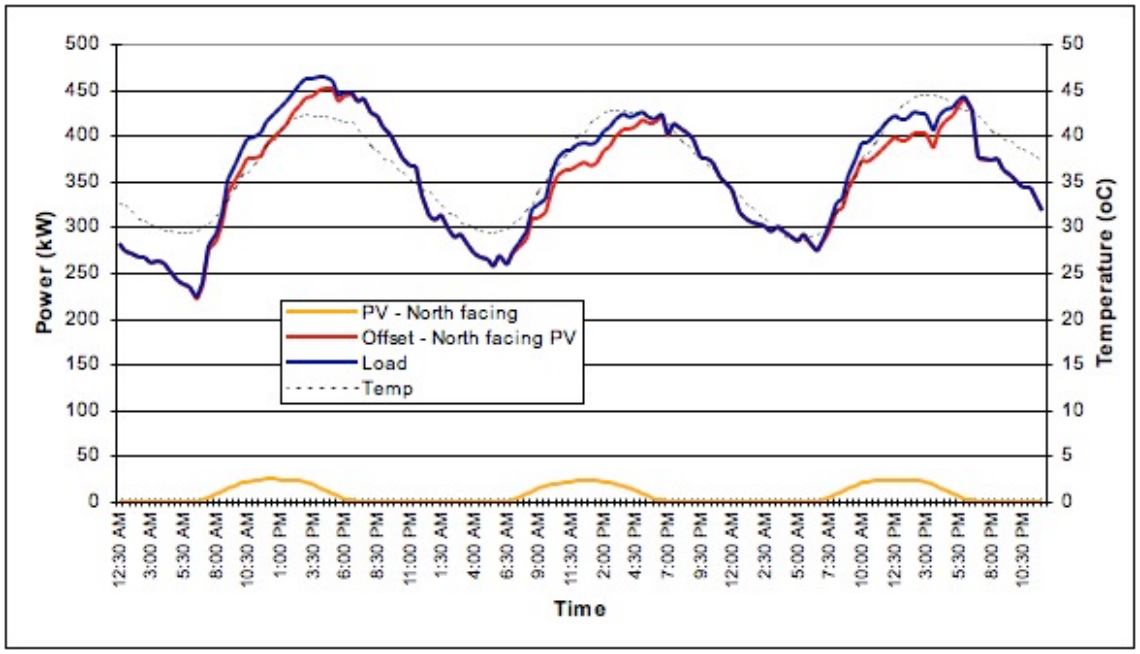

Figure 16: Summer peak days (north-facing PV)
12th - 14th Jan 2006
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset

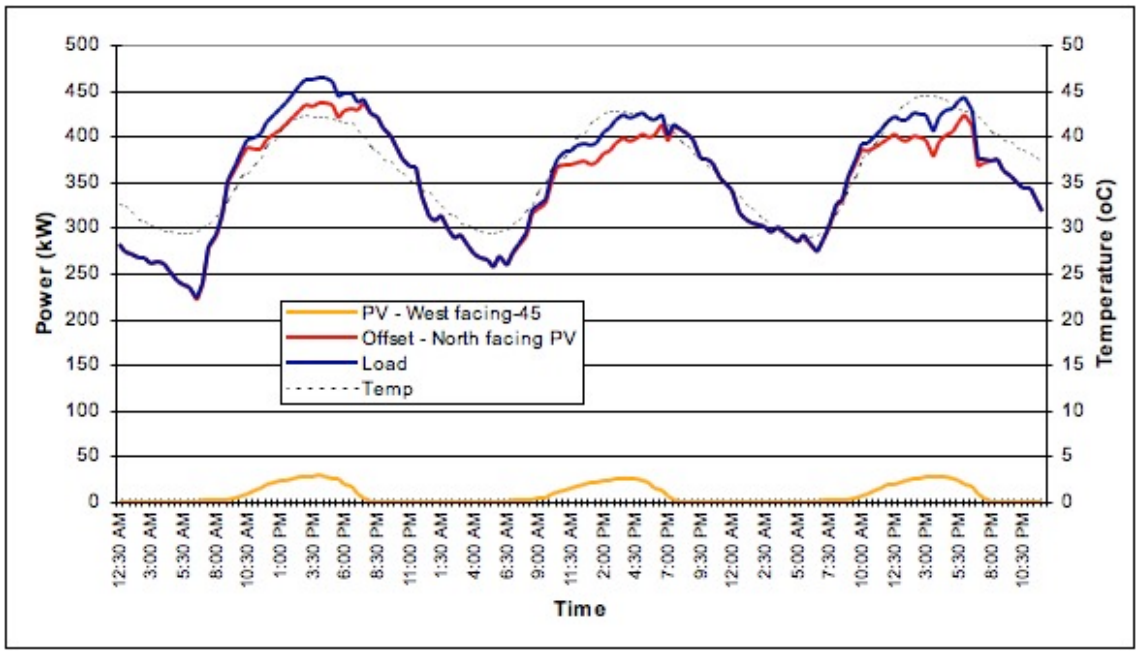

Figure 17: Summer peak days (west-facing-45 PV)
12th - 14th Jan 2006
Marble Bar Load, Marble Bar Simulated West-facing-45 PV (40kW) and Net Load after PV Offset

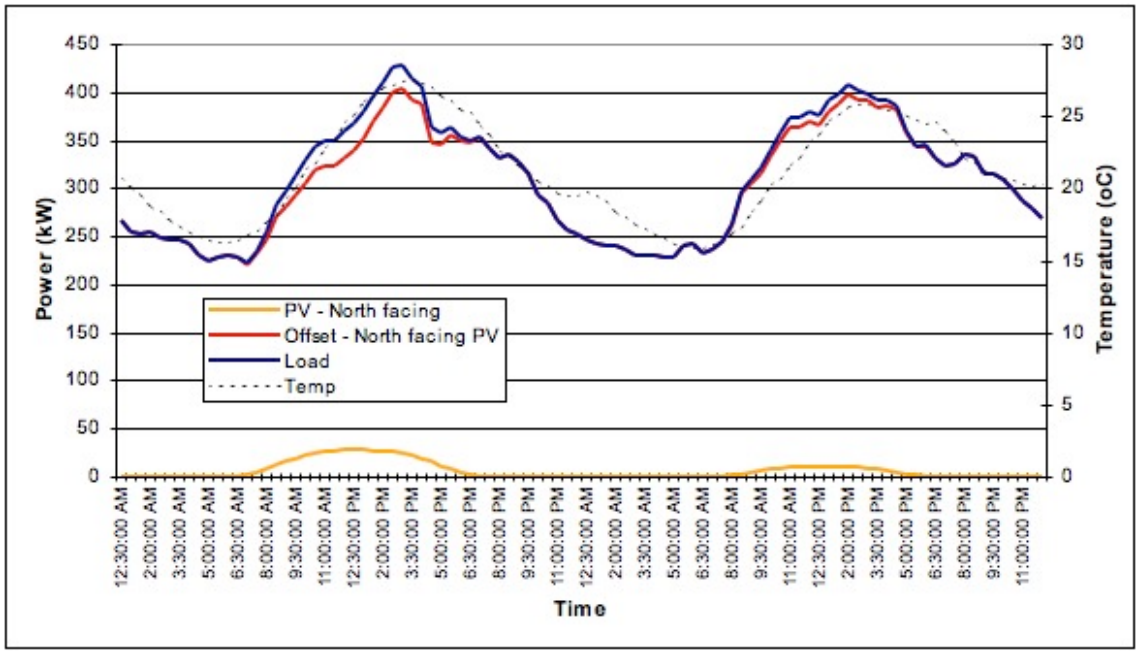

Figure 18: Autumn peak days
27th – 28th March 2006
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset

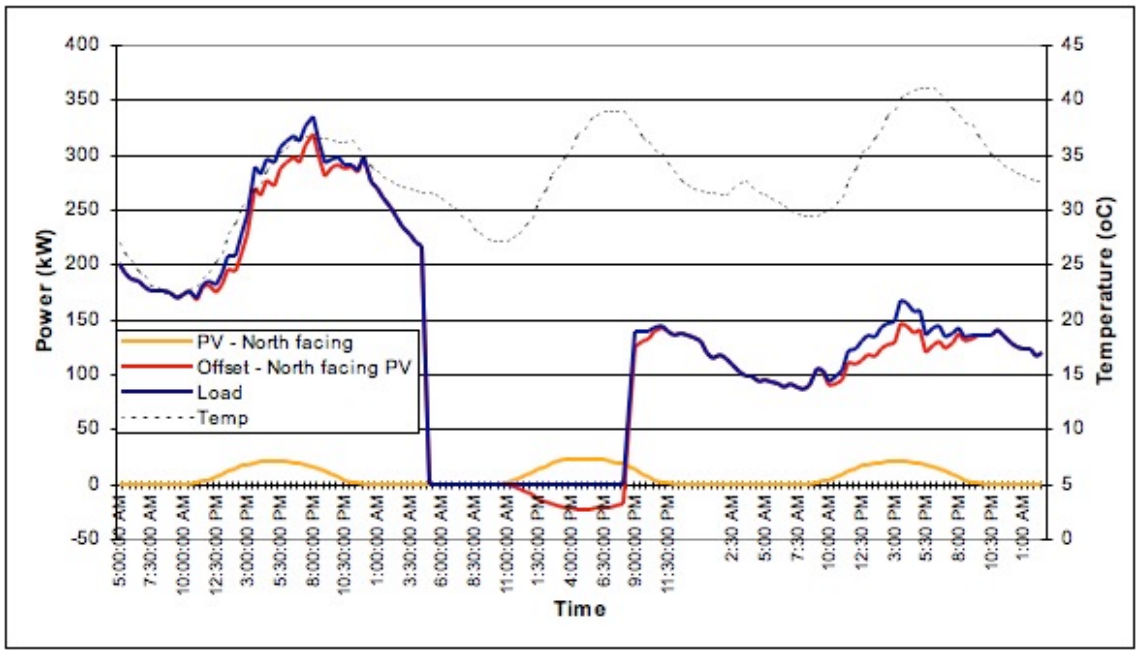

Figure 19: Summer load loss
31st Jan - 2nd Feb 2006
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset

Load duration curves

The load duration curve for Marble Bar is in Figure 20. The top 50% of the load occurred for about 36% of the study period, while the top 10% occurred for 0.86% of the time.

Figure 21 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^o and 45^o). It can be seen that, part from the highest load period, the simulated west-facing-45 PV resulted in the lowest offset load duration curve, followed by west-25 then north-facing simulated PV. 40kW of simulated west-facing-45 PV resulted in the highest offset load period being 14kW lower than the highest original load period, and resulted in the top 10 offset load periods being lower by an average of 23.2kW.

Figure 22 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, 76% of the simulated west-facing-45 40kW PV would have contributed to load reduction, reducing it from 472.5W to 442.2kW. However, what was the 15th highest load period, which occurred at 8pm on the 12th Dec 2005 (Figure 23), and so was not matched at all to PV, became the study period's highest offset load period – and so is the highest offset period in Figure 21. On average during the 10 highest load periods, 73% of the simulated west-facing-45 PV would have contributed to reducing peak load.

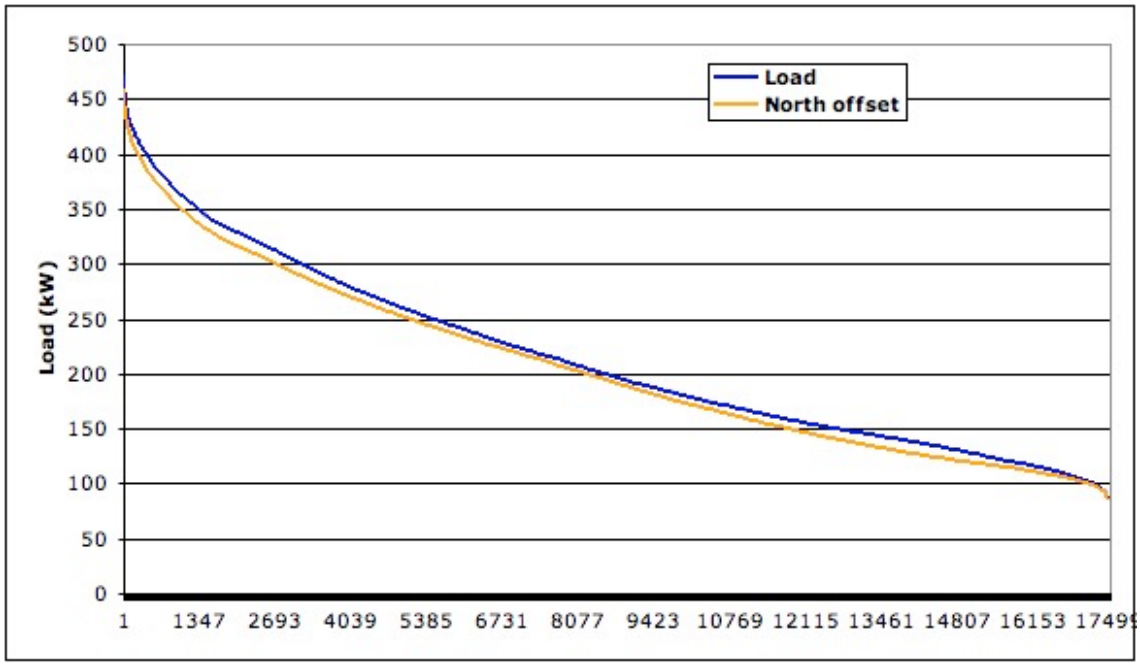

Figure 20: Load Duration Curve - July 2005 to June 2006
Marble Bar Load and Marble Bar Net Load after PV Offset (40kW)

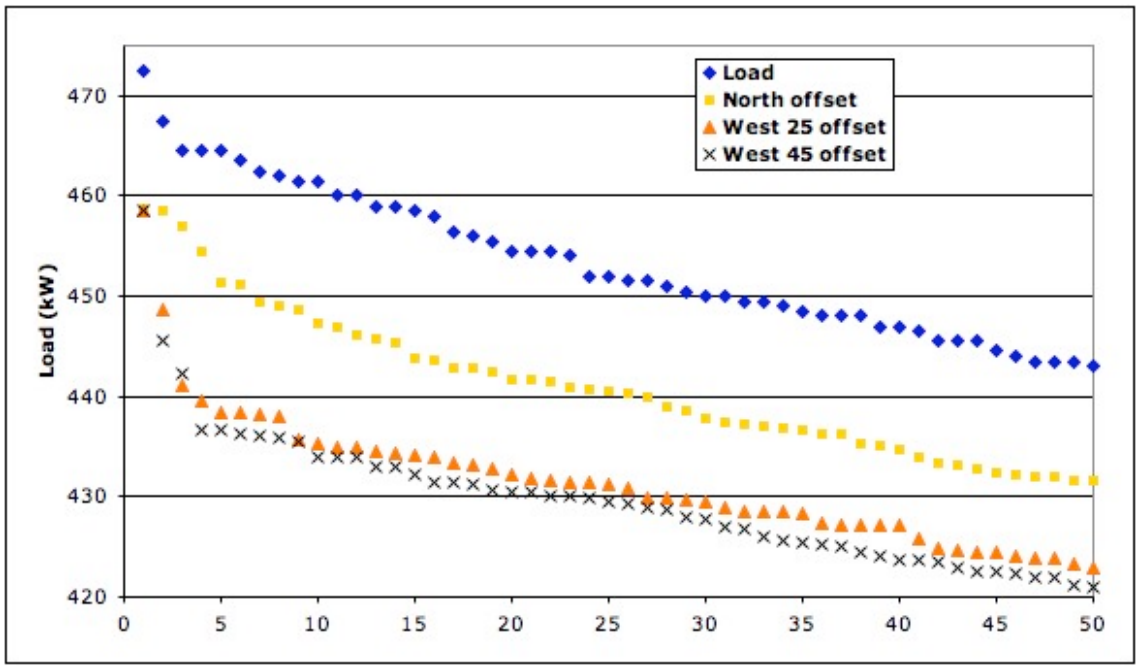

Figure 21: Load Duration Curve - top 50 load periods
North, and West (25° and 45° inclinations)
Marble Bar Load and Marble Bar Net Load after PV Offset (40kW)
July 2005 to June 2006

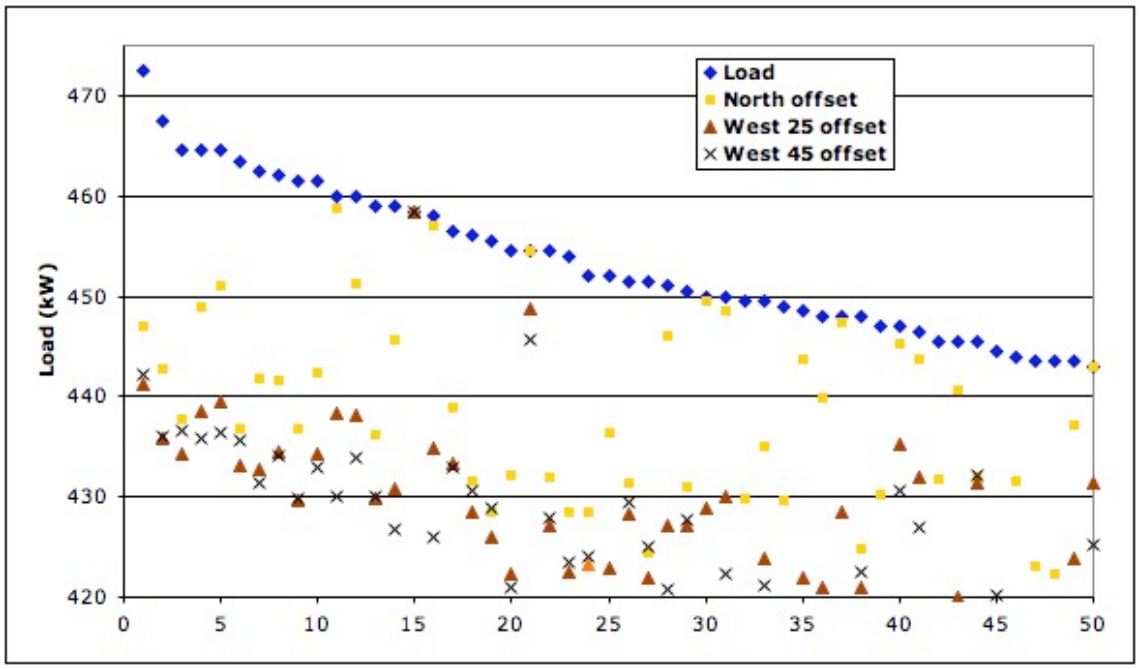

Figure 22: Load Duration Curve - top 50 load periods (linked)
North, and West (25° and 45° inclinations)
Marble Bar Load and Marble Bar Net Load after PV Offset (40kW)
July 2005 to June 2006

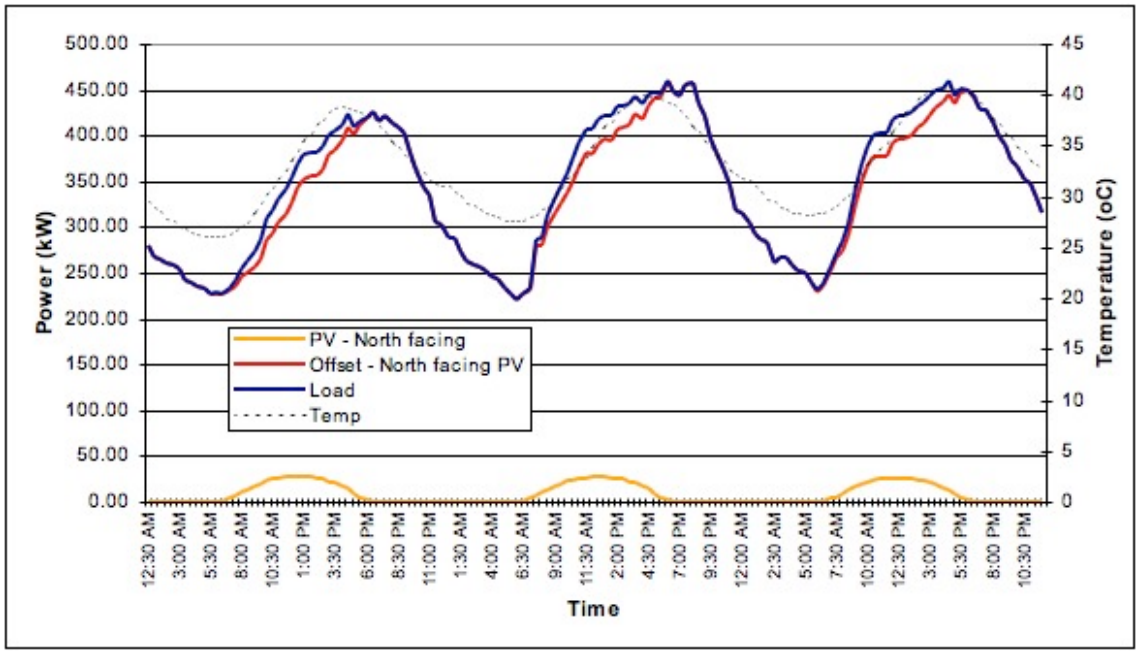

Figure 23: Summer peak days
11th-13th Dec 2005
Marble Bar Load, Marble Bar Simulated North-facing PV (40kW) and Net Load after PV Offset

General correlation between PV Output and Load

Figure 24 shows the relationship between north-facing simulated PV output and the Marble Bar load at any one time, and shows limited 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 spread almost into two regions, corresponding to the baseload periods and the daytime peaks – where the latter displays limited 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, which include the study period's highest load points, to the left – see Figure 25.

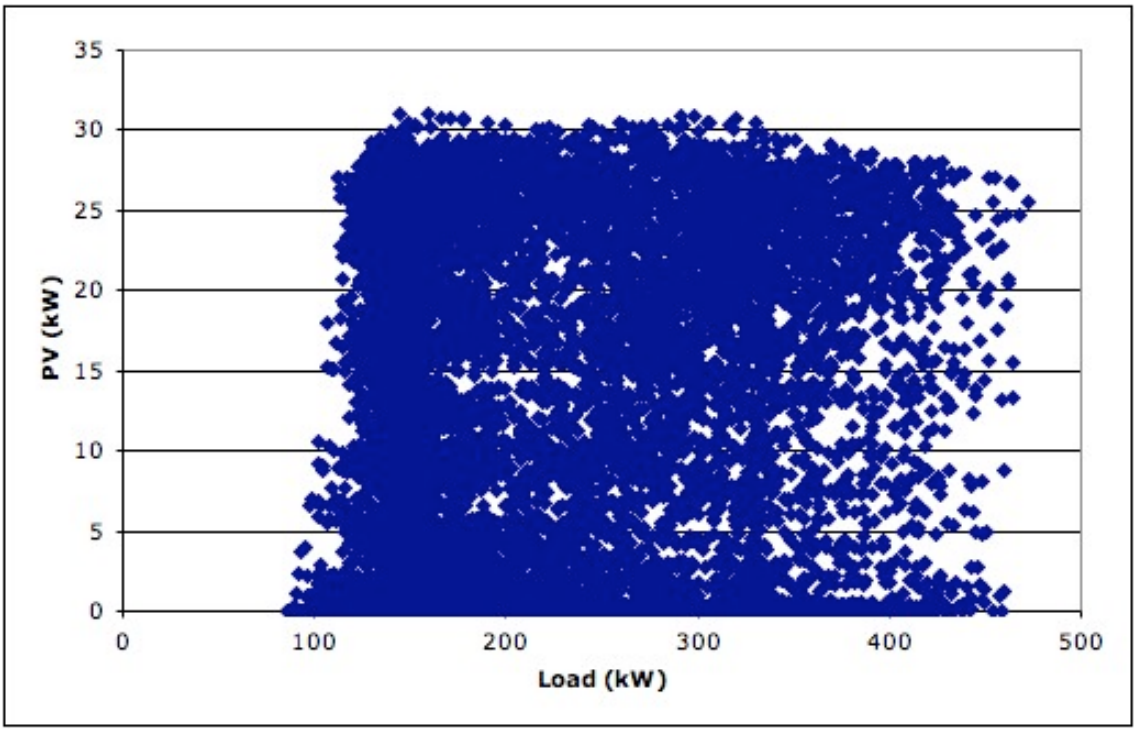

Figure 24: Marble Bar Simulated North-facing PV (40kW) vs Marble Bar Load
July 2005 to June 2006

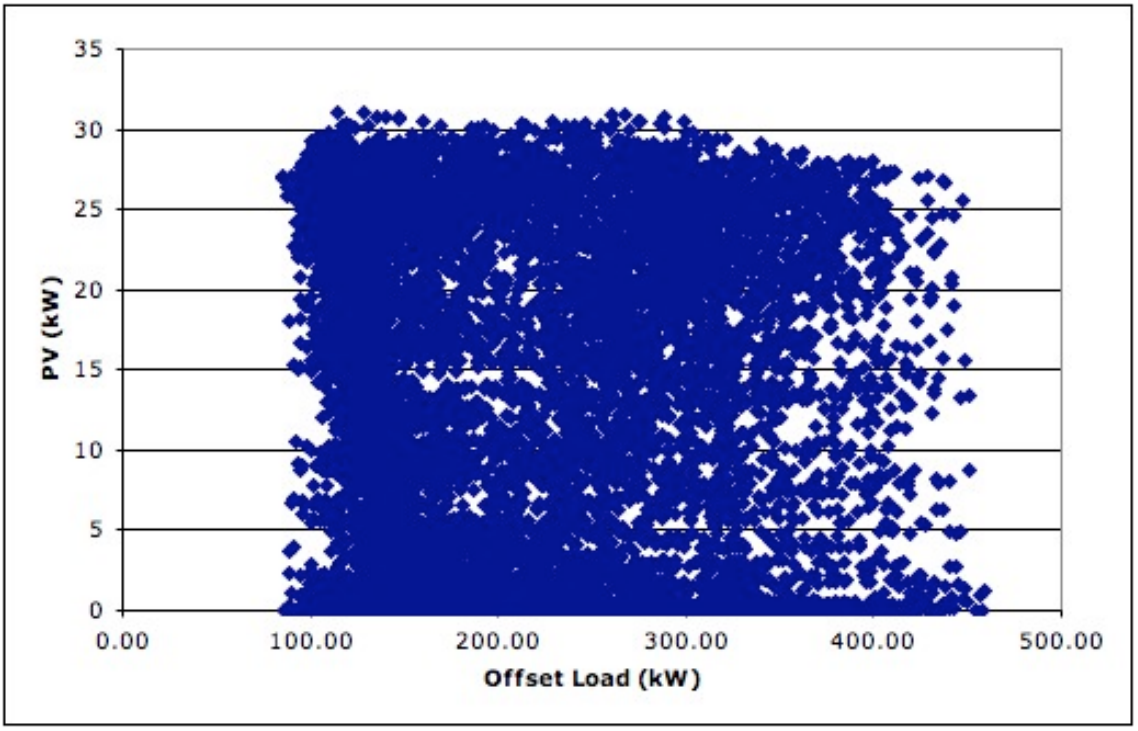

Figure 25: Marble Bar Simulated North-facing PV (40kW) vs Marble Bar Net Load after PV Offset
July 2005 to June 2006

Correlation with temperature

Figure 26 shows the relationship between the Marble Bar load and temperature, and shows a good correlation, with load tending to increase with temperature. Figure 27 shows the relationship between simulated north-facing PV output and temperature, and shows limited correlation, and there are instances of zero PV output at high temperatures, presumably on hot summer evenings.

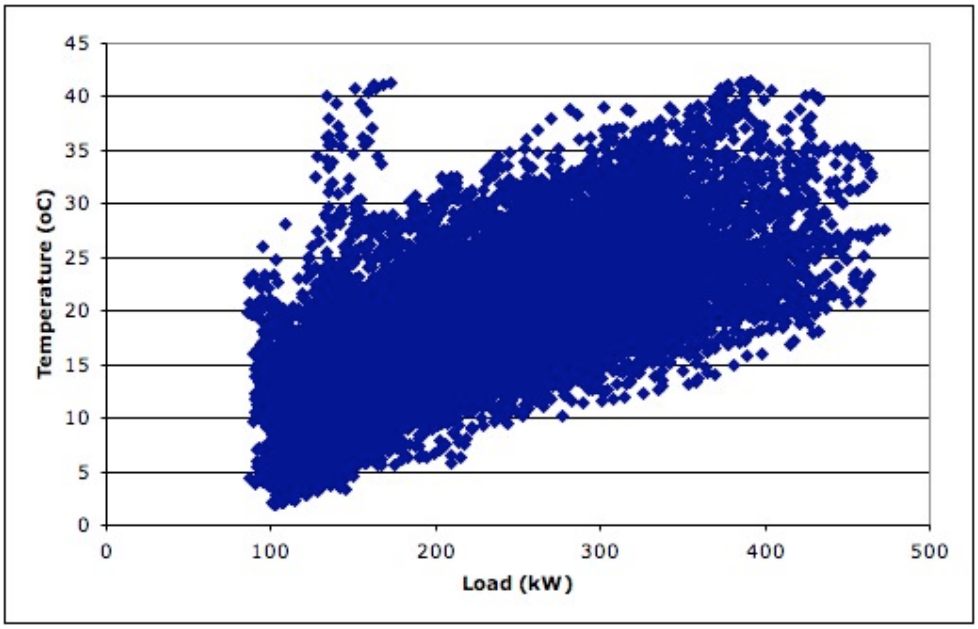

Figure 26: Marble Bar Load vs Temperature
July 2005 to June 2006

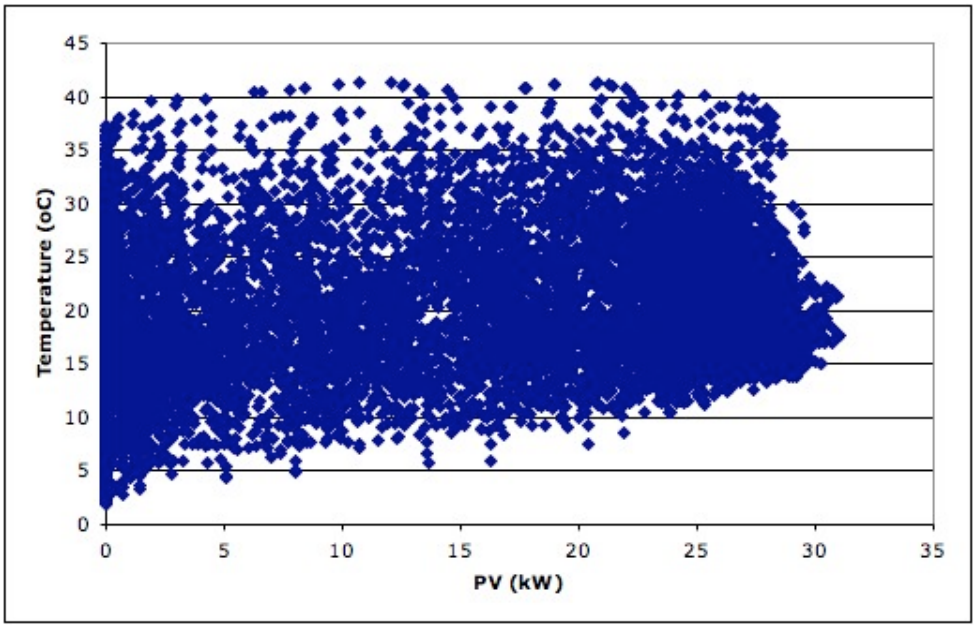

Figure 27: Marble Bar Simulated North-facing PV (40kW) vs Temperature
July 2005 to June 2006