

Eco-Sense Solar PV Analysis

June 15, 2010 – June 16, 2011

Eco-Sense Started the test year with 12 Sharp 175w panels, providing a 2kW array. On Oct. 12, 2010 the panels were tilted to their winter position and 4 new 175w panels were added. On March 20, 2011 the panels were tilted back to the summer angle. Summer angle is 60 deg; Winter angle is 35 deg.

All 16 panels are wired to feed two parallel Outback MX 60 Charger controllers, an 800 amp hour sealed AGM battery bank, 3500W Outback Grid-Tie inverter, and linked to the BC Hydro grid. There is no generator backup power supply. When batteries are fully charged and the panels are producing extra kW, they are fed into the BC Hydro grid. When the house is using electricity and drawing the batteries down, the inverter will keep the batteries topped up either from the solar PV or the BC hydro grid. Everyday, the BC Hydro net meter sells and buys electricity with Eco-Sense.

Solar PV Data Summary:

	Measured kWh
Total Yearly Production	2699
Total Yearly Consumption	2302
Average Daily Consumption	6.33
Average Daily Production	7.42
Net zero surplus for the year	397

It is very difficult to compare the electricity usage of the Baird home with the conventional or average single detached residence in BC (SDR), as there is a very different energy profile. The make up of energy consumption shows a drastically decreased use of electricity, using only 18.3% of the average BC SDR. A summary of energy intensity inclusive with electricity follows:

Energy Use by Energy Source (kWhr)	BC Avg Single Detached Residence (NRCAN NEUD 2008)	Eco-Sense (kWhr)
Electricity	12731.12	2324.85
Natural Gas – LP Gas	16235.09	1263.00 ⁱ
Heating Oil	204.40	0
Other2 (inclusive of Solar Thermal)	262.80	5709.29
Wood	2452.78	20890.7

Total Energy (kWhr)	31886.19	30187.84
Shares (%)		
Electricity	39.9%	7.6%
Natural Gas	50.9%	4.2%
Heating Oil	0.6%	0.0%
Other2	0.8%	18.9%
Wood	7.7%	69.2%
Average Floor Space (m ²)	187.74	200.67
Energy Intensity (GJ/m ²)	0.61	0.54
Energy Intensity (GJ/household)	114.70	108.7
Energy intensity per person m ² (per detached residence)	0.24	0.11
Energy intensity per person per detached residence	45.88	21.70
Energy Intensity (kWhr/m ²)	169.44	150.43
Energy Intensity (kWhr/household)	31861.11	30187.84
Energy intensity per person m ² (per detached residence) (kWhr/m ²)	67.78	30.09
Energy intensity per person per detached residence (kWhr)	12744.44	6037.57

The tactic the Baird home uses to make the use of solar PV cost effective is conservation. This is represented in having less electronic items to plug in and for those that they do use, to invest in very efficient choices. An example of energy saving choices include:

- Corded phones - (no battery chargers and no phantom load)
- 12 DC chest fridge -(uses 157 Whr/day or 57 kWhr/year compared to Energy Star minimal for comparable fridge which is 377 kWhr/year. The sundanzer has an energy consumption of just 15% of the standard meaning it is 84.8% more efficient)
- LED lighting – bulbs range in power from .8W to 3.2W
- Use of Natural Lighting – (The home has five light tubes installed acting as a main light source in both main living areas)
- 24 VDC wiring – the home tries to minimize efficiency losses from inverting power from DC to AC, thus using it in the form it is collected and stored.
- DC pumps, valve and controllers – the hydronic and solar thermal systems use Ivan Labs El Sid pumps as circulators; Belimo 24 VDC actuator valves, and Caleffi/Resol 12VDC controllers.
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BC Hydro Net Metering - Payback

The Baird home is a net supplier to BC Hydro on a yearly basis wherein it sells to BC Hydro at the same price it purchases energy, at \$0.0812 /kWhr (8.12cents/kWhr).

For the period of research the Bairds would have earned 397 kWhrs X \$0.0812, the equivalent of \$32.24; this compared to the average home that uses 12,731 kWhrs at a yearly cost of \$1033.75/year.

The solar PV panels have a warranty period for 25 years, the batteries a period of 10 year. Using an amortization period of 25 years for the system less batteries (\$40,180), and 10 years on the batteries (\$4836), where the total cost of the alternative energy system is \$45,016 (depreciation and net present value not accounted for), the yearly costs of energy generation to meet needs is:

Main system

$\$40,180/25 \text{ yrs} = \$1607.2/\text{yr}$

$\$1607.20/2554 \text{ Avg yearly kW generated} = \$0.63/\text{kW}$

Batteries

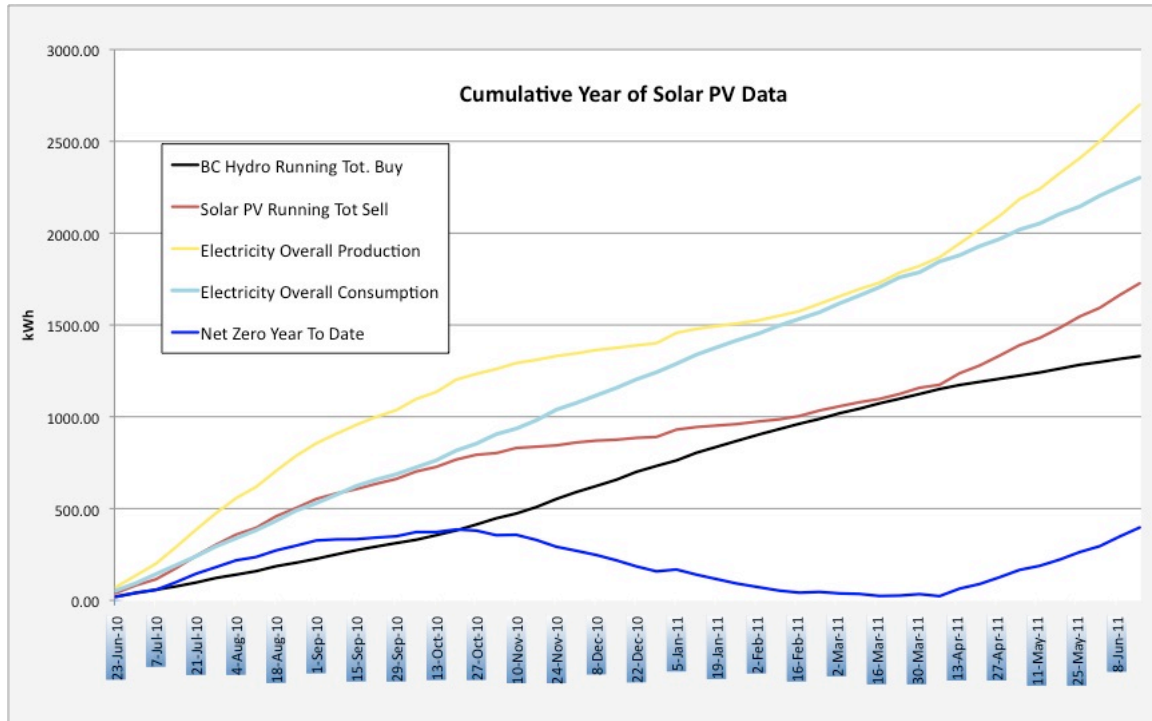
$\$4,836/10 \text{ yrs} = \$483.6/\text{yr}$

$\$483.60/2554 \text{ Avg yearly kW generated} = \$0.19/\text{kW}$

\$2090.80/ year which when converted to cost per kWhr ($\$0.63 + \0.19) is \$0.82/kWhr (this is based on the average yearly production over the past three years of 2554 kWhr/year).

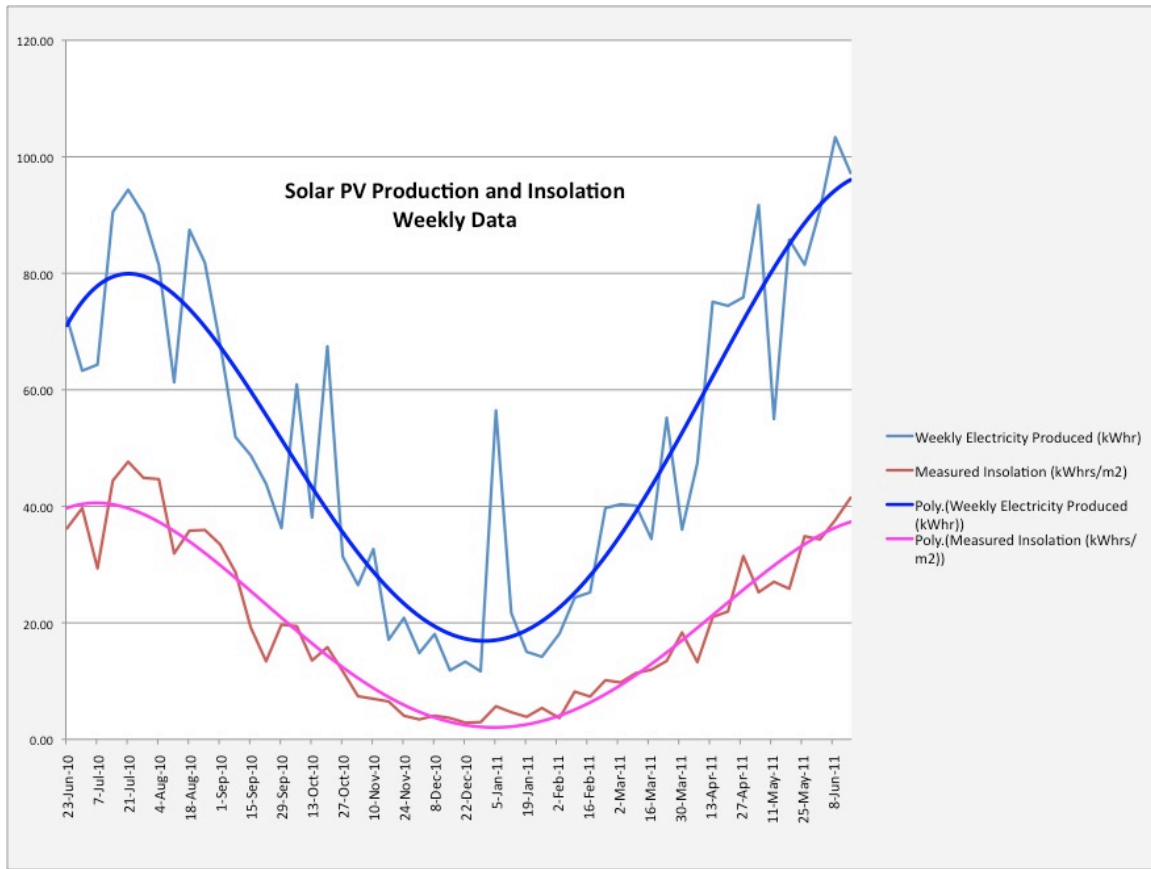
BC Hydro presently pays \$0.0812/kWhr, thus the Baird system costs them 10 times the price for their electricity than those whom are using BC Hydro. Of interesting note, the Province of Ontario, at the time of this report, had a feed in tariff program where they are paying customers \$0.82/kWhr, the same calculated cost that the Baird system comes in at.

Graphs:



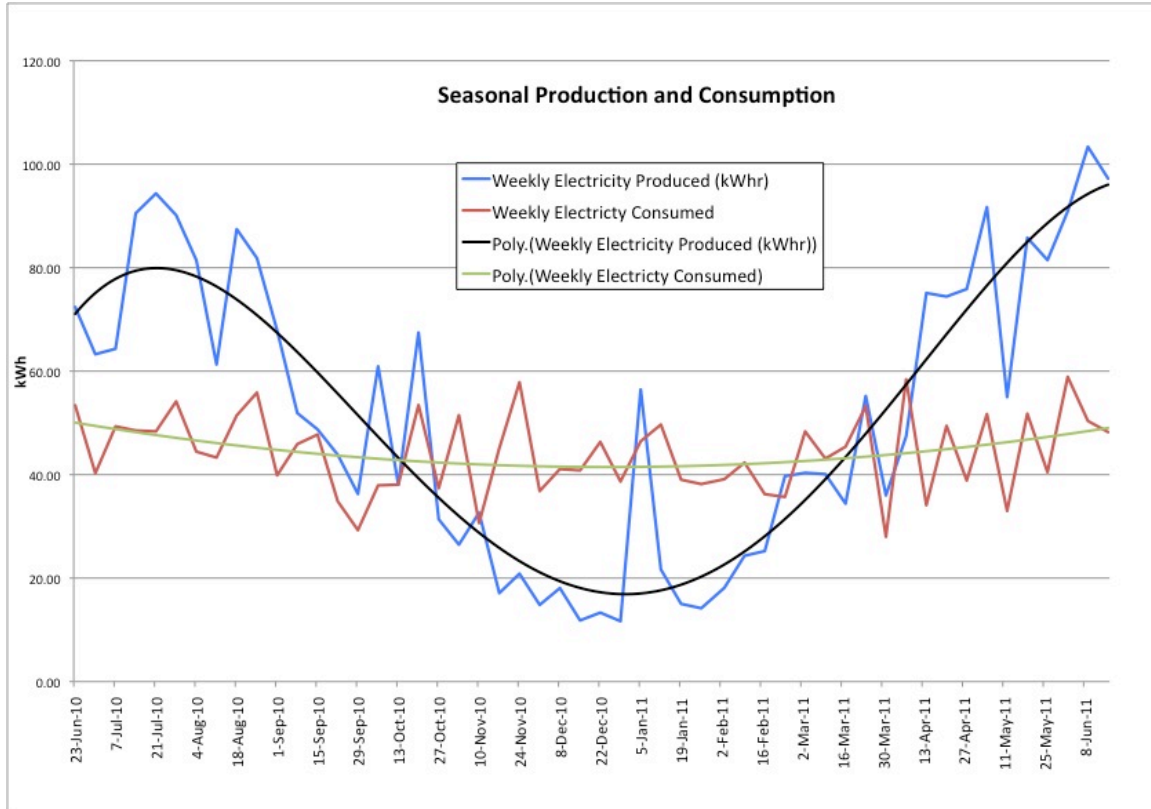
Notes:

1. Eco-Sense was net zero electricity for the entire year
2. This graph shows the flow of electricity to/from BC Hydro with relation to Eco-Sense production and consumption



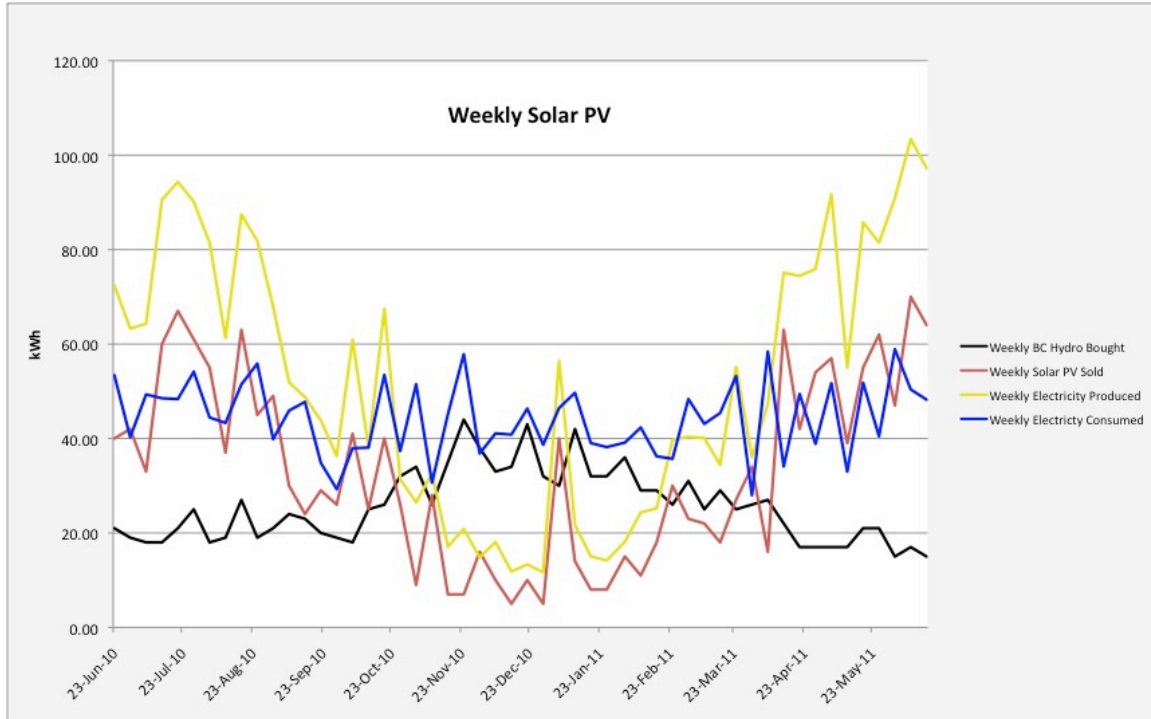
Notes:

- Using the polynomial trendline shows that the production of electricity for the solar PV system mirrors the measured insolation data.
- Snow cover impacts measured insolation from the local school. This is the likely explanation for the Jan spike in production that is not mirrored in the insolation data.
- The spread in trendlines is greater in the summer than in the winter. Solar PV efficiency is greater when the panels are cooler.
- Snow on the eco-sense roof reflects more sunlight onto the solar panels thus explaining the observed high solar output in early Jan.



Notes:

- Weekly electricity consumption is quite steady during the year with only a slight increase during summer months. May be due to water pumping for irrigation and aeration of grey water tank.



Notes:

8. Weekly buy and sell relationship with BC Hydro is clearly demonstrated showing how these two are seasonally opposite.
9. Household consumption is calculated from measured values. Consumption = Production + (BC Hydro Sold - BC Hydro Bought).

Appendix
Data:

Week of:	CUMULATIVE (Year to date)				Net Zero Year To Date
	BC Hydro	Solar PV	Electricity	Electricity	
	Running Tot.	Running Tot	Overall	Overall	
	Buy	Sell	Production	Consumption	
23-Jun-10	21.00	40.00	72.40	53.40	19.00
30-Jun-10	40.00	82.00	135.68	93.68	42.00
7-Jul-10	58.00	115.00	200.00	143.00	57.00
14-Jul-10	76.00	175.00	290.53	191.53	99.00
21-Jul-10	97.00	242.00	384.88	239.88	145.00
28-Jul-10	122.00	303.00	475.03	294.03	181.00
4-Aug-10	140.00	358.00	556.48	338.48	218.00
11-Aug-10	159.00	395.00	617.78	381.78	236.00
18-Aug-10	186.00	458.00	705.23	433.23	272.00
25-Aug-10	205.00	503.00	787.08	489.08	298.00
1-Sep-10	226.00	552.00	854.95	528.95	326.00
8-Sep-10	250.00	582.00	906.85	574.85	332.00
15-Sep-10	273.00	606.00	955.60	622.60	333.00
22-Sep-10	293.00	635.00	999.45	657.45	342.00
29-Sep-10	312.00	661.00	1035.73	686.73	349.00
6-Oct-10	330.00	702.00	1096.65	724.65	372.00
13-Oct-10	355.00	727.00	1134.73	762.73	372.00
20-Oct-10	381.00	767.00	1202.18	816.18	386.00
27-Oct-10	413.00	793.00	1233.55	853.55	380.00
3-Nov-10	447.00	802.00	1260.03	905.03	355.00
10-Nov-10	473.00	830.00	1292.68	935.68	357.00
17-Nov-10	508.00	837.00	1309.78	980.78	329.00
24-Nov-10	552.00	844.00	1330.63	1038.63	292.00
1-Dec-10	590.00	860.00	1345.45	1075.45	270.00
8-Dec-10	623.00	870.00	1363.53	1116.53	247.00
15-Dec-10	657.00	875.00	1375.35	1157.35	218.00
22-Dec-10	700.00	885.00	1388.68	1203.68	185.00
29-Dec-10	732.00	890.00	1400.35	1242.35	158.00
5-Jan-11	762.00	930.00	1456.80	1288.80	168.00
12-Jan-11	804.00	944.00	1478.48	1338.48	140.00
19-Jan-11	836.00	952.00	1493.50	1377.50	116.00
26-Jan-11	868.00	960.00	1507.68	1415.68	92.00
3-Feb-11	904.00	975.00	1525.80	1454.80	71.00
10-Feb-11	933.00	986.00	1550.13	1497.13	53.00
17-Feb-11	962.00	1004.00	1575.35	1533.35	42.00
24-Feb-11	988.00	1034.00	1615.05	1569.05	46.00
3-Mar-11	1019.00	1057.00	1655.40	1617.40	38.00
10-Mar-11	1044.00	1079.00	1695.50	1660.50	35.00
17-Mar-11	1073.00	1097.00	1729.90	1705.90	24.00
24-Mar-11	1098.00	1124.00	1785.10	1759.10	26.00

31-Mar-11	1124.00	1158.00	1821.10	1787.10	34.00
7-Apr-11	1151.00	1174.00	1868.50	1845.50	23.00
14-Apr-11	1173.00	1237.00	1943.60	1879.60	64.00
21-Apr-11	1190.00	1279.00	2018.03	1929.03	89.00
28-Apr-11	1207.00	1333.00	2093.90	1967.90	126.00
5-May-11	1224.00	1390.00	2185.60	2019.60	166.00
12-May-11	1241.00	1429.00	2240.60	2052.60	188.00
19-May-11	1262.00	1484.00	2326.38	2104.38	222.00
26-May-11	1283.00	1546.00	2407.85	2144.85	263.00
2-Jun-11	1298.00	1593.00	2498.75	2203.75	295.00
9-Jun-11	1315.00	1663.00	2602.13	2254.13	348.00
16-Jun-11	1330.00	1727.00	2699.35	2302.35	397.00

	WEEKLY				
Week of:	Weekly	Weekly	Weekly	Weekly	Net Zero
	BC Hydro	Solar PV	Electricity	Electricity	Weekly
	Bought	Sold	Produced (kWhr)	Consumed	
23-Jun-10	21.00	40.00	72.40	53.40	19.00
30-Jun-10	19.00	42.00	63.28	40.28	23.00
7-Jul-10	18.00	33.00	64.33	49.33	15.00
14-Jul-10	18.00	60.00	90.53	48.53	42.00
21-Jul-10	21.00	67.00	94.35	48.35	46.00
28-Jul-10	25.00	61.00	90.15	54.15	36.00
4-Aug-10	18.00	55.00	81.45	44.45	37.00
11-Aug-10	19.00	37.00	61.30	43.30	18.00
18-Aug-10	27.00	63.00	87.45	51.45	36.00
25-Aug-10	19.00	45.00	81.85	55.85	26.00
1-Sep-10	21.00	49.00	67.88	39.88	28.00
8-Sep-10	24.00	30.00	51.90	45.90	6.00
15-Sep-10	23.00	24.00	48.75	47.75	1.00
22-Sep-10	20.00	29.00	43.85	34.85	9.00
29-Sep-10	19.00	26.00	36.28	29.28	7.00
6-Oct-10	18.00	41.00	60.93	37.93	23.00
13-Oct-10	25.00	25.00	38.08	38.08	0.00
20-Oct-10	26.00	40.00	67.45	53.45	14.00
27-Oct-10	32.00	26.00	31.38	37.38	-6.00
3-Nov-10	34.00	9.00	26.48	51.48	-25.00
10-Nov-10	26.00	28.00	32.65	30.65	2.00
17-Nov-10	35.00	7.00	17.10	45.10	-28.00
24-Nov-10	44.00	7.00	20.85	57.85	-37.00
1-Dec-10	38.00	16.00	14.83	36.83	-22.00
8-Dec-10	33.00	10.00	18.08	41.08	-23.00
15-Dec-10	34.00	5.00	11.83	40.83	-29.00
22-Dec-10	43.00	10.00	13.33	46.33	-33.00
29-Dec-10	32.00	5.00	11.68	38.68	-27.00
5-Jan-11	30.00	40.00	56.45	46.45	10.00
12-Jan-11	42.00	14.00	21.68	49.68	-28.00
19-Jan-11	32.00	8.00	15.03	39.03	-24.00
26-Jan-11	32.00	8.00	14.18	38.18	-24.00
3-Feb-11	36.00	15.00	18.13	39.13	-21.00
10-Feb-11	29.00	11.00	24.33	42.33	-18.00
17-Feb-11	29.00	18.00	25.23	36.23	-11.00
24-Feb-11	26.00	30.00	39.70	35.70	4.00
3-Mar-11	31.00	23.00	40.35	48.35	-8.00
10-Mar-11	25.00	22.00	40.10	43.10	-3.00
17-Mar-11	29.00	18.00	34.40	45.40	-11.00
24-Mar-11	25.00	27.00	55.20	53.20	2.00
31-Mar-11	26.00	34.00	36.00	28.00	8.00
7-Apr-11	27.00	16.00	47.40	58.40	-11.00

14-Apr-11	22.00	63.00	75.10	34.10	41.00
21-Apr-11	17.00	42.00	74.43	49.43	25.00
28-Apr-11	17.00	54.00	75.88	38.88	37.00
5-May-11	17.00	57.00	91.70	51.70	40.00
12-May-11	17.00	39.00	55.00	33.00	22.00
19-May-11	21.00	55.00	85.78	51.78	34.00
26-May-11	21.00	62.00	81.48	40.48	41.00
2-Jun-11	15.00	47.00	90.90	58.90	32.00
9-Jun-11	17.00	70.00	103.38	50.38	53.00
16-Jun-11	15.00	64.00	97.23	48.23	49.00

			CUMULATIVE
Week of:	YTD Average	YTD Average	Measured Insolation (kWhrs/m2)
	Daily	Daily	
	Produced	Consumed	
23-Jun-10	10.34	7.63	36.20
30-Jun-10	9.69	6.69	39.68
7-Jul-10	9.52	6.81	29.34
14-Jul-10	10.38	6.84	44.41
21-Jul-10	11.00	6.85	47.66
28-Jul-10	11.31	7.00	44.88
4-Aug-10	11.36	6.91	44.67
11-Aug-10	11.03	6.82	31.91
18-Aug-10	11.19	6.88	35.82
25-Aug-10	11.24	6.99	35.94
1-Sep-10	11.10	6.87	33.46
8-Sep-10	10.80	6.84	28.70
15-Sep-10	10.50	6.84	19.18
22-Sep-10	10.20	6.71	13.39
29-Sep-10	9.86	6.54	19.69
6-Oct-10	9.79	6.47	19.42
13-Oct-10	9.54	6.41	13.54
20-Oct-10	9.54	6.48	15.81
27-Oct-10	9.27	6.42	11.70
3-Nov-10	9.00	6.46	7.39
10-Nov-10	8.79	6.37	6.96
17-Nov-10	8.51	6.37	6.49
24-Nov-10	8.26	6.45	4.04
1-Dec-10	8.01	6.40	3.42
8-Dec-10	7.79	6.38	4.06
15-Dec-10	7.56	6.36	3.65
22-Dec-10	7.35	6.37	2.86
29-Dec-10	7.14	6.34	2.95
5-Jan-11	7.18	6.35	5.67
12-Jan-11	7.04	6.37	4.65
19-Jan-11	6.88	6.35	3.86
26-Jan-11	6.73	6.32	5.38
3-Feb-11	6.61	6.30	3.64
10-Feb-11	6.51	6.29	8.19
17-Feb-11	6.43	6.26	7.34
24-Feb-11	6.41	6.23	10.14
3-Mar-11	6.39	6.24	9.76
10-Mar-11	6.37	6.24	11.38
17-Mar-11	6.34	6.25	11.95
24-Mar-11	6.38	6.28	13.45
31-Mar-11	6.35	6.23	18.34
7-Apr-11	6.36	6.28	13.25
14-Apr-11	6.46	6.24	20.99
21-Apr-11	6.55	6.26	21.95

28-Apr-11	6.65	6.25	31.46
5-May-11	6.79	6.27	25.25
12-May-11	6.81	6.24	27.03
19-May-11	6.92	6.26	25.85
26-May-11	7.02	6.25	34.86
2-Jun-11	7.14	6.30	34.31
9-Jun-11	7.29	6.31	37.63
16-Jun-11	7.42	6.33	41.47

ⁱ Eco-Sense uses LP gas for cooking, canning and preserving food. Unlike most homes, 80 % of the food for on average three people is provided onsite, without the reliance on embodied energy found in conventional foods bought at the grocery store. 300 lbs of LP gas is used per year, with an energy footprint of 1894.53 kWhr. To account for the sheer volume of processed and preserved foods, 1/3 of this number is estimated to be the embodied energy of preserving. This leaves a figure of 1263 kWhr allocated for conventional food prep.