Energy Consumption and Carbon Emission Offsets

2013/2014

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Summary

Ballarat Health Services (BHS) and Central Victoria Solar City (CVSC) have been successful in receiving funding from the Commonwealth Government to implement what is known as the Solar City Program.

The Solar City Program wishes to trial sustainable models of electricity supply, energy efficiency and load management on large scale grid connected urban sites. One objective of the funding agreement is to trial energy efficiency technologies in hospitals particularly hospitals located within the Central Victoria Solar City Catchments area.

Several initiatives to reduce energy consumption and carbon footprints have been completed or soon to be completed as part of the BHS and CVSC partnership.

- Purchase of two fully electric cars
- Installation of photovoltaic arrays
- Solar Hot Water Evacuated Tubes
- Ballarat Regional Integrated Cancer Centre (BRICC) energy efficiency measures

The total expected savings of both carbon emissions and energy costs per annum are 263.38 tonnes of CO_2 and $17,048.38 these are estimations provided across all seasons within a calendar year

The following is a breakdown of the various installations and expected efficiency within each individual installation.

Queen Elizabeth Centre (QEC) Solar Panels

The QEC solar array installation was originally to be a 25kW system to the George Skerritt Building and a 9kW installation to the Supply Department Building. Due to shading effects of panels at the Base site carport it was found to be more beneficial to install the shaded panels to the Supply Department Building increasing the size to 13kW.

Increasing the size of the installation at the QEC is financially a better investment as BHS pays an extra three cents per kilowatt hour at this site compared to the Base site.

The Clean Energy Council (CEC) has calculated the average kWh output per kW of photovoltaic solar array installations for each capital city within Australia. According to the CEC Melbourne has an average daily expected yield of 3.6kWh for each kW of solar installation. This figure will be used for the purpose of calculations in this report. However it must be mentioned that this reference seems to be a conservative figure when comparing BHS real time data and generation figures for the Ballarat Solar Park published in CVSC 2011-2012 Annual Report.

PV solar arrays and Solar Hot Water systems have been interfaced with BHS Building Management System (BMS) OPTO22. OPTO22 is a non propriety open platform BMS maintained by BHS internal staff. With the use of OPTO22 we are able to monitor and log the performance and status of our solar initiatives.

George Skerritt
Estimated Output – 32,850kWh per annum
Estimated CO_2 Savings – 32,850 by a factor of 1.19 divided by 1000 = 39.09 tonnes per annum
Projected Financial Savings – 32,850 by 0.1703 cents per kWh = $5,594.35 per annum

The George Skerritt building was commissioned on the 18th January 2013 (figure 1) below show the real time figures of this installation from our OPTO22 Building Management System (BMS)

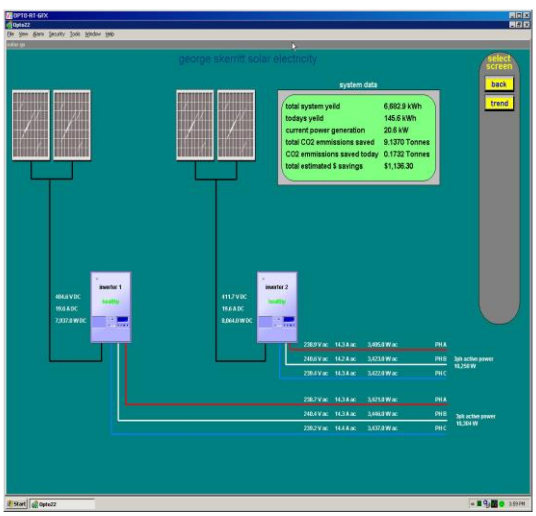


Figure 1 George Skerritt 25kW solar installations commissioned 18/01/2013

Solar Car Shelters

Base Site
The construction of a carport shelter and 5kW solar PV array in the existing pool carpark area of the Base Hospital site provides parking space for six vehicles including one electric vehicle.
The original intent was to provide a 9kW solar PV array to this shelter however due to shading effects (figure 2) caused from the height safety guard rail it was decided the best outcome would be to use the effected 4kW's on the QEC car shelter to maximize output.

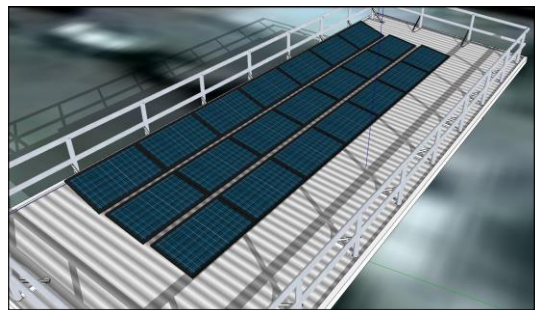


Figure 2 5kW carport installation configuration and shade effect during winter solstice

The expected daily average total for the Base car shelter 5kW PV array is

3.6kWh by 5kW = 18kWh per day
18kWh by 365 = 6,570 kWh per annum
CO_2 savings = 6,570 by 1.19 = 7,818.3 divided by 1000 = 7.818 tonnes per annum
Projected Financial Savings – 6,750 by 0.135 cents per kWh = $911.25

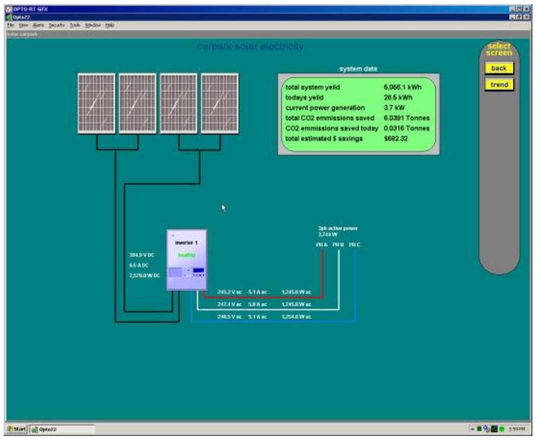


Figure 3 Base Carport 5kW installation commissioned 28/08/2012

QEC Site

Using existing structures a 13kW solar PV array was installed to the supply department roof. To supply amongst other loads the QEC electric carport shelter

Estimated Output – 18,396kWh per annum
Estimated CO_2 Savings – 18,396 by a factor of 1.19 divided by 1000 = 21.89 tonnes per annum
Estimated Financial Savings – 18,396 by 0.1703 cents per kWh = $3,127.32 per annum.

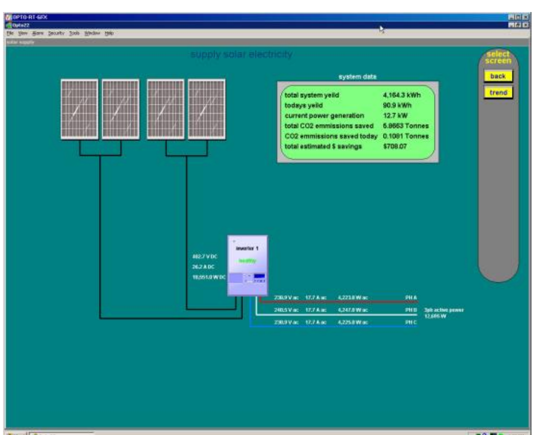


Figure 4 Supply Department 13kW installation commissioned 18/01/2013

Ballarat Regional Integrated Cancer Centre (BRICC)

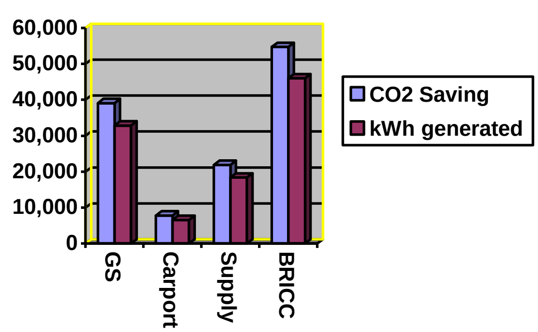
BRICC solar array is a 35kW installation to be installed to the rooftop of a four story building.

The projected output from this installation is

Estimated output- 45,990 kWh
Estimated CO_2 Saving – 45,990 by 1.19 = 54,728.1 divided by 1000 = 54.72 tonne
Estimated Financial Savings – 45,990 by 0.135 cents per kWh = $6,208.65

Estimated Annual CO_2 kg saving and kWh production per annum

	GS	Port	Supply	BRICC
kWh	32,850	6,570	18,396	45,990
CO_2 kg	39,091.1	7,818.3	21,891.25	54,728.1



Two Electric Cars

Currently the two electric Mitsubishi MIEV cars are housed separately at BHS two largest sites the Base Hospital and QEC.

The Base Hospital vehicle is currently being utilized predominately by BHS engineering. Engineering provide a diverse range of services to multiple BHS sites across Ballarat. The availability of the electric vehicle is ideal to complete a variety of tasks and a single full tank each day is ample supply to complete all tasks.

The QEC vehicle is currently utilized by the BHS Ballarat Regional Integrated Cancer Centre (BRICC) project team.

Both vehicles according to users can expect to be anywhere from half full to quarter full at the end of a days use.

Mitsubishi make claims that the MIEV is capable of doing 155km on a single charge experience tells BHS the realistic distance that can be expected on a single charge is 120km batteries completely depleted.

According to Mitsubishi Motors Australia Limited President and CEO Genichiro Nishina the Mitsubishi MIEV will cost 16kWh of energy to fill from empty and will take 8 hours to fully charge. www.goauto.com.au

The sizing of 18kW solar PV array to support the charging of these cars is more than adequate when charging from empty. 18kW PV solar array can provide on average 64.8kWh daily even if the cars needed to be fully charged it still leaves a surplus of 32.8kWh enough to charge an extra two electric cars without the need of grid connected electricity.

"The MIEV has been a great success as a transport vehicle within the Engineering department. Its small size and zippy performance allows our maintenance personnel to quickly respond to requests across our many facilities in Ballarat. We have found it easy to drive and easy to charge and have never found range to be a problem."

Bob Pickard BHS Engineering Manager

BHS current petrol driven small vehicle fleet consists of Holden Cruze cars. The Cruze comes packed with a 60 litre tank and is claimed to provide 7L/100km fuel efficiency but again BHS experience indicates the realistic range is 7.5L/100km. This gives the Cruze a driving range of 800km per full tank of petrol. To get this type of range from the MIEV it would take 6.66 refills. However, as already stated this does not hinder the effectiveness of the MIEV for the purpose of both engineering and BRICC project team as a daily drive will not exceed the 120km range limit of the MIEV.

Currently the MIEV's combined total for km traveled is 8000km saving the organisation $900 in fuel costs (at $1.50per/L) compared to the fuel needs of a Holden Cruze.

For each litre of petrol used 2.3kg of CO_2 emissions are released through the vehicles tailpipes. To travel the same distance in a Holden Cruze you would need to fill up 10 times therefore:

10 by 60L = 600Litres of fuel

600 by 2.3kg = 1,380kg of CO_2 emissions saved.

Currently BHS does not intend to expand its fleet of electric cars. Considerations to expand the electric fleet will be assessed in the future. Points to consider will be principal cost, vehicle range, availability of green energy, lifetime costs and reliability.

Solar Hot Water Installation QEC
Evacuated tube collectors have been connected to the existing QEC kitchen domestic hot water supply.

The existing system is supported by a Raypak boiler feeding into plate heat exchangers. The secondary side of the plate heat exchangers feed into a buffer tank which in turn supplies the kitchen domestic hot water needs.

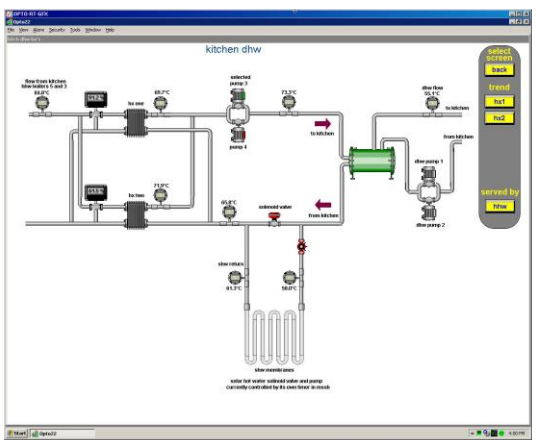


Figure 5 QEC Kitchens Solar Hot Water Installation

It is estimated that the Kitchen average domestic hot water consumption per day during solar irradiation periods is 4500 litres and the mean daily temperature average of solar boosted water returning to the continuous loop from SHW has a Delta-T of 5 degrees.

Calculating the savings of both CO_2 and energy costs below does not take into consideration any efficiency losses.

Energy requirements to heat 4500 litres of water 5 degrees using natural gas.

5 by 4187 joules = 20,935 joules
20,935 divided by 1000 = 20.93kj
20.93 By 4500L = 94,207.5kj
94,207 divided by 1000 = 94.20Mj

Estimated CO_2 Savings – 94.20 by 0.0633 = 5.96kg per day
5.96 By 365 = 2,175.40kg per annum

Estimated Financial Savings – 94.20Mj by 365 days = 34,383Mj
34,383 divided by 1000 = 34.38Gj
34.38Gj by $5.42 = $186.33 per annum

Solar Hot Water Installation Base
Evacuated tube collectors have been connected to the existing Psychiatric Services domestic hot water supply.

The existing system is supported by four Rinnia instantaneous water heaters.

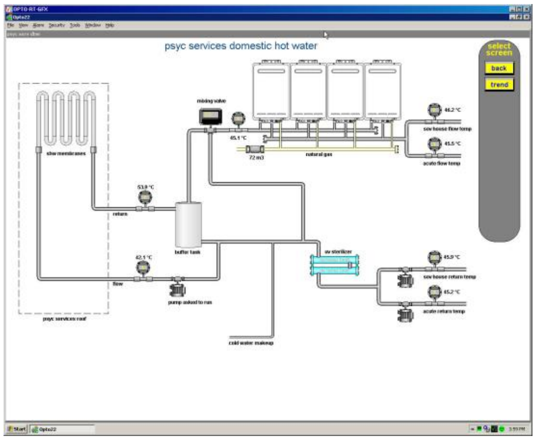


Figure 6 Base Sites Psychiatric Solar Hot Water Installation

It is estimated that Psychiatric Services average domestic hot water consumption per day during solar irradiation periods is 1800 litres and the mean daily temperature average of solar boosted water returning to buffer tank from SHW has a Delta-T of 7.5 degrees.

Calculating the savings of both CO2 and energy costs below does not take into consideration any efficiency losses.

Energy requirements to heat 1800 litres of water 7.5 degrees using natural gas.

7.5 By 4187 joules = 31,402.5 joules
31,402.5 divided by 1000 = 31.40kj
31.40 By 1800L = 56,524.5kj
56,524.5 divided by 1000 = 56.52Mj

Estimated CO2 Savings – 56.52Mj by 0.0633 = 3.57kg per day
3.57 by 365 days = 1,303kg per annum

Estimated financial Savings – 56.52Mj by 365 days = 20,629.8Mj
20,629.8Mj divided by 1000 = 20.63Gj

20.63Gj by $5.84 = $120.48 per annum

BRICC Building

It is very difficult to estimate the energy savings for the new building due to control factors such as occupancy, weather, treatment cycles and the like. Furthermore some of the measures introduced as part of the sustainability effort had the effect of increasing energy by improving indoor environment quality. We believe that the design affords a minimum saving of the Day procedure areas and clinics of 10%. Based on this we would estimate that the project, not including the solar panels provided as part of CVSC, would save approximately 135,000kg CO_2e per year.

Workings

0.6	*GJ/m²*	
600	*MJ/m²*	
7000	*m²*	
4200000	*MJ/Annum*	
420000	*@ 10% Saving MJ*	
336000	*Electrical Component*	
93333.3	*convert to kWh*	
1.381	*kg/kWh*	
128893	*kg CO2 Saved*	
84000	*Gas Component*	
0.0633	*kg/MJ*	
5317.2	*kg CO2 Saved*	
134211	*Estimated kg CO2*	

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Note

When installing solar PV arrays over 30kW on one NMI you are required to sign an “Embedded Generation Agreement” with the network supplier. I strongly recommend these talks happen ASAP as the turnaround for such agreements can take over five months to receive.

Conclusion

The estimated CO2 savings per annum is equivalent to the removal of seventy five motor vehicles from our roads each year.

BHS are proud to partner CVSC to deliver this sustainability package. BHS hope that the information provided will provide further motivation to advance the current and not yet thought of technologies that will drive and ultimately protect the planets future.