A Solar Energy Initiative to Reduce Cost and Carbon Emission
Bhagat Chandra Hospital, India

GGHH Agenda Goals

- Energy

Hospital Goal

- Reduce energy costs
- Reduce carbon dioxide emissions
- Promote clean energy

Progress Achieved

- Financial benefits: Bhagat Chandra hospital makes use of a 50kW solar panels connected to the grid which is connected to the electrical system. The installed capacity reduces 20%-30% of their consumption.

- Environmental Benefit: The solar energy generated has conserved about 93,000 kilograms of CO_2 emissions since 2016.

- The hospital staff members have been empowered to become advocates for reduced energy usage and cost savings within the hospital.

The Issue

The management of Bhagat Chandra hospital wanted to reduce their carbon footprint and invest in clean energy. Implementing this will have both environmental and economic benefits. The proposal to exchange all the compact fluorescent lamps (CFLs) and bulbs for light emitting diodes (LED) lamps was first proposed in 2014. After witnessing economic benefits from this initiative, the management decided to install 20kW of Solar panel in December, 2015 and added 30kW more in September, 2016 to further improve their initiative on reducing carbon footprint.

Sustainability Strategy Implemented

The hospital management had a clear vision on its objective, which was to reduce their energy consumption from conventional sources and move toward clean energy. Thus, following steps were taken,

- All the electrical appliances installed at the facility have a 4 star or above rating, according to Bureau of Energy Efficiency in India.
- Conventional light bulbs such as CFLs are not used anymore. Instead, LED were procured, after conducting a comparative study on brightness level and cost.
- Auto lock was installed on door to automatically close all doors when not in use. This action helps maintain the temperature of rooms and minimize the load on the air conditioners. This practice minimized electricity use in cooling the rooms.
- Engage with renowned companies to set up a system for solar power generation. Technology, longevity and cost were taken into account before procurement.
- Steps were taken to ensure that the installation company assist in regular monitoring and update, and training of staff members on maintaining the solar panels.
- After training, dedicated staffs were given the responsibility of regular monitoring of the solar panel and the off grid system.
- Internal staff members were assigned to regularly clean the solar panel for maximum capacity.

Figure 1: Installed Solar Panel located at the hospital

Implementation process

The initiative begun as a cost cutting measure as well as to reduce the carbon footprint generated by the hospital. The hospital management had implemented a lot of initiatives in the construction stage of the facility to reduce energy consumption. Such as, wooden thermal insulator walls for partitions which reduces temperature fluctuation, thermostat timer to control the temperature. Many such initiatives were implemented in the construction stage to make the hospital eco-friendly.

To reduce energy consumption which was resulting in added cost on electricity, the first initiative on the successful energy leadership begun in 2014. A measure to change the CFL light bulbs to LED bulbs were considered. After a cost-benefit analysis on the future procurement, the light bulbs which were functional continuously for more than 8 hours were changed to LED bulbs. The LED initiative had an impact on the power bills which encouraged the management to proceed further.

A proposal was put forth to research and select a suitable option in solar power generation. A cost-benefit analysis was done before the purchase and installation of the solar panels. The initiative started with a 20kW solar panel connected to the grid in December, 2015. The direct grid connection helps in eliminating the use of batteries and energy created is directly used in offsetting the hospital power capacity load. After the installation of the 20kW solar power unit, the power bills were substantially reduced.

The hospital management installed 10 new individual air conditioning units and a 20kW oxygen generation plant in 2016 for better patient care and facilities. To compensate the energy demand from the newly installed air conditioners and oxygen generator, 30kW solar panels were added to the existing 20kW. Thus, at present Bhagat Chandra Hospital is currently supported by 50kW of solar grid power supply.

The hospital electric department and the director of the hospital are involved in monitoring, learning and evaluating this initiative. The staff members involved in cleaning and maintaining the solar panels were trained by ORB Energy, the vendor responsible for installing and maintaining the solar panels.

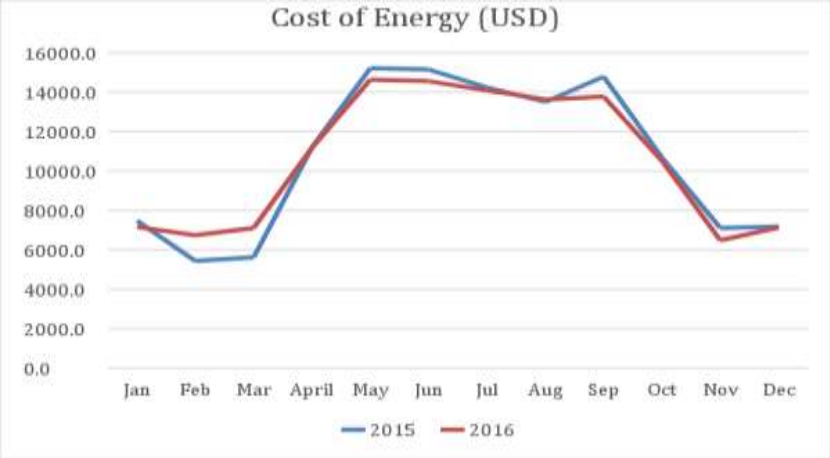
Figure 2: Solar panels used for water heating

Tracking Progress

Month-wise Cost of energy (USD)		
	2015	**2016**
Jan	7470.5	7156.8
Feb	5435.8	6743.0
Mar	5625.2	7109.7
April	11206.9	11182.7
May	15214.0	14627.5
Jun	15142.5	14549.1
Jul	14233.3	14090.6
Aug	13499.8	13623.2
Sep	14782.6	13771.9
Oct	10673.3	10500.5
Nov	7102.1	6480.6
Dec	7174.0	7131.1
1USD = 63 INR		

Table 1: Difference in Cost of energy (USD) recorded in 2015 vs 2016

The above table represents the cost of energy accounted in the year 2015 and 2016. The difference in cost of energy in 2015 and 2016 is marginal because of increase in installed load capacity. The total installed capacity load in 2015 and 2016 were 130.5 kW and 170.5 kW respectively. Addition of new air conditioning and oxygen supplier unit increased the load capacity by 40.5 kW.



Graph 1: Cost of energy in 2015 and 2016

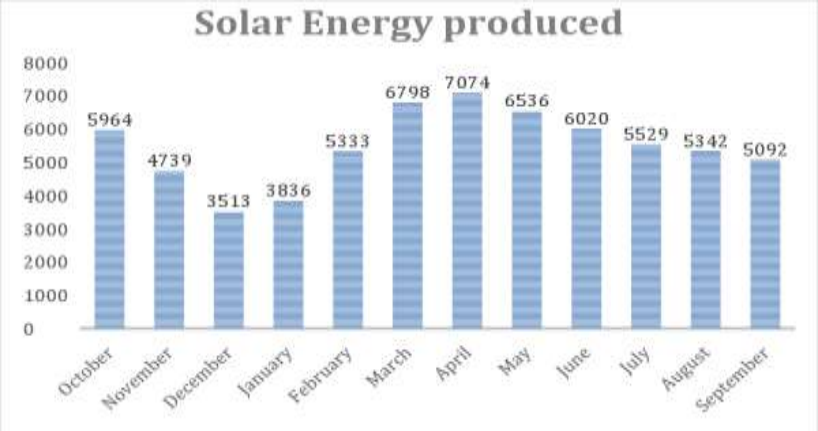
Graph 1 shows the cost of energy spent in 2015 and 2016. The energy use is high during the months of April to October, this could be because of regular use of air-conditioners. The average temperature during these month's range between 32.8C to 36.3. The energy use steeps down during winters, as the requirement for air conditioning is not necessary in in-patient and out-patient units. We can't draw any conclusions from graph 1, since the total installed capacity between 2015 and 2016 weren't same. Thus, the cost spent per kW was analyzed for above years.

Graph 2: Cost of energy per kW in 2015 vs 2016

The cost of energy spent per kW in the year 2015 and 2016 gives a better idea on the cost savings. The above graph represents the month wise cost spent per kW. The graph provides some evidence on the difference in cost spent per kW for both the years. On an annual average, 81.45 USD was spent per kW in 2015 on a monthly basis. For 2016, 62.05 USD was spent per kW in 2016. The cost per kW has been reduced by 19.4 USD (1222.2 INR). The below table provides the cost spent per kW for the year 2015 and 2016.

Month-wise Cost of energy per kW (USD)		
	2015	**2016**
Jan	57.2	42.0
Feb	41.7	39.5
Mar	43.1	41.7
Apr	85.9	65.6
May	116.6	85.8
Jun	116.0	85.3
Jul	109.1	82.6
Aug	103.4	79.9
Sep	113.3	80.8
Oct	81.8	61.6
Nov	54.4	38.0
Dec	55.0	41.8
1USD = 63 INR		

Table 2: Month-wise cost per kW recorded in 2015 vs 2016



Graph3: Solar Energy produced between October 2016 to September 2017

Efficiency and Longevity

The above graphical (Graph 3) representation shows the amount of energy produced between October 2016 to September 2017 by the 50kW solar panels installed at the facility. The solar panel targeted efficiency is to produce 4.2 units per kW per day which is a minimum of 200 kW on a clear day. The above graph gives us proof to indicate that the solar panels are working on full efficiency during the summer months. The months November to February are the winter months of Northern India and Delhi is subjected to a lot of smog events during this time. Thus, the productivity is low during these months. The monsoon months July, August and September have a considerable cloud cover which could be a reason for drop in efficiency.

Solar Energy Produced at Bhagat Hospital	
Months	**Energy produced (kWh)**
October	5964
November	4739
December	3513
January	3836
February	5333
March	6798
April	7074
May	6536
June	6020
July	5529
August	5342
September	5092

Table 3: Solar Energy recorded at Bhagat Hospital between October 2016- September 2017

From table 3, we can infer that the solar system is achieving its full capacity in months of March to June. The drop in efficiency between July to September could be due to the monsoon cloud cover. The installed solar system has recorded a total of 65,776 kW in 12 months (September 2016- October 2017) since installation.

Recorded Energy Use	
2016- 2017	**kWh**
October	66196
November	38610
December	42912
January	46272
February	35538
March*	40485
April	71832
May	87132
June	83028
July	89124
August	88830
September	73128

(Reference: Bombay Suburban Electric Supply (BSES), Delhi)

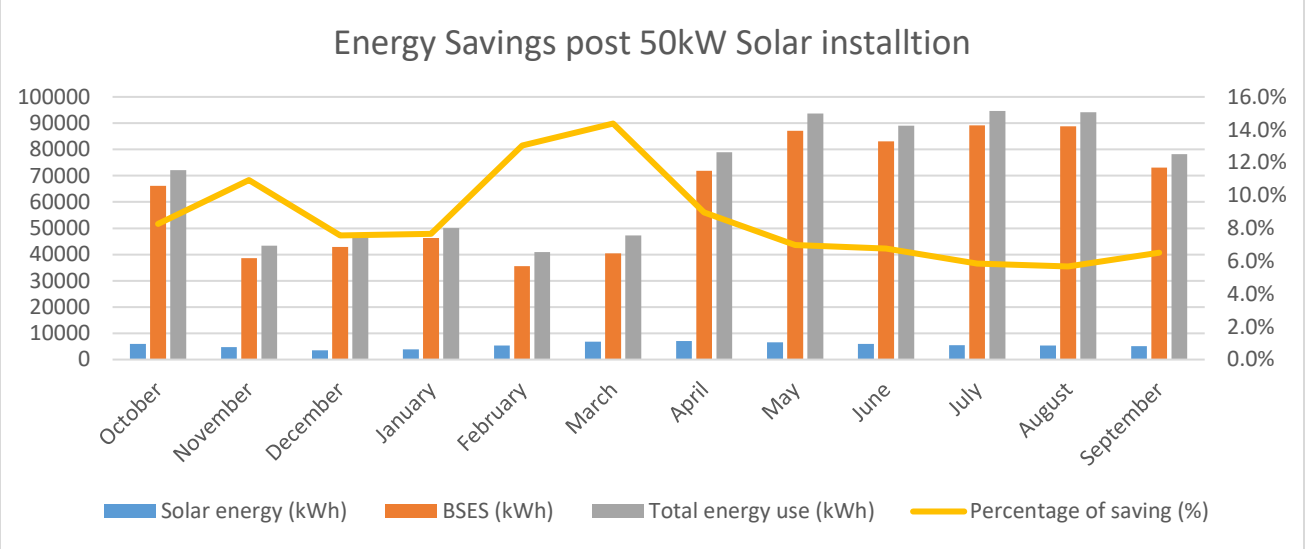
Table 4: Recorded Energy Use by Bhagat hospital between October 2016- September 2017

The above table represents the energy used by the facility after the installation of 50kW solar system. The energy data was provided by Bombay Suburban Electric Supply (BSES), Delhi. The energy use varied across seasons, ranging between 35,538 kWh to 89,124 kWh. The kilowatt hour recorded for March 2017 was not available, thus the kWh recorded for previous years were taken into account to derive at the March 2017 kWh.

Months (2016-2017)	Solar energy (kWh)	BSES (kWh)	Total energy use (kWh)	Percentage of saving (%)
October	5964	66196	72160	8.3%
November	4739	38610	43349	10.9%
December	3513	42912	46425	7.6%
January	3836	46272	50108	7.7%
February	5333	35538	40871	13.0%
March	6798	40485	47283	14.4%
April	7074	71832	78906	9.0%
May	6536	87132	93668	7.0%
June	6020	83028	89048	6.8%
July	5529	89124	94653	5.8%
August	5342	88830	94172	5.7%
September	5092	73128	78220	6.5%
Annual Energy Savings				7.94%

Table 5: Energy Savings

Table 5 shows the total annual energy used by the facility by both solar and conventional input. Maximum energy savings can be seen during winter months of February and March. Thus, from the collected evidence it shows that the solar energy is helping conserve 7.94% of its total energy use annually.



Graph 5: Graphical representation of Energy saved post 50Kw Solar installation.

According to the manufacturers, the solar panel lifetime extends to 25 years. Post the period minor changes needs to be made to upgrade the system. The system also has a reduce efficiency of .83% per year. Taking the market cost of Solar panels in to account, the investment made for a 50kW solar panels will be received back in 6 years in terms of economic savings. So, given the amount of energy produced by the solar panels, the 50 kW system will save energy costs of approximately 14,800 USD and approximately 65,000 kg of CO_2 every year.

Challenges and lessons learned

The panels need to be cleaned regularly, as the panels accumulate lot of dust due to proximity to main road. Winter months are subjected to loss of productivity due to smog and cloud cover.

Next Steps

The management will be taking further steps towards achieving high efficiency in the current system. Actions will be taken to advance low emission and energy consumption.

Demographic information

Bhagat Chandra Hospital is a multi-specialty hospital located in Dwarka, New Delhi, India. The hospital was established in the year 2009. The facility has a capacity of 85 beds for in-patients and efficiently provides services for approximately 70000 out-patients in a year. The hospital was built in 2009 at a total site area of 4013 m^2. At present there are 260 full time staffs working in the facility. The hospital has a 50kW solar panel connected to the grid installed to reduce their power consumption.

Submission date: May 2018