Case Study - Performance, Benchmarking & Carbon Offset Achievements of Pacific Controls USGBC LEED NC Platinum Green Building

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ABSTRACT

The paper presents the findings of a preliminary analysis carried out on pacific control USGBC LEED NC Platinum Certified green building situated at Techno Park, in Dubai. The purpose of the carbon offset analysis is to verify the performance and do benchmarking of green building in the year 2007. The results of the analysis shows that Pacific Control green building is actually offsetting its 21% of the energy needs annually and hence reducing the impact of 113 tons carbon in the atmosphere. This make pacific control Headquarter building the one and only building in the entire region to generating 21 % of it annual energy needs from renewable sources in house. The life cycle cost saving for both the technologies i.e. solar PV system and Solar Hot water powered VAM system is coming out to be AED 0.94 million and AED 1.06 million respectively at the end of 25th year. This sets an attractive example for building owners and developer for strategic investment and utilization of hybrid power generation technologies for sustainable energy use in an area which is well fed by renewable energy in the form of solar radiations.

1.0 INTRODUCTION

The Pacific Control green building is LEED Platinum rated building **[7]**, the energy and the weather related data is logged seamlessly within the premises of green building by state of the art building automation system. This data has been used to derive analysis results and some data has been derived out of a calibrated energy model of the pacific control green building.

The building is approximately 10000 m^2 in area and a half shell type in space planning and structure. Apart form optimum envelop fabrics, glazing walls and orientation in the building, it has been very well designed for daylight utilization. This make the energy demand in lighting very less as compare to conventional office building. The building also house renewable energy generating systems which includes 35 KW solar Photovoltaic System with inverter whose panel are mounted on roof and solar hot water generating system for use in a vapor absorption chiller for assistance in base cooling load of the green building. The Number of PV panel is 336 and Area of single panel is 1.815 m x 1.030 m or 1.87 m^2. The total number of hot water solar panel is 240 and area of a single panel is 3 x 1 m = 3 m^2. This is used as a heat source to 90 Ton vapor absorption chiller.

The current case study aims at finding some indicative number related to the carbon neutrality and energy performance benchmarking of the building system as a whole. The total amount of carbon released and saved from being released to the atmosphere and some financial indicator like Life Cycle Cost (LCC) and payback etc. The in house renewable energy generation capabilities were also assessed in a year round operation.

2.0 METHODOLOGY

The data from logs and calibrated energy model were used to evaluate energy performance of the green building. The electricity bill and other consumption details were taken in to account for accurate assessment of energy utilization. The energy to carbon conversion for Dubai power supply can't be established from any source so it was assumed as 0.31 kg CO_2/KWh. This value has been established by the fact that most of Dubai power supply comes form Dubai Electricity and Water Authority (DEWA). Whose power plant actually burn natural gas to run either steam or gas turbine for generation of electricity **[3].**

The value of global average radiation was taken from station no. 411940, which is located at Dubai international airport. The weather file has been issue by ASHRAE, and recommended to be used in energy calculation for Dubai region **[2].**

3.0 ANALYSIS

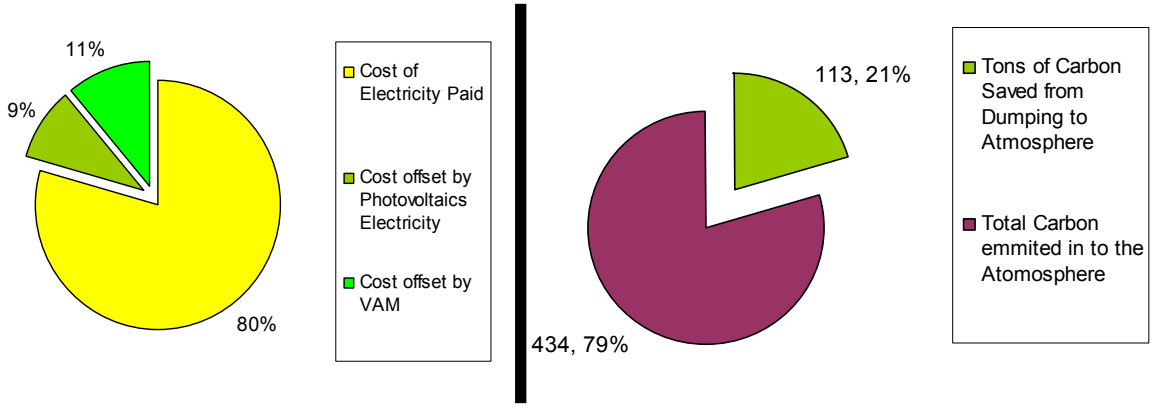
The analysis has been strictly based on the metered data which is logged seamlessly in a SQL server within the premises of the site. The data set were conditioned for any out standing and non consistent value. On some occasion when the meter data for certain location is not available then the data has been generated by a calibrated energy simulation model, which was built in Energy Plus simulation software. The cost of electricity has been assumed to be 0.2 AED/KWh **[1]** on an average and energy to CO_2 conversion factor has been taken as 0.31Kg CO_2/KWh

The weather data has been taken from typical representative year weather data files whose source is American Society for Heating Ventilation and Air Conditioning Engineers (ASHRAE). Metered electrical data and BTU usage from plant room chillers and lighting KWh were available for calculation.

3.1 ENERGY MIX

In the first part of the analysis we assessed the real energy mix which is prevailing in the facility. Energy mix is the measure of the contribution of different sources of energy to serve the demand side. The data shows that about 9% of the cost of energy is offset by the photovoltaic panel's generated electricity, which is installed on the roof top. Another 11% of the cost of energy is offset by the operation of solar hot water based Vapor Absorption System, which is contributing in catering the base cooling load in the office timing round the year.

Rest of the 80% of the total annual energy demand is been supplied by the Dubai Electricity and Water Authority. The pi chart in **Figure 3a (Section A-Energy and Cost Mix)** is pictorially representing the energy and cost mix in pacific control green building.



A: **Energy and Cost Mix**

B: **Carbon Offset** - Total carbon saved and total carbon dumped in to the atmosphere

Figure 3a: Energy mix and carbon impact

3.2 CARBON OFFSET

The term carbon offset is often used to asses the impact of a buildings or any utility on its capability to negate the larger cause of global warming, or it capability to save carbon dioxide dumping in to the atmosphere. The Pacific Control Green Building employees two measures for offsetting the carbon emission into the atmosphere. The two measures fall in using the available renewable sources of energy i.e. solar photovoltaic and solar hot water based cooling, which is achieved by a process of vapor absorption.

Both the two measure are alternatives to the conventional means of electricity generation and cooling respectively. The analysis of the data showed that 21% of the total carbon emissions were saved due to the operation of these two renewable energy generation systems. Total of 547 tons of carbon were to emit to the

atmosphere, but the use of renewable energy source cuts it down to a level of 434 tons. There is a direct saving of 113 tons of carbon emission annually. **Figure 3a Section B-Carbon offset)** is depicting the carbon offset figure in a pi chart.

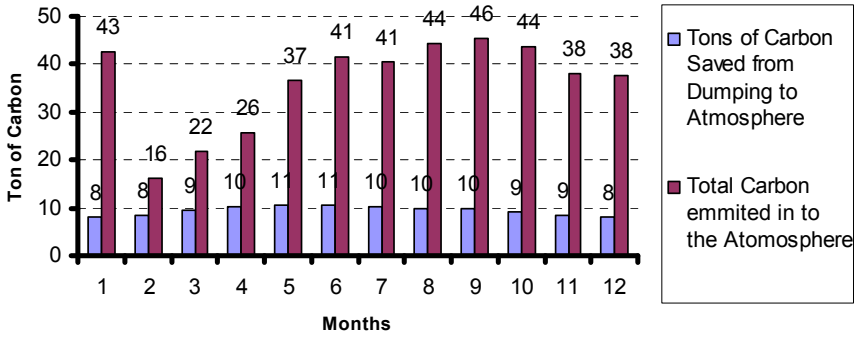
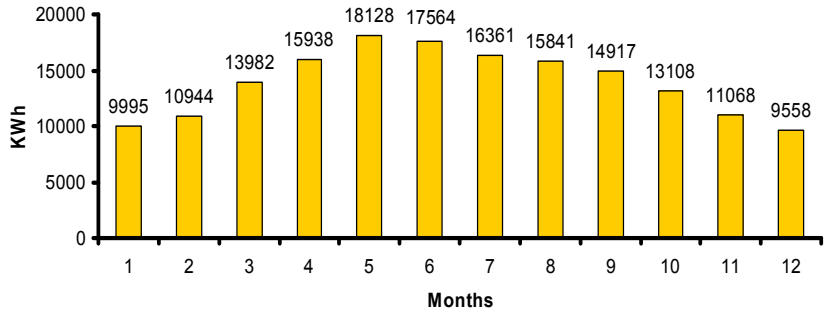


Figure 3b: Monthly Carbon Accounts

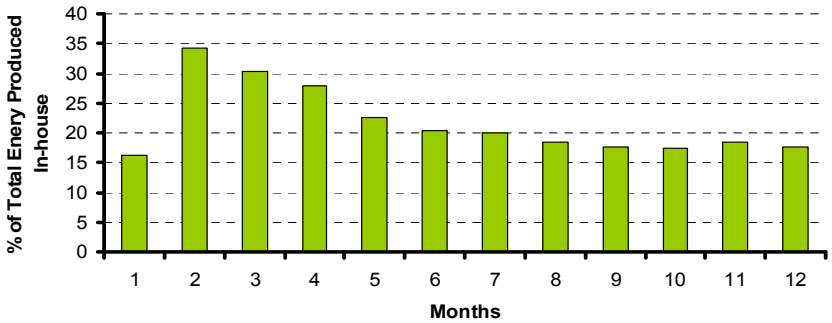
The **Figure 3b** is depicting the monthly carbon emission figures. On an average 10.5 tons of carbon dioxide emission is saved from dumping in to the atmosphere every month. The peak saving occurs in the month of May and June as the solar radiation are on peak in these months and the cooling load on plant is also not very high which is an obvious fact. Although the minimum saving of carbon emission is 8 tons, which is not very different from the peak saving. The highest carbon emissions were recorded in the months of August and September, which actually highlight that both sensible and latent cooling load are very high and air conditioning takes most of the energy.

3.3 ENERGY USE & GENERATION

The following bar chart in **Figure 3c (A)** shows the total KWh of energy produced monthly by solar photovoltaic system. It also shows that May and June receives highest solar radiation and hence highest energy production is achieved. They key of optimum utilization of renewable energy is its priority, which make it serve the base load when ever it is available. This has been programmed within the automation framework.



A: Monthly KWh produced by solar photovoltaic system, which is mounted on the roof top of the pacific control green building.



B: The percentage fraction of energy demand met by in-house renewable energy production setup.

Figure 3c: Monthly electricity generation and In-house energy production

The **Figure 3d (B)** shows the fraction of in-house energy utilized for the year 2007 on a monthly basis. This also makes sense as it is clearly depicted that the fraction of in house energy is higher in the months of February March and April. These months do not require high amount of electricity because of less latent cooling load purpose. Hence higher fraction of the cooling demands is met by the solar hot water based Vapor Absorption system. Since August September and October are the months of high air conditioning load so the fraction of cooling and electrical demand served by renewable energy system is also less.

4.0 BENCHMARKING

Benchmarking of a building is generally a comparison of its energy use from similar buildings, which operates in similar climate and with similar schedules of operation. There are many organizations, which stores and publish such kind of benchmarking data. This includes Building Services Research & Information Association (BSRIA) **[4]**, International Facility Management Association (IFMA) **[5]** and Charted Institute of Building Services Engineers (CIBSE) **[6]**. Unfortunately data for the building in the Middle Eastern region can not be found at this stage. So we considered to benchmark it from BSRIA published data, which is quite stringent and gathered from a climate which is colder than Dubai's hot and humid climate. This benchmarking process is approximate should be considered as an approximate indication of building health and energy use status. It should not be considered as a final figure. Another argument can be that the building is still in progressive occupancy stage.

The net usable area of the building is approximately 8000 m^2 **[8]** where the total built floor area is approximately 10000 m^2 .The total energy use as reported by the logs and the electricity invoices of the Pacific control green building is 1400MWh in 2007 **[1].** The benchmark figures are reported in the **Table 4a.**

Table 4a. BSRIA Typical Office Building Benchmarking

Benchmarked Status	Range in KWh/m2/yr.	PCS Green Building KWh/m2/yr.
Poor	Greater Then 410	--
Fair	250 to 410	--
Good	less then 250	175 #(Pacific Controls Green Building

benchmarking has been done for partially occupied building.

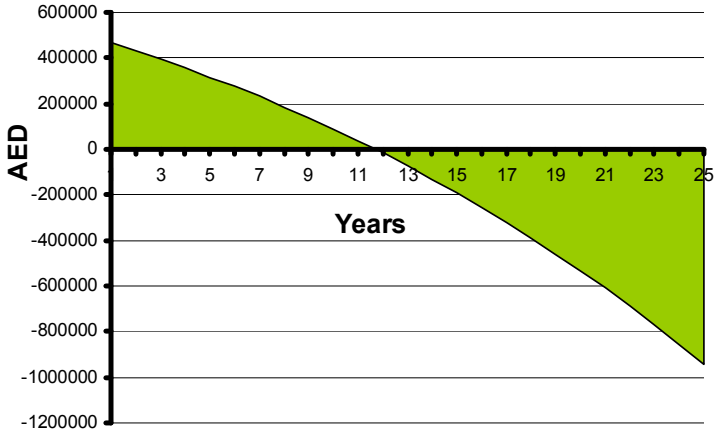
The pacific control green building operate in a very good benchmark as the value 175 KWh/m^2/ yr. comes well with in the range which is less than 250 KWh/m^2/ yr benchmark category. This determines that the building is operating in a very good Energy Use Index (EUI).

5.0 CONCLUSIONS

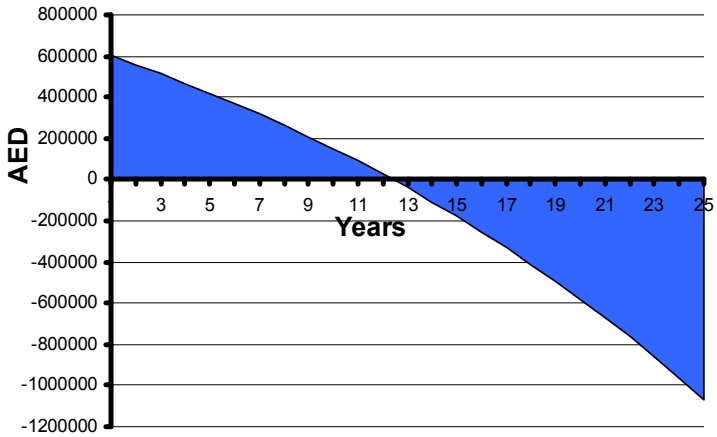
Concluding point for the year 2007 operation for the pacific control green building is following.

1. The building has saved 113 ton of carbon dioxide from being dumped into the atmosphere. While the total energy used from grid caused 413 ton of carbon to be emitted into the atmosphere.
2. The total carbon offset achieved during the year 2007 operation is evaluated as 21%.
3. The total energy use from the utility is 1400 MWh. This is about 80% of the actual energy demand for the building. Rest of the 20% was generated in-house by renewable energy generating setups.
4. 9% and 11% of the energy demands were met by solar photovoltaic electricity and solar hot water based cooling system respectively.
5. The operational pay back on both the technology i.e. solar photovoltaic and solar hot water based cooling system considering a an average 4% energy price inflation for next 25 years is coming out to be 12^a and 13^a yr. respectively.
6. The life cycle cost of both the renewable energy technologies implemented in Pacific Controls green building is resulting to a saving of AED 0.94 million and AED 1.06 million in the life span of 25 years. The LCC curve and payback is depicted in the **Figure 5a.**

a - The pay back has been calculated assuming an annual energy price inflation of 4% on an average for next 25 years. This 4% energy price inflation also includes the upcoming and yet to be introduced carbon taxes in the region.



A: The area chart shows the yearly life cycle cost components of Solar Photovoltaic electricity generation system in Pacific control green building. The curve shows that a capital of AED 0.5 million has been invested in the beginning of first year, at the end of 12th year the capital is paid back and at the end of 25th year a saving of AED 0.94 million will be realized.



B: Similarly in this area chart the yearly life cycle cost components of Solar Hot Water powered VAM Based Cooling system is depicted. Here an initial investment on AED 0.64 million has been made in the beginning; the energy investment paid it self back at the end of 12th year and the life cycle cost saving of AED 1.06 Million will be realized the end of 25th year.

Figure 5a: Yearly Life Cycle Cost and Payback with average 4% energy inflation for 25 years.

6.0 REFERENCES

1. Logs of automation and metering system in the building, electricity invoices and manual of renewable energy generation system installed in the Green Building.
2. ASHRAE Handbook 2005 (www.ashrae.org)
3. Dubai Electricity and Water Authority web site (www.dewa.gov.ae)
4. BSRIA Web site (www.bsria.co.uk)
5. IFMA web Site (www.ifma.org)
6. CIBSE web Site (www.cibse.org)
7. Web site of United States Green Building Council.(www.usgbc.org)
8. As built Architectural drawing of the site