Report No.: Draft Report

ENERGY AUDIT REPORT

of

SHETHASHRI B. C. SHAH

ARTS COLLEGE VADALI

Sabarkantha, Gujarat

Submitted by:

Energy Solution

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The Energy Solution placed its sincere gratitude to M/s Shethashri B. C. Shah, Arts College, Vadali for having entrusted the Energy Audit study to us.

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Our thanks for proper coordination, and timely help during the energy audit and providing accurate data required for preparing energy audit report. We also thank to Operation Team for support during field measurement.

We are thankful to other staff members of the company whose contribution directly or indirectly helped us during the Energy Audit Study at Shethashri B. C. Shah Arts College, Vadali and Off-site facilities.

This report is valid for submission of respective University's academic cycle (which is 5 years). Also, this report submission is valid for only once for entire academic cycle.

This energy audit report is only valid for "Shethashri B. C. Shah Arts College, Vadali"

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Abbreviation

CD - Contract Demand

GLP - General Lighting Purpose

LT - Low Tension

DBT - Dry Bulb Temperature

WBT - Wet Bulb Temperature

RH - Relative Humidity

UGVCL - Uttar Gujarat Vij Company Ltd

DISCOM - Distribution Company

AC - Air Conditioners

CO_2 - Carbon Dioxide

RPM - Revolution per minute

LED - Light Emitting Diode

CFL - compact fluorescent lamp

DG – Diesel Generator

Nomenclatures

P – Power

V – Voltage

I – Current

PF – Power Factor

℃ – Celsius

Φ – Relative Humidity

f – Frequency

kVA – Kilo Volt Ampere

kWh - Unit

Rs. - Indian Rupees

TR – Ton of Refrigeration

v – velocity

Q - Flow rate

m – mass flow rate

Cp - Specific heat at constant pressure

ℑ - Density

1. Introduction

Shethashri B. C. Shah Arts College, Vadali affiliated to North Gujarat University has five major departments such as English, Gujarati, Sanskrit, Sociology, Sports, History & Defence Studies with highly qualified faculties. The college has a large number of students from the Tribal Areas of Sabarkantha District of Gujarat State. Most of the students are from rural villages. They are from poor background, but they are not poor in talent, knowledge and capability. This college provides opportunity for the rural youth, especially for the economically backward students from nearby villages. The college starts from 08:00 AM to 01:00 PM with weekly off along with Diwali & Summer vacations.

This college published four publication includes Gulmahor, Avasar, Vatpalli & Smaranika. The principal and the faculty members have been participating and presenting research papers at national and international seminars.

Institute Name: Shethashri B. C. Shah Arts college
Located At: Ta-Vadali, Dist: Sabarkantha, Gujarat
University: North Gujarat University
Departments: Seven

1.1 Observation:

The following are the main observation done at Arts college, Vadali

Connection Type:	WWPR (General Lighting Purpose)
Contract Demand:	05 kW
Installed Solar Panels:	0 kW
No. of AC:	NA
No. of DG Set:	01
No. of Pumps (Above 1 kW):	01
No. of lights	40
No. of Fans	94
RO system:	01

2. Electricity Bill Analysis:

Arts College Vadali has a WWPR means GLP (General Lighting Purpose) that is commercial Low Tension (LT) connection of electricity. The power distributor company (DISCOM) is Uttar Gujarat Vij Company Ltd (UGVCL). The contract demand of the institute is 05 kW. For commercial GLP LT connection the billing cycle comprising of two months that is "2 months billing cycle".

2.1 Twelve months bill analysis for FY 2019-2020

Following table comprising of latest financial year electricity bill analysis

SI NO	Billing Date	CD kW	Unit Consumption kWh (Unit)	Unit Generation kWh (Unit)	Net Consumption kWh (Unit)	Bill Amount Rs.	Unit Rate Rs./Unit
1	04-06-2019	5	2101	0	2101	17691	8.42
2	29-07-2019	5	917	0	917	7202	7.85
3	28-09-2019	5	990	0	990	7785	7.86
4	24-11-2019	5	887	0	887	6814	7.68
5	18-01-2020	5	729	0	729	5645	7.74
6	30-03-2020	5	1374	0	1374	10377	7.55
Total			**6998**	**0**	**6998**	**55514**	**7.93**

Table 1: FY 2019-2020 twelve months bill analysis

During Covid19 pandemic lockdown situation the meter reading was not taken between April-19 to August-19. The electricity bill generated on previously consumption bases and/or random basis, due to this the consumption is vary and we can clearly see those effects on above table.

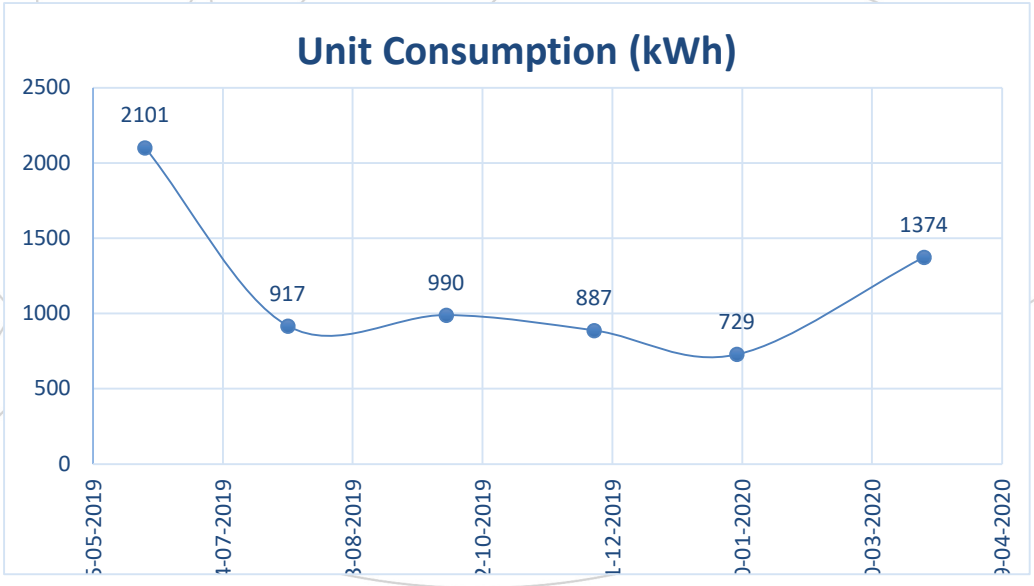

Figure 1: FY 2019-2020 unit consumption

The consumption increases after oct month due to regularization of institute activities after covid19 lockdown.

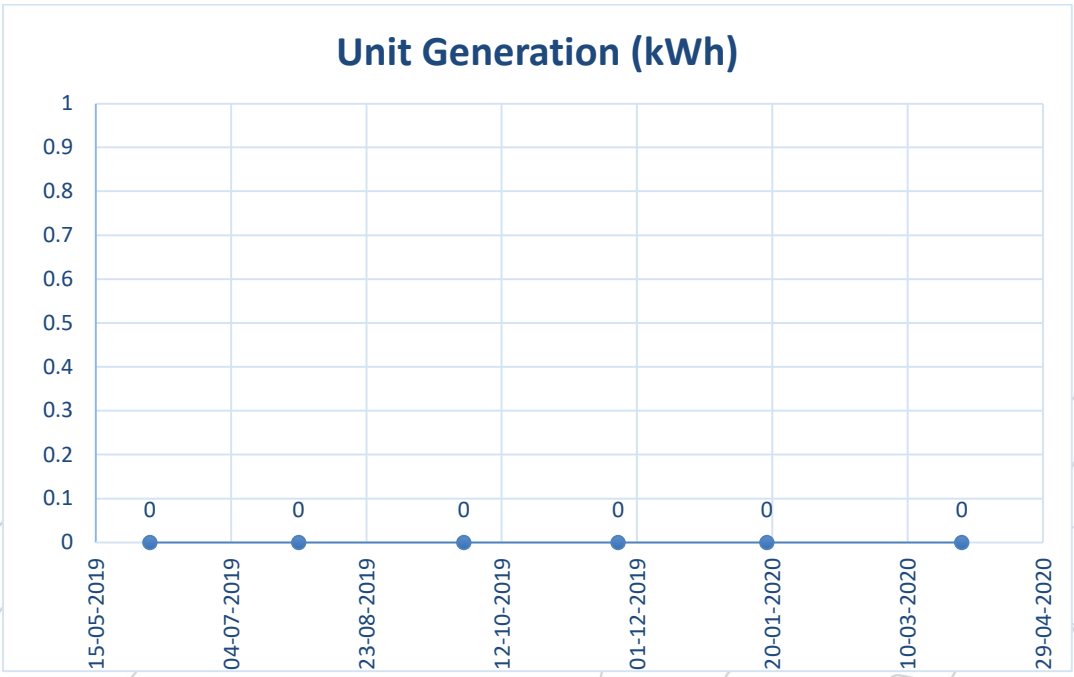

Figure 2: FY 2019-2020 unit generation from solar roof-top

As institute planning for installation of Solar Roof-Top panels for green energy electricity generation, hence as of now there are no unit generation from green energy. That's why, the graph shows "0" unit generation. But in near future, there will be a green energy generation.

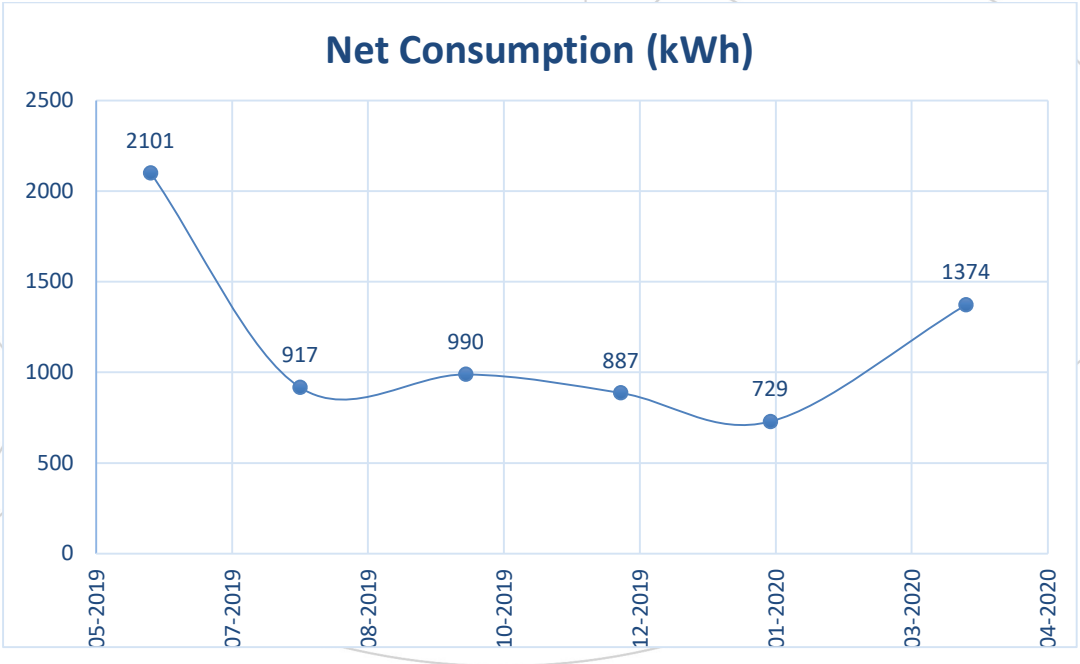

Figure 3: FY 2019-2020 net unit consumption

After summer season, the net consumption is around 850~900 units per month, which indicates the influence of random meter reading. Also, increase after October month due to regularization.

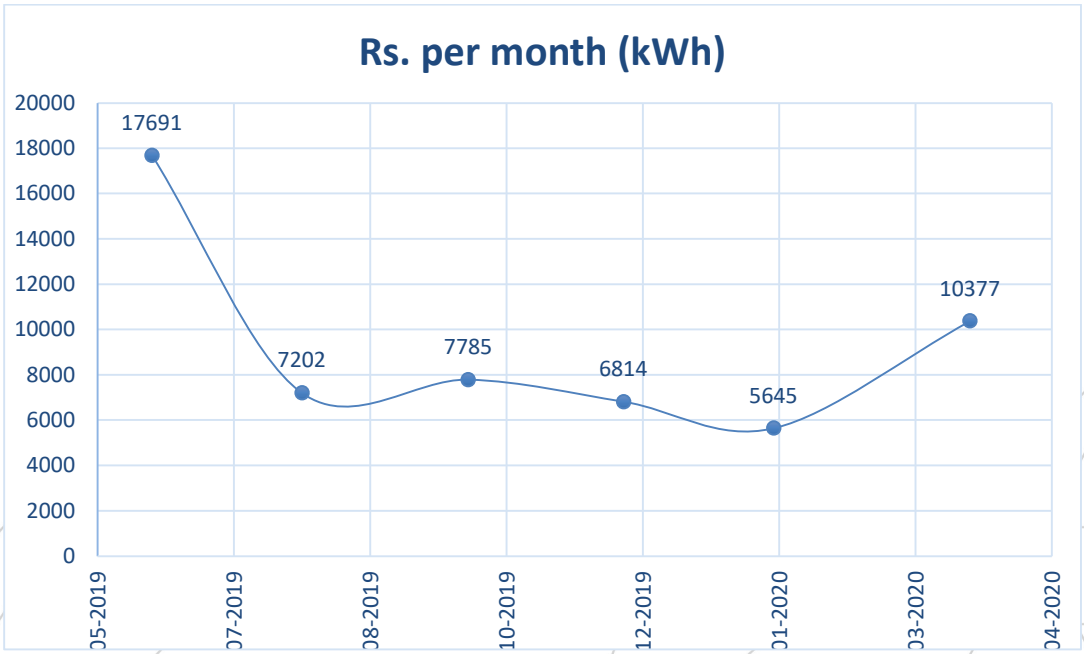

Figure 4: FY 2019-2020 monthly bill amount in Rs.

The above graph represents the monthly bill amount. In summer season the consumption was highest due to higher running hours of fans.

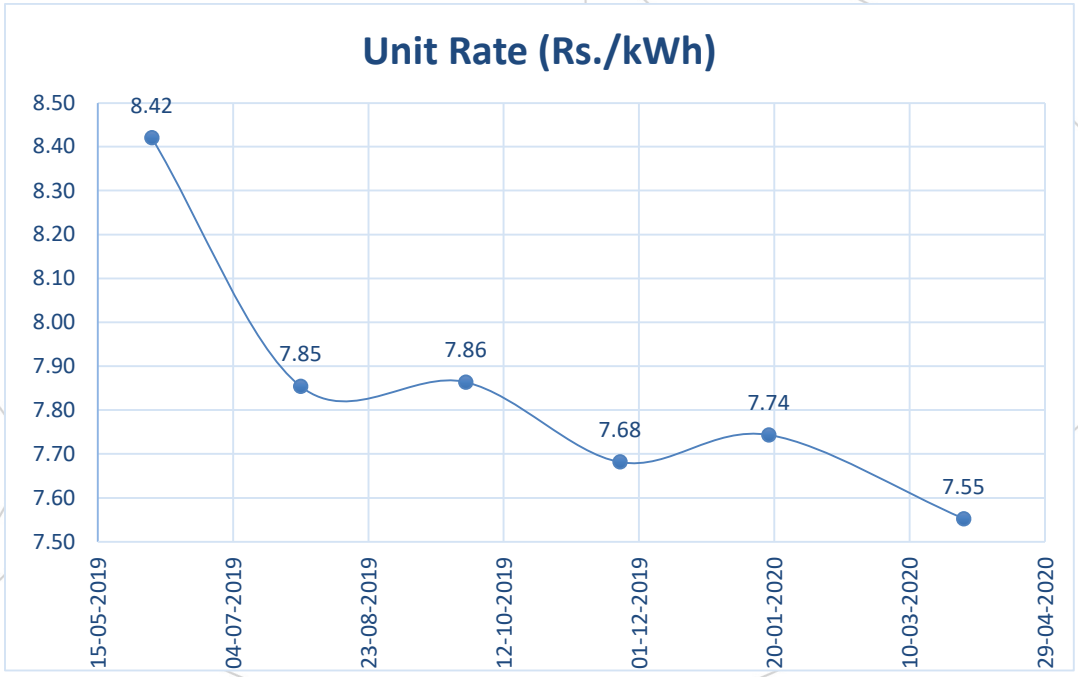

Figure 5: FY 2019-2020 average monthly unit rate

As we can see in the above graph, the average unit rate comes out to be 7.93 Rs./Unit, which is normal for LT connection based consumer billing. Also, after Summer season, the unit rate goes down from 8.42 to 7.85 Rs./Unit due to reduction in fan load.

2.2 Observation on FY 2019-2020 electricity bills

- If we ignore the effects of Covid19 pandemic lockdown period the electricity bill looks normal as in the case of LT commercial connection.
- The institute panning to installed the Solar Roof-Top panels having capacity of around 10 kW (9.93 kW), which can generate average 900 kWh (Units) to 1000 kWh (units) per month depending on the weather conditions. This indicates the decision of installation of Solar Roof-Top panels is in the favor of institute by reducing 100 % of the monthly electricity bill.
- As unit generation through Solar Roof-Top means "Green Energy" the carbon emission will also reduce, which indicates the institute building progress towards the "Carbon neutral".

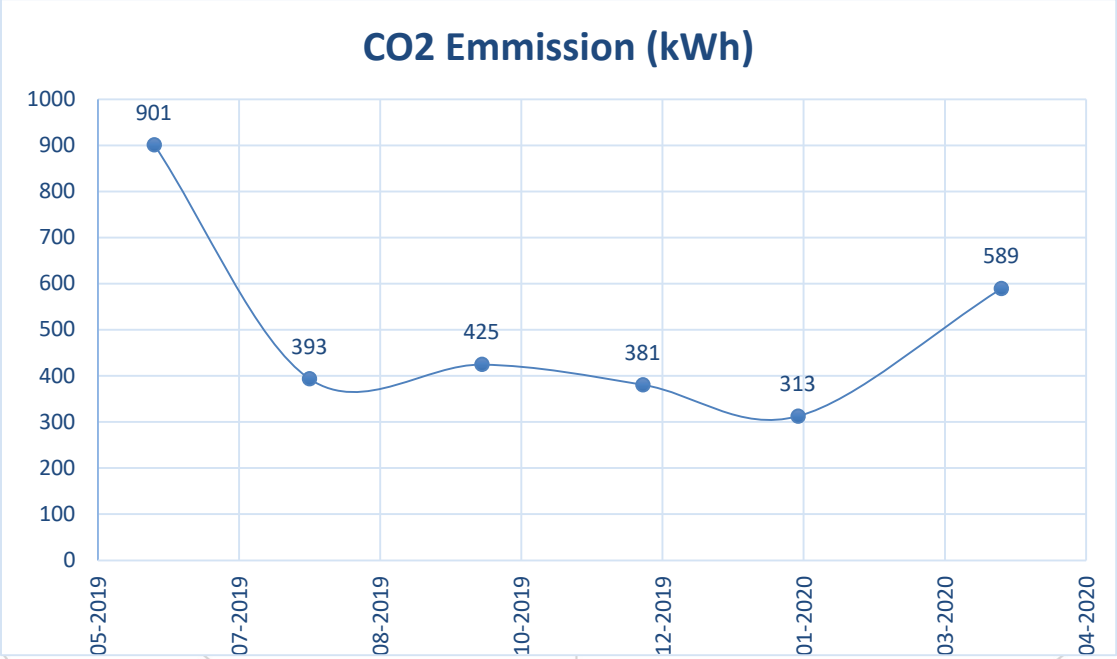

Figure 6: FY 2019-2020 CO2 Emission Analysis

After consideration of Solar generation that is after installation, the carbon emission reduced from around 900 kg to 0 kg which is almost 100% lower than the previous year.

- The average unit rate is around 7.55 Rs/Unit to 7.85 Rs/Unit which is found normal.
- There were no any peak demand charges, which indicates the connected load is normal.
- No any other penalty found in the electricity bills.
- Overall electricity bills found normal and acceptable.

3. Proposal cum estimation for Solar Roof-Top Installation

There are two proposals for installation of solar roof-top, one in for 5 kW and other is for 10 kW. The detail analysis including economic feasibility is briefly describe in following tables. Also, make observation on each of the suggested proposal.

3.1 Proposal for 5 kW Solar Roof-Top installation

This will consider the current load scenario of the institute that is connected load of 5 kW. The detail analysis of installation of 5 kW Solar Roof-Top system are represented on below table:

SI NO	Particular	Unit	5 kW
1	Contract Demand	kW	5
2	Proposed Solar Capacity	kW	5
3	Average day light hours	hrs	8
4	Annual sunlight days	days	300
5	Average generation per day per kW	kWh/day/kW	4.5
6	Total average generation	kWh/day	22.5
7	Approx. Annual Generation	kWh/Year	6750
8	Average electricity bill per month	kWh/month	600
9	Annual electricity bill in Units	kWh/Year	7200
10	Average unit rate	Rs./Unit	7.93
11	Annual electricity bill in Rupees	Rs./Year	57096
12	Approx. Installation cost	Rs.	225000
13	Approx. Annual savings in Rupees	Rs./Year	57096
14	Surplus generation rate	Rs./Unit	2.25
15	Additional saving in rupees	Rs./Year	3568.5
16	Net annual saving in rupees	Rs.	53527.5
17	Simple Pay-back period	Years	4.2
18	CO2 reduction per annum	kg of CO2	3528
19	Life cycle of solar panels	Years	25

Table 2: 5 kW Solar Roof-Top System Installation Analysis

Observation: As mentioned in the above table, the installation of 5 kW solar roof-top panel is sufficient for the current load scenario with annual saving around Rs. 50,000 ~ Rs. 55,000 /-. Also, the pay-back period is around 4.2 years, which indicates the feasibility of installation of solar roof-top system with initial investment Rs. 2.25 Lakhs.

3.2 Proposal for 10 kW Solar Roof-Top installation

This will consider the future load scenario of the institute that is connected load of 10 kW. The detail analysis of installation of 10 kW Solar Roof-Top system are represented on below table:

SI NO	Particular	Unit	10 kW
1	Contract Demand	kW	5
2	Proposed Solar Capacity	kW	10
3	Average day light hours	hrs	8
4	Annual sunlight days	days	300
5	Average generation per day per kW	kWh/day/kW	4.5
6	Total average generation	kWh/day	45
7	Approx. Annual Generation	kWh/Year	13500
8	Average electricity bill per month	kWh/month	600
9	Annual electricity bill in Units	kWh/Year	7200
10	Average unit rate	Rs./Unit	7.93
11	Annual electricity bill in Rupees	Rs./Year	57096
12	Approx. Installation cost	Rs.	450000
13	Approx. Annual savings in Rupees	Rs./Year	57096
14	Surplus generation rate	Rs./Unit	2.25
15	Additional saving in rupees	Rs./Year	14175
16	Net annual saving in rupees	Rs.	71271
17	Simple Pay-back period	Years	6.3
18	CO2 reduction per annum	kg of CO2	3528
19	Life cycle of solar panels	Years	25

Table 3: 10 kW Solar Roof-Top System Installation Analysis

Observation: As mentioned in the above table, the installation of 10 kW solar roof-top panel is sufficient for the current as well as future load scenario with annual saving around Rs. 70,000 ~ Rs. 75,000 /-. Also, the pay-back period is around 6.3 years, which indicates the feasibility of installation of solar roof-top system with initial investment Rs. 4.5 Lakhs.

3.3 Comparison of 5 kW and 10 kW Solar Roof-Top System

The comparison between 5 kW and 10 kW solar roof-top system for current load scenario and future scenario are represented on below table:

SI NO	Particular	Unit	10 kW	5 kW
1	Contract Demand	kW	5	5
2	Proposed Solar Capacity	kW	10	5
3	Average day light hours	hrs	8	8
4	Annual sunlight days	days	300	300
5	Average generation per day per kW	kWh/day/kW	4.5	4.5
6	Total average generation	kWh/day	45	22.5
7	approx. Annual Generation	kWh/Year	13500	6750
8	Average electricity bill per month	kWh/month	600	600
9	Annual electricity bill in Units	kWh/Year	7200	7200
10	Average unit rate	Rs./Unit	7.93	7.93
11	Annual electricity bill in Rupees	Rs./Year	57096	57096
12	approx. Installation cost	Rs.	450000	225000
13	approx. Annual savings in Rupees	Rs./Year	57096	57096
14	Surplus generation rate	Rs./Unit	2.25	2.25
15	Additional saving in rupees	Rs./Year	14175	3568.5
16	Net annual saving in rupees	Rs.	71271	53527.5
17	Simple Pay-back period	Years	6.3	4.2
18	CO2 reduction per annum	kg of CO2	3528	3528
19	Life cycle of solar panels	Years	25	25

Table 4: Comparison of 5 kW & 10 kW Solar Roof-Top System Installation Analysis

Observation: With consideration of future load the installation of 10 kW solar roof-top system will be more beneficial as compared to the 5 kW solar roof-top system as mentioned in the above table. Also, there will be an availability of installation space for 10 kW solar roof-top system. From the above table the installation of 10 kW solar roof-top system covers all the future demand with green-house gases reduction, which encourage the efforts towards the carbon neutral building. So, it is concluded that the 10 kW system will be more feasible as compared to 5 kW system.

4. Pumping System

The institute has only one major pumping system, that is Bore-well pump capacity of 5 HP. As the bore-well pump is not visible the design data for the same was not available. The details of the pumping system are represented as below:

SI NO	Particular	Unit	Bore-Well Pump
1	Rated Voltage	Volt	440
2	Frequency	HZ	50
3	Rated Power	kW	3.728
4	Rated Current	Amp	
5	Rated RPM	Rev/min	
6	Connection type	Phase	Three
7	Design Flow	m^3/hr	
8	Design Head	m	
9	Maximum Head	M	
10	Maximum Pressure	Bar	
11	Measured Voltage	Volt	440.2
12	Current	Amp	11.54
13	Power Factor	PF	0.68
14	Power Consumption	kW	5.5
15	Motor efficiency	%	92
16	Overall efficiency	%	67.78

Table 5: Pumping system performance analysis

Observation: The power consumption of pumping system found higher as compared to the design value, therefore the pumping system performance found on lower side that is 67.78 %. However, the bore-well pump voltage is nearer to design value as there is a three-phase connection, which indicates satisfactory. Therefore, it is suggested to replace the existing pump-set with the latest Energy Efficient Pump-set. Now-a-days, there is a subsidy on energy efficient pump-set which lowers the burden of purchase cost of new energy efficient pump-set. Also, the energy efficient pump-set comes with higher operating efficiency with longer life.

5. Lighting & Fan System:

In every institutional building the lighting and Fans are one of the major electrical loads, hence there should be the consideration of both the lighting as well as fans. Now-a-days, use of LED lights is found very energy efficient as compared to CFL and halogen lights. The available details of the lights and fans are as below:

5.1 Lighting System

There is total 40 number of lights installed at different premises including class rooms, staff rooms, lab room and administration offices. Among of that all are LED bulbs and the remaining are tube lights. During the observation some of the lights are found old halogen, so we suggest to replace those bulbs with LED tube lights to improve the energy efficiency. Also, reduced the energy consumption and monthly electricity bill.

LED bulbs: 40

LED Tube lights: 0

Suggestion: Replace the old halogen bulbs with LED tube lights

Energy Saving: Around 25 % to 30 % power consumption reduced

Initial investment: 30 % more costly than old conventional bulbs.

Life span: LED tube lights has a longer life than old halogen bulb.

Payback period: with-in a year

Carbon emission: LED consume less energy hence it will reduce the carbon emission as compared to CFL & halogen lights.

Overall benefits: More lumens, longer life, less power consumption and less pollutants.

Observation:

The college campus has installed an energy efficient lighting system, which includes sensor-based campus street lights with automatic controlling system. Also, major old lights were replaced with the LED bulbs. Hence, the overall lighting system performance found satisfactory.

5.2 Fan System

The institute building has a total 94 numbers of fans installed at different premises includes class rooms, staff rooms, laboratories, conference room, administration offices and principal office. Now-a-days, the energy efficient fans are available in the market which almost consumes 50% less as compared to conventional fans. The detail analysis are as follows:

Total installed fans: 94

Average power consumption per fan: 70 watts

Average running hours per day: 6

Annual working days: 200

Annual consumption: 7896 kWh

Average unit rate: 7.93 Rs./Unit

Annual operating cost: 62,615 Rs/year

Energy Efficient Fan consumption: 30 Watts

Annual consumption: 3384 kWh

Annual Savings: 4512 kWh

Annual Savings: 35,780 Rs/year

Cost difference for Energy Efficient Fan: 1200 Rs. / Fan

Total investment requires for 94 fans: 1,12,800 Rs.

Pay-back period: 3 years

Reduction in CO_2 Emission: 2210 kg of CO_2

Observation:

It is a suggestion to replace the existing fans with latest energy efficient fans to improve energy efficiency. Also, the pay-back time is around 3 years which is feasible. The energy saving is around 55 % and reduced 2210 kg of CO_2 on annual basis. Further suggest that, replace step by step that is on failure basis means instead of rewinding (which increases the power consumption) replace with energy efficient fan.

6. Summary:

- This institute planning for Roof-Top Solar panels, which generates almost 100 % of the total consumption indicates the feasibility as well as benefits of installation. Hence, the decision of installation of solar panels is really appreciable.
- Also, after the installation of Solar panels reduced the carbon emission in indirect manner due to less consumption from the GRID. Hence, this will make the institute a carbon neutral building with consideration in greenery of the college campus.
- "Wheeling to the GRID" will benefit for both consumer side as well as DISCOM side because of installation of solar roof-top panels. Hence, the surplus generation will export to the GRID and lowers the generation.
- The campus has sensor-based street lights to optimize the energy use by automatically control the ON/OFF switch.
- There are no any kind of penalty observed in electricity bills, this indicates all the electrical loads are balanced and well maintained.
- The lux level in all the campus premises includes class rooms, staff rooms, administrative offices, laboratories and seminar/conference room found satisfactory with required lumens.
- Also, there is a good provision of ventilation in all the concerned area of the institute campus along with good utilization of day light. Which will reduce the HVAC consumptions as well as lighting load on the system.
- There's no any reactive charge found the electricity bills; hence the capacitors are in good condition and in working condition.
- Overall performance of the college building found satisfactory with all the requirements of energy audit activity.

7. Suggestions:

- It is suggested to replace the non-star rated bore-well pump-set with star-rated (4 or 5 Star rated) energy efficient pump-set for better operation and lower consumption.
- It is suggested to install Solar Roof-Top system having 10 kW capacity to handle current as well as future load and make a campus building carbon neutral. Also, it will be considered as a green effort towards the environment.
- Replace the old conventional bulbs with LED tube lights as per the failure to avoid the burden of purchase cost.
- Same for the old celling fans, just replace with the Energy Efficient fans as they failed to avoid the burden of initial investment.