ENERGY AUDIT REPORT

PREPARED FOR

M/s JANKI DEVI MEMORIAL COLLEGE

Sir Ganga Ram Hospital Marg, Old Rajinder Nagar,
Rajinder Nagar, New Delhi - 110060

PREPARED BY

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M/s GREENTREE GLOBAL

B-67, Sector 67 Rd, Block B, Sector 67,
Noida, Uttar Pradesh 201301

OCTOBER 2024

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ACKNOWLEDGMENT

M/s GreenTree Global, Noida (hereafter referred to as GreenTree Global) appreciates the keen interest shown by **M/s. Janki Devi Memorial College, New Delhi** (hereafter referred to as **JDMC, New Delhi**) for carrying out an energy audit of their College. The energy audit was conducted in the month of **September-2024**.

We acknowledge the wholehearted guidance & continuous support extended by **Smt. Swati Pal – Principal.** The Study team members of GreenTree Global would sincerely like to thank all the officials, department heads and support staff members of JDMC, New Delhi who have rendered their all possible assistance and co-operation and courtesy extended to the energy audit team during the entire period of assignment.

We do hope that you will find the recommendations given in this report useful in helping you save energy. While we have made every attempt to adhere to high quality standards, in both data collection and analysis, as well as in presentation through the report, we would welcome any suggestions from your side as to how we can improve further.

Officials from Janki Devi Memorial College, New Delhi

Smt. Swati Pal – Principal

Energy Audit Team Members for GreenTree Global, New Delhi

Mr. Gurpreet Singh (Sr. Engineer)

Mr. Satish Chandra Madhukar (Engineer)

Mr. Nitin Kumar Mishra (Engineer)

Dhruv Jain, Director

For GreenTree GLobal

ABBREVIATIONS

Avg.	:	Average
BSES, Yamuna	:	Bombay Suburban Electric Supply Yamuna Power Limited
Consump.	:	Consumption
DG	:	Diesel Generator
ECM	:	Energy Conservation Measure
GreentTree	:	GreenTree Global
HT	:	High Tension
JDMC	:	Janki Devi Memorial College
kV	:	kilo Volt
kVAh	:	kilo Volt Ampere Hour
kWh	:	kilo Watt Hour
LED	:	Light Emitting Diode
LT	:	Low Tension
SPC	:	Specific Power Consumption
TR	:	Tonnes of Refrigeration
THD	:	Total Harmonics Distortion
VFD	:	Variable Frequency Drive

1. INRODUCTION

1.1 GENERAL COLLEGE DETAILS & DESCRIPTION

Janki Devi Memorial College, is an A+ NAAC accredited and ISO 21001: 2018 and 9001: 2015 certified premier women's college of the University of Delhi. The Institution was founded in 1959 by the famous Gandhian Shri Brij Krishan Chandiwala in memory of his mother Smt. Janki Devi.

JDMC aims to provide quality education to young women and empower them to become economically self-reliant, have the confidence to face the vicissitudes of a challenging society, contribute meaningfully to the community at large and acquire the capability to think, lead and change the world. The focus is on providing access and resources to develop an ecosystem of research, inculcating the values and principles of Indian philosophy and culture, and instilling a sense of pride, service, duty and responsibility to the nation and society.

In JDMC, there are three main buildings where maximum power is consumed

1. Admin
2. Janki Devi Vocational Centre (JDVC)
3. Hostel

Apart from these, there are several other locations such as the library, auditorium, and others where power is also consumed.

1.2 SCOPE OF WORK

The Broad Scope of work was to:

1. **Earthing Resistance Measurement**

   Objective: To ensure earthing systems are functioning optimally and meeting safety regulations.

   Tasks:
   - Conduct comprehensive testing and analysis of existing earthing systems.
   - Measure and document the resistance levels at various earthing points.
   - Compare measured values against industry standards and safety regulations.
   - Identify and report areas where earthing resistance exceeds acceptable limits.
   - Provide detailed recommendations for improvements.
   - Deliver a final report summarizing findings, analysis, and corrective actions.

2. **Electrical Load Balance Analysis**

   Objective: To assess and optimize the distribution of electrical loads across the campus to improve efficiency and safety.

   Tasks:
   - Perform an in-depth assessment of electrical load distribution.
   - Identify load imbalances and areas of overloading or underutilization.
   - Analyze the impact of current load distribution on system performance and safety.
   - Develop strategies to correct load imbalances.
   - Suggest actionable steps to optimize load distribution and reduce energy wastage.
   - Prepare a comprehensive report detailing findings and recommendations.

3. **Energy Saving Evaluation**

Objective: To identify opportunities for reducing energy consumption and improving energy efficiency.

Tasks:

- Assess current energy consumption patterns across the campus.
- Use historical data and real-time monitoring for energy usage analysis.
- Identify areas and equipment with high energy consumption.
- Evaluate the effectiveness of existing energy-saving measures.
- Recommend new energy-saving initiatives and improvements to existing measures.
- Estimate potential energy savings and cost reductions.
- Compile a detailed report with findings and proposed energy-saving strategies.

4. **Deliverables**

- Detailed reports for each of the assessments, including findings, analysis, and recommendations.
- Data logs and measurement records supporting the analyses.
- An executive summary highlighting key findings and suggested actions for management review.

5. **Additional Evaluations**

Electrical Bill Analysis:

- Review electricity bills for billing structure, tariff rates, and other fees.
- Identify billing errors, discrepancies, or unusual charges.
- Compare billing data with energy consumption data.
- Calculate key performance indicators for energy efficiency.

Power Factor Analysis:

- Measure power factor to evaluate system efficiency.
- Identify power factor correction opportunities.
- Install correction capacitors or adjust equipment to optimize power factor.

Utilities Survey:

- Survey utilities like electricity, gas, water, and steam for energy waste.
- Inspect equipment and facilities for energy-saving opportunities.
- Engage with utility providers for efficiency incentives or audits.

1.3 Objective of Study

The purpose of this study is to demonstrate the technical and financial feasibility of implementation of energy efficiency measures at JDMC, New Delhi. The purpose of this report is –

- To analyze the present energy consumption pattern.
- To investigate for energy conservation measures without compromising the comfortable level.
- To assess the techno-economic feasibility of the energy conservation measure.

2. EXECUTIVE SUMMARY

2.1 ECMs SUMMARY

The College's total grid power consumption from **July 2023 to Jun 2024** was **526,626 kWH**. Total **05 numbers** of ENCON's of **Rs. 15.6 Lacks** are identified with an investment of **Rs. 27.4 Lac** with a simple payback period of **21 months**. The total energy saving potential identified in the College is around **1,07,745 kWH.** Some of the energy saving options identified for JDMC, New Delhi, are mentioned below.

Table 1 Summary of Key Points

Sr. No.	Energy Saving Area	Expected Annual Saving Potential, kWH	Expected Saving Potential, Rs. Lakh	Estimated Investment, Rs. Lakh	Payback Period, Month
Short Term Projects (Up to 12 Months)					
1	Replacing Drinking Water Transfer Pump of 3.7 kW with new energy efficient pump of 2.2 kW	1,465	0.2	0.22	12
2	Replacing Old Conventional Tube Light of 40 Watt with LED tube of 20 Watt	4,570	0.7	0.24	4
Medium Term Projects (Between 1 to 3 Years)					
3	Replacing Old Fan of 120 Watt in Admin Building with BLDC Fans of 30 Watt	14,381	2.1	2.68	15
4	Replacing Old Window AC's in JDVC building with new 5 Star Rated Inverter AC	17,250	2.5	5.25	25
5	Installing 50kWP Solar Rooftop Power Plant for Renewable Power Generation	70,080	10.2	19	22
Grand Total		**1,07,745**	**15.6**	**27.4**	21
6	Annual Grid Electricity Consumption, kWH				5,26,626
7	**Estimated Annual Energy Saving, kWH**				**1,07,745**
8	**Estimated Annual Monetary Saving in Electrical, Rs. Lakh**				**15.6**
9	**Estimated Electrical Energy saving, %**				**20.5%**
10	**Estimated Investment, Rs. Lakh**				**27.4**
11	Simple Payback Period, Months				21

2.2 KEY POINTS OF THE REPORT

The College has taken a contract demand of **141 kVA from BSES Yamuna**, and was paying **Rs. 311/- per kVA** as a fixed charge. The maximum demand of the College from **July-2023 to June-2024** was **234 kVA (in the month of May 2024)**. In eight months, the college's **maximum demand has exceeded the contract demand**, resulting in penalties, which are reflected under the **"Other"** column in the electricity bills. It is not advisable to increase the contract demand because it has been evaluated that if the college increases its contract demand, it will have to pay **Rs. 250/kVA** as a fixed charge to the electricity provider, which is much higher than the **penalties**. Currently, the college is paying a fixed charge of **Rs. 311/kVA**, as the difference due to the exceeded contract demand has been added to the fixed charge. (Please refer Table # 8 & 9).

- When the APFC was checked, none of the capacitors could be turned on, either manually or in auto mode. In our opinion, all the capacitors are connected to the power supply going to the hostel and JDVC. The college has two feeders for the total power supply—one for the hostel and JDVC, and another for the rest of the building. It is recommended that the college get the capacitors repaired and connected to both feeders to maintain the overall Power Factor (P.F.).

- To assess the total load of the college, data was logged for both feeders. The average running voltage on both feeders was around **405 volts**, which is satisfactory. The total maximum running load was **173.2 kW**, with an average load of **129.8 kW**. The running average power factor (P.F.) was close to **0.98**. However, due to the presence of single-phase loads, a significant **unbalanced load** was observed in the college, leading to a higher current flow in the **neutral phase**. For the Admin area, the neutral current was **40 amperes** against an average running ampere of **131**, and for the Hostel & JDVC, it was **29.4** amperes against an average running ampere of **55.7**. It is always advisable to balance the load, but due to the nature of single-phase loads, this becomes challenging. Additionally, current harmonics were found to be higher than acceptable levels, which are discussed in the next sub-heading of the report. (Please refer table # 11 & 12)

- The average voltage harmonics distortion level at Admin & Hostel, JDVC Building Feeder was **1.0% & 0.9% respectively** and average current harmonics distortion level was **8.4% & 11% respectively.** The average voltage harmonic distortion level was well under the limit of **5%,** but average current harmonics distortion of Hostel, JDVC feeder is exceeding the permissible limit of **8%. A suitable sized harmonic filter is needed to mitigate the problem of harmonics** and the average voltage unbalance of Admin & Hostel, JDVC Building Feeder was **0.4% & 0.3% respectively** and the current unbalance was **5.6% and 14.4%.** The average voltage unbalance level was well under the limit but average current unbalance of Hostel, JDVC feeder is exceeding the permissible limit of **10%. It is recommended to balance the load of each phase to reduce the current unbalance.** (Please refer table # 13 &14)

- The transformer efficiency at an average load of **130 kVA** was **99.14%, which is satisfactory.** This shows that the evaluated transformer efficiency is running at their best efficiency range. However this transformer is operated by BSES Yamuna. (Please refer table # 17)

- The evaluated overall pump efficiency of the **drinking water transfer Pump-1 was 19%**. The result is not satisfactory. The pump is exhibiting low overall efficiency. The lower efficiency of the pump is due to its higher capacity against the actual requirement. It is recommended to replace the existing pump with a new, energy-efficient pump. The estimated saving potential is calculated based on replacing only one pump. The management can consider replacing the second pump once they achieve the payback from the first pump. The resultant benefit in terms of energy savings workout by replacing transfer pump-1 of **3.7kW** with new pump of **2.2 kW** is **Rs. 0.21** Lac per annum with an estimated investment of **Rs. 0.22 Lac** with the simple payback period of **12 months.** (Please refer table # 21 & 22)

- Management has replaced most of the old conventional lights with LEDs, but **JDVC** building is still left with **old conventional tube lights** of **40 Watt.** It is recommended to replace all the tube lights with **20 watt LED**

tubes. The resulting benefit in terms of energy savings is **Rs. 0.66 lakhs per annum (4,570 kWH**), with an estimated investment of **Rs. 0.24 lakhs,** resulting in a simple payback period of **4 months**. (Please refer table # 24)

- The washroom lights are always kept ON regardless of whether they are in use or not. Total **13** washrooms has been identified in the college where it is recommended to install occupancy sensors. Each washroom requires a total of two **(2)** occupancy sensors. The resulting benefit in terms of energy savings is **Rs. 0.13 lakhs per annum (922 kWH),** with an estimated investment of **Rs. 0.44 lakhs**, resulting in a simple payback period of **40 months. We have not included this saving in the college's total energy savings due to the high payback period.** (Please refer table # 25 & 26)

- Two types of fans are installed in the college—one that consumes **70 watts** of power and another that consumes approximately **100 watts**. The 100-watt fans are mostly installed in classrooms in the admin building. It is recommended that all these fans be replaced with new **BLDC fans**, which consume only **30 watts** of power. The resulting benefit in terms of energy savings is **Rs. 2.09 lakhs per annum (14,381 kWH),** with an estimated investment of **Rs. 2.68 lakhs**, resulting in a simple payback period of **15 months.** (Please refer table # 27)

- During the onsite assessment, the lux levels of the college were measured and found to be satisfactory everywhere except for the JDVC class rooms. We have already recommended replacing the old conventional lights in the JDVC building with LED lights, which will slightly improve the lux level. It is always recommended to maintain a lux level between 200-250 in classrooms. (Please refer table # 28)

- The average performance evaluation i:e **kW/TR of Staff Department VRV-1, 2 & Library VRV was 0.95, 0.98 & 090** respectively. According to the current evaluation, the VRV system is operating within acceptable limits against its rated **kW/TR**. Therefore, no further recommendations are required. (Please refer table # 30)

- The College has split and window ACs installed in different areas. In each location, there are a minimum of three-star rated or inverter ACs are installed, but only the JDVC section has **old window ACs**. The old window ACs in JDVC consume **approximately 2.26 kW** of power, while the new 5-star rated inverter ACs consume around **1.3 kW**. Therefore, it is recommended that the college replace all the old ACs with new inverter ACs. There are a total of **15** window ACs installed in the JDVC building, and replacing them with new ACs will result in savings of approximately Rs. **2.5 lakh (17,250 kWh),** with an estimated investment **of Rs. 5.25 lakh**. This will lead to a simple payback period of **25 months**. (Please refer table # 31)

- One (1) Solar Rooftop Power Plant of the capacity **50.02 kWP** is installed by the third party and college is purchasing generated electricity at **Rs. 5.30 kWH. The rooftop solar power plant generated 60,730 kWH** of electricity from **July-2023 to June-2024.** Considering the grid electricity cost of **Rs. 14.5/kWh and Rs. 5.30/kWh** being paid to the third-party vendor for solar power consumption, the college is benefiting by **Rs.**

9.2/kWh when purchasing solar units from the third party. Considering cost of **Rs. 9.2 per kWh**, plant saved approximately **Rs. 5.6** lakh/annum. (Please refer table # 32)

- Calculated CUF of the existing rooftop solar system is **0.14.** This indicates that the CUF of the solar panel is **slightly low**. It is always recommended to maintain the PLF at **0.16**, which might indicate factors like shading, inefficiencies, or other operational issues. It is recommended that the college discuss with its vendor to increase the capacity utilization to **0.16.** By doing so, the college could benefit approximately **Rs. 0.86 lakh per annum (9378 kWh)**. The only suggestion is to increase the frequency of cleaning the solar panels. (Please refer table # 33 & 34)

- The available rooftop spaces have been identified for installing Solar Power Panels. Total **six (6)** locations have been identified where solar panels can be installed. To install a 1 kW solar panel, approximately **10-12 m^2** of free space is required. Approximately **1,307 m^2** of rooftop area is available, where an approximately **100 kWP** solar power system can be installed. The college's hourly average power consumption is **61 kW**, and the average power generation from the rooftop solar plant is **28.1 kW** (data considered from electricity bills from July 2023 to June 2024). Therefore, we recommend that the college install an additional **50 kWP** rooftop solar plant to meet its average power consumption requirements. (Please refer table # 35,36 & 37)

3. GENERAL ASPECT

The general aspect of the College is shown in below table:

Table 2 General Aspects

Particulars	Units	Details
Name of the Facility	-	Janki Devi Memorial College
Address	-	Sir Ganga Ram Hospital Marg, Old Rajinder Nagar, Rajinder Nagar, New Delhi - 110060
Contact Person	-	Smt. Swati Pal
Sector	-	Educational Institute
No. of Operating Days	Days	250
Source of Electricity	-	1. Electricity from Grid Bombay Suburban Electric Supply Yamuna Power Limited (BSES, Yamuna)
		2. Power generation from Solar
		3. Power generation from D.G. Sets
Contract Demand	kVA	141
No. of DG Sets	No's	Total 3 D.G. Sets (160 kVA, 125 kVA & 62.5 kVA)
No. of Transformers	No's	One Transformer of 400 kVA (Installed & Maintained by BSES, Yamuna)
Total Approximate Plot Area	SQM	43108.6
Annual Grid Power Consumption (July-2023 to June-2024)	kWH/annum	5,26,626
Solar Power Consumption (July-2023 to June-2024)	kWH/annum	60,730
Total Power Consumption (July-2023 to June-2024)	kWH/annum	5,87,356

4. PRESENT ENERGY SCENARIO

4.1 BRIEF DESCRIPTION

The College mainly relies on the state electricity board to meet its electricity requirement. There are total **three (3)** sources of Energy at JDMC, New Delhi:

1. Grid Electricity from Bombay Suburban Electric Supply Yamuna Power Limited (BSES, Yamuna)
2. Power Generation from D.G. Sets
3. Rooftop Solar Power Generation

4.2 PURCHASED POWER

JDMC, New Delhi receives its power supply from BSES Yamuna at a high voltage of **11 kV.** The incoming 11 kV is stepped down to **0.433 kV** using one (1) transformer of **400 kVA which is installed and maintained by BSES Yamuna**. The stepped-down voltage is distributed to two (2) circuit breakers installed in Main Panel Room.

Sr. No	Service	Contract Demand	Service Connection	Distribution Brief	Electricity Bill CA No.
1	JDMC	141 KVA	Through 11 KV O/H Line VCB is Installed by BSES Yamuna	Two LT distribution, one for Hostel & JDVC and one for Admin at 415V level 3-Ph	100001930

4.3 SELF GENERATED NON RENEWABLE POWER (DIESEL GENERATOR)

For self-generation, College has total three **(3) DG Sets, 62.5 kVA** for girls hostel, while the other **two, 160 kVA and 125 kVA,** supplies to the rest of the building**.** The DG sets are operated only during power failures, serving as a backup power source.

4.4 SELF GENERATED RENEWABLE POWER (SOLAR)

One (1) Rooftop Solar Power Plant of the capacity **50.02 kWp** is installed at the rooftop of classroom**.** The solar power plant is maintained by a third party, and for all the solar power consumed by the college, it pays **Rs. 5.30 per kWh** to the third party.

4.5 INSTALLED LOAD LIST

Total connected Load list of JDMC, New Delhi is shown in below table and figure:

Table 3 Total Connected Load List

Area	Lighting Load, kW	Fan Load, kW	Air Conditioning Load, kW	Total Connected Load, kW	Percentage (%)
Admin	15.7	33.4	70.8	155.9	49.6%
Hostel	6.0	6.2	34.5	57.6	18.3%
JDVC	4.8	6.2	27	37.9	12.1%
Other	1.1	1.0	59	63.1	20.1%
TOTAL				**315**	**100.0%**

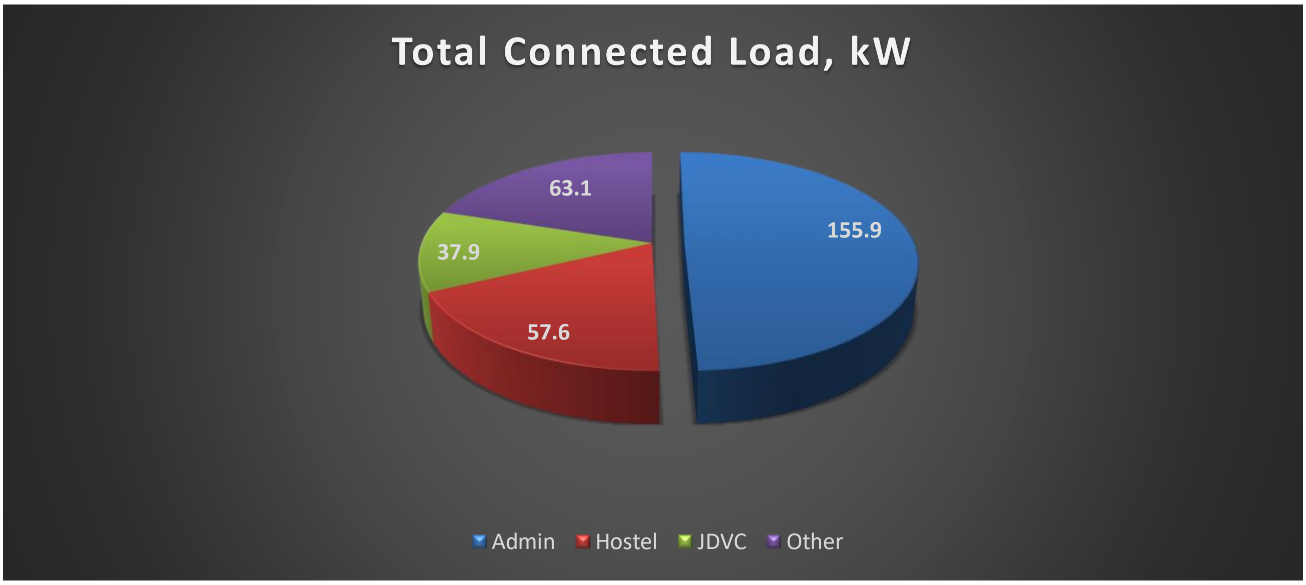


Figure 1 Total Connected Load List

4.6 SHARE OF ENERGY CONSUMPTION

The table and pie chart below gives the segregation of various energy consumption.

Table 4 Grid Power Consumption (July-2023 to June-2024)

Sr. No.	Particulars	Value
1	Annual Grid Power Consumption, kWH	5,26,626

Table 5 Solar Power Consumption (July-2023 to June-2024)

Sr. No.	Particulars	Solar
1	Total Solar Unit Generation, KWH	60,730

Table 6 Share of Energy Consumption, kWH

Particulars	Annual Consumption (kWH)	% of Total Energy Consumption
Electricity	5,26,626	89.7%
Solar	60,730	10.3%
Total	**5,87,356**	**100%**

NOTE: DG power is not considered while calculating the sgare of enrgy consumption

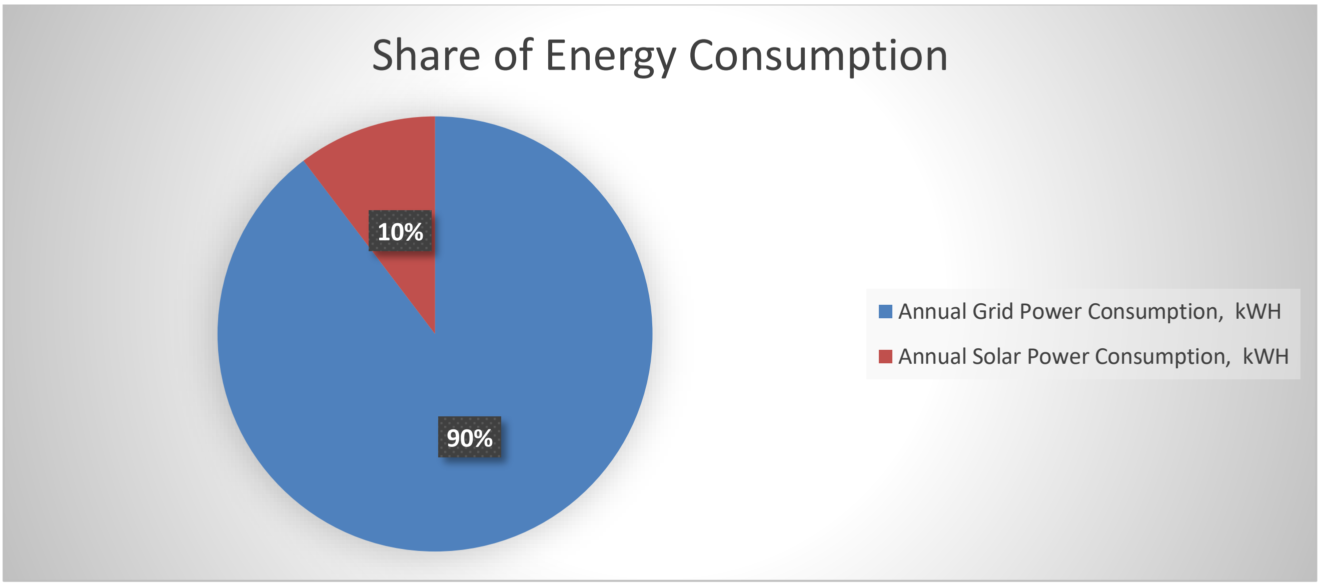


Figure 2: Share of Annual Energy Consumption, kWH

The College's total power consumption **(July-2023 to June-2024)** was **5,87,356 kWh**, of which **5,26,626 kWh** was consumed from grid and **60,730 kWh** was power generated from Solar.

5. ELECTRICITY BILL ANALYSIS

5.1.1 MONTHLY ELECTRICITY BILL ANALYSIS

The electricity billing data was analyzed for a full year, covering the period from **July-2023 to June-2024**. The study likely included monthly electricity consumption, costs, and any variations in usage patterns or demand charges. All parameters have been studied & tabulated in below tables.

Table 7 Monthly Electricity Bill Analysis (July-2023 to June-2024)

Billing Month	Sanctioned Load, KVA	Contract Demand, KVA	Total Units Consumed, kWh	Total Solar Unit Generation (kWh)	Recorded Max. Demand, kVA	Average P.F.	Energy Charge, Rs.	Fixed Charge, Rs.
Jul-23	210	141	47,440	5012	**176**	0.95	4,03,240	44,000
Aug-23	210	141	47,120	5927	**208**	0.95	4,00,520	52,671
Sep-23	210	141	51,260	5622	**208**	0.95	4,35,710	51,329
Oct-23	210	141	36,224	4666	**176**	0.95	3,07,904	46,034
Nov-23	210	141	30,288	3376	98	0.95	2,57,448	33,663
Dec-23	210	141	40,056	3195	76	0.95	3,40,476	35,295
Jan-24	210	141	40,840	3574	108	0.95	3,47,140	36,237
Feb-24	210	141	28,104	4703	89	0.95	2,38,884	30,937
Mar-24	210	141	32,640	6365	73	0.95	2,77,440	35,637
Apr-24	210	141	53,014	6511	**187**	0.95	4,50,619	46,298
May-24	210	141	69,402	6521	**234**	0.95	5,89,917	59,066
Jun-24	210	141	50,238	5258	**223**	0.95	4,27,023	55,210
Max/Sum/Avg.	**210**	**141**	**5,26,626**	**60,730**	**234**	**0.950**	**44,76,321**	**5,26,378**

Table 8 Monthly Electricity Bill Analysis (July-2023 to June-2024)

Billing Month	Slab-wise FPA/PPA @ 31.6% on Energy Charge, Rs.	Srch @8% on (Energy + Fixed Charge-Rebate)	Pension Surcharge @7% on Energy + Fixed Charge - Rebate, Rs.	PPAC on Fixed Chg @ 31.6, Rs.	Electricity Tax @ 5% Rs.	TCS Amount, Rs.	Other Charges, Rs.	Rebate/ Subsidy, Rs	Total Bill, Rs.	Grid Power Cost, Rs. / KWH
Jul-23	1,27,424	34,811	30,460	13,904	27,302	0	2,609	15,920	6,67,830	14.1
Aug-23	1,26,564	35,294	30,882	16,644	27,118	0	5,076	15,813	6,78,957	14.4
Sep-23	1,37,684	37,917	33,178	16,220	29,500	0	4,944	17,202	7,29,281	14.2
Oct-23	97,298	27,576	24,129	14,547	20,851	0	2,733	12,156	5,28,916	14.6
Nov-23	81,354	22,671	19,837	10,638	17,431	0	(4)	10,164	4,32,873	14.3
Dec-23	1,07,590	29,245	25,589	11,153	23,052	290	3	13,442	5,59,251	14.0
Jan-24	1,21,454	29,837	26,107	12,729	24,074	559	1	14,058	5,84,081	14.3
Feb-24	96,390	21,012	18,386	12,483	17,188	584	1	10,058	4,25,806	15.2
Mar-24	1,11,947	24,380	21,333	14,379	19,964	440	(13,131)	11,682	4,80,707	14.7
Apr-24	1,78,235	38,672	33,838	18,328	32,248	0	3,400	18,866	7,82,771	14.8
May-24	2,22,694	50,503	44,190	22,297	41,701	0	7,030	24,378	10,13,020	14.6
Jun-24	1,61,201	37,554	32,860	20,842	30,186	0	6,077	17,647	7,53,306	15.0
Max/Sum/Avg.	**15,69,835**	**3,89,473**	**3,40,789**	**1,84,165**	**3,10,612**	**1,872**	**18,738**	**1,81,385**	**76,36,797**	**14.5**

5.1.2 GRAPHICAL REPRESENTATION OF ELECTRICITY BILL ANALYSIS

A. kWH Consumption

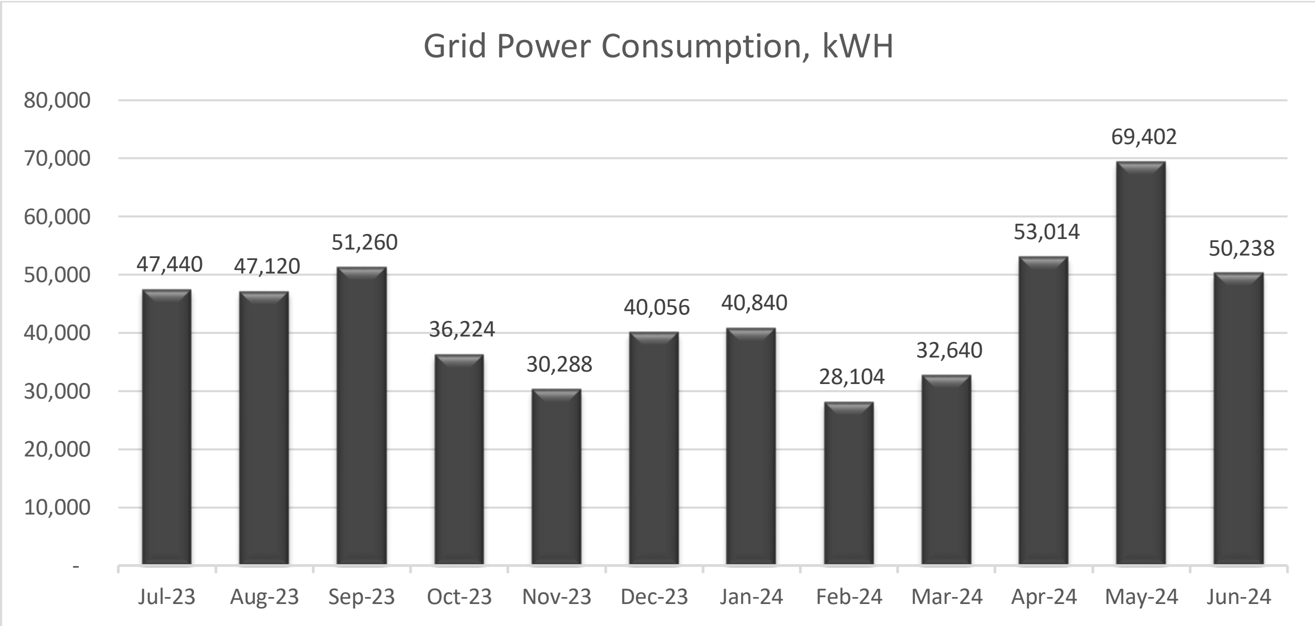


Figure 3: Monthly kWH Consumption

B. Average Per Unit Cost Variation, Rs./kWH

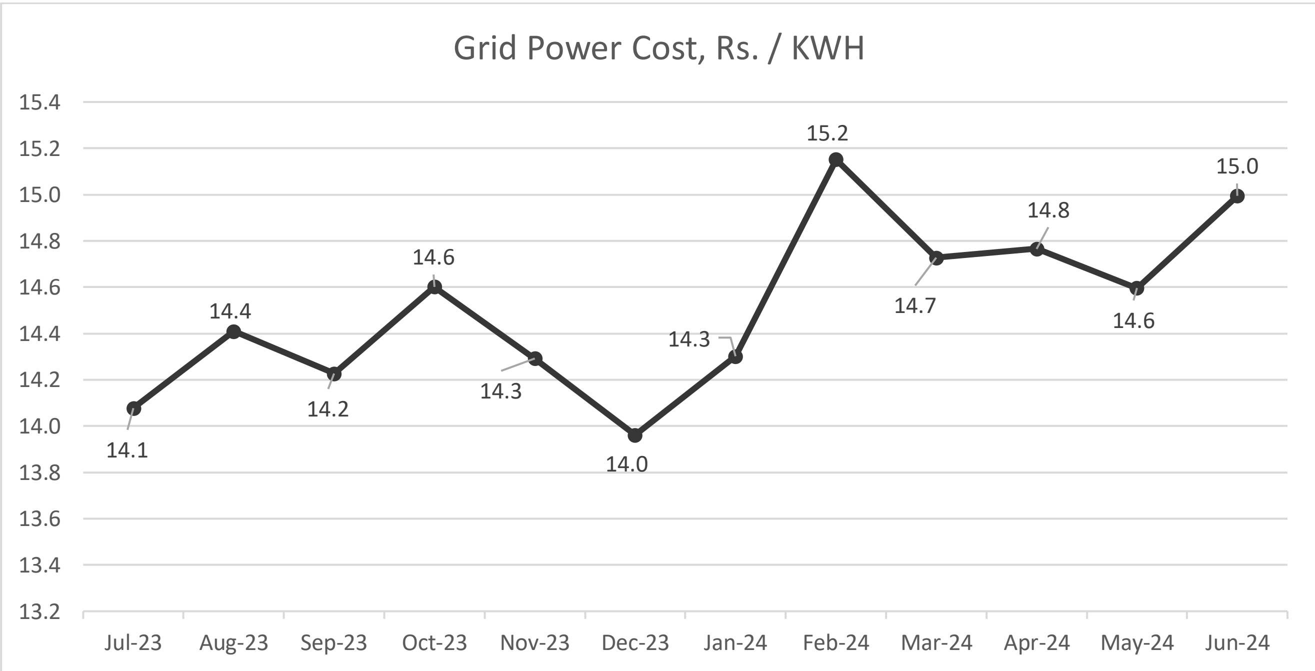


Figure 4: Monthly Average per Unit Cost Variation

C. Contract V/s Recorded Max. Demand

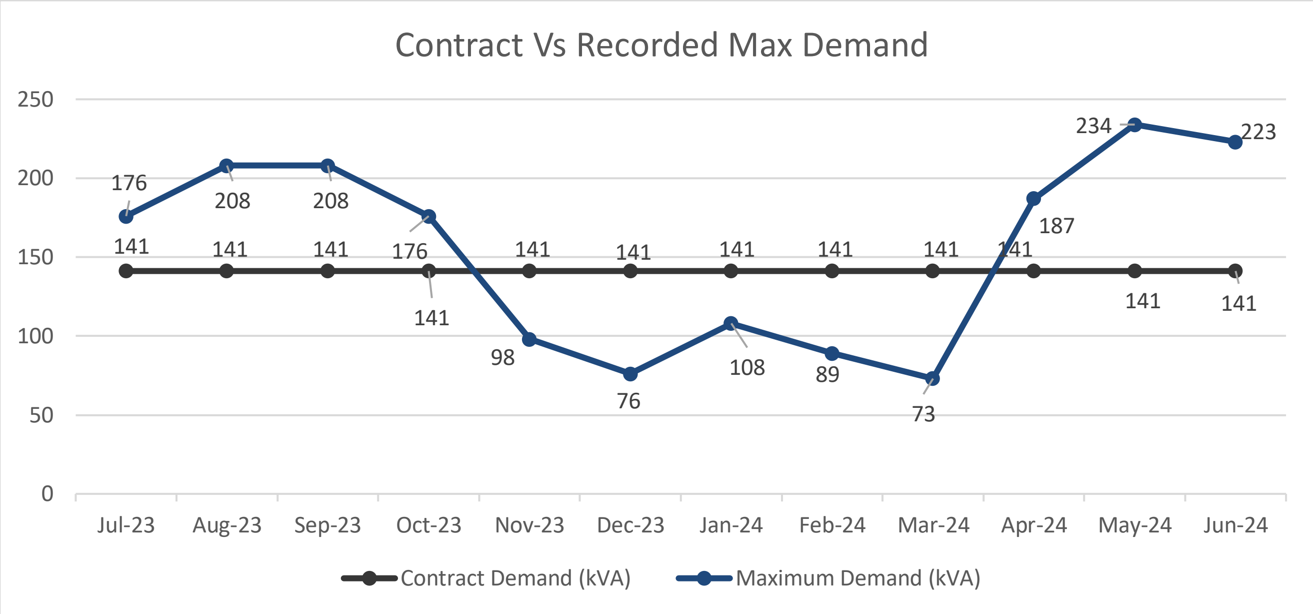


Figure 5 Contract V/s Recorded Max Demand

- **Summary of electricity tariff are given below**

Summary of Grid Power Consumption	Value
Sanctioned Load	210 kVA
Contract Demand	141 kVA
Energy Charges	Rs. 44.8 Lac
Fixed Charges	Rs. 5.3 Lac
Other Charges	Rs. 28.2 Lac
Rebate/Subsidy	Rs. 1.8 Lac
Unit charged on the basis of	kWH
Total kWH Consumed	5.3 Lac Units
Average billing Rate (including all Taxes & Fixed Charges)	Rs. 14.5 (kWH) per Unit
Highest recorded Demand	234 KVA in the month of May-24
Average P.F.	0.95 (constant throughout the year)

5.1.3 OBSERVATIONS BASED ON ELECTRICITY BILLS ANALYSIS

Contract Demand

A customer's contract demand is the amount of power which a customer agrees to pay to have available at all times. Because this refers to power which must be made available, as opposed to energy which can actually be consumed, Contract demand is measured in kilowatts or KVA. The College has taken a contract demand of **141 kVA from BSES Yamuna**, and was paying **Rs. 311/- per kVA** as a fixed charge. The maximum demand of the College from **July-2023 to June-2024** was **234 kVA (in the month of May 2024)**.

In eight months, the college's **maximum demand has exceeded the contract demand**, resulting in penalties, which are reflected under the **"Other"** column in the electricity bills. It is not advisable to increase the contract demand because it has been evaluated that if the college increases its contract demand, it will have to pay **Rs. 250/kVA** as a fixed charge to the electricity provider, which is much higher than the **penalties**. Currently, the college is paying a fixed charge of **Rs. 311/kVA**, as the difference due to the exceeded contract demand has been added to the fixed charge.

6. POWER FACTOR ANALYSIS

6.1 CAPCITOR BANKS

At JDMC, New Delhi, energy charges are based on **kWh** consumption, and there is **no incentive for maintaining Power Factor (P.F.)**, so P.F. does not play a role in **energy-saving potential**. However, to maintain the P.F., the college has installed a **210 kVAR APFC**. In the monthly electricity bills, the P.F. is consistently shown as 0.95 each month, which is not feasible. Rated kVAR Capacity of each capacitor is shown in below table:

Table 9 Rated kVAR of Capacitors

Sr. No.	Capacitor Bank	Make	kVAR Installed	Rated Voltage (Volt)
APFC PANEL				
1	1F2, 25KVAR Capacitor Panel	L&T	25	440
2	1F3, 25KVAR Capacitor Panel	L&T	25	440
3	2F1, 50KVAR Capacitor Panel	L&T	50	440
4	2F3, 25KVAR Capacitor Panel	L&T	25	440
5	2F4, 5KVAR Capacitor Panel	L&T	5	440
6	3F1, 50KVAR Capacitor Panel	L&T	50	440
7	3F3, 25KVAR Capacitor Panel	L&T	25	440
8	3F4, 5KVAR Capacitor Panel	L&T	5	440

6.1.1 OBSERVATIONS BASED ON POWER FACTOR ANALYSIS

- When the APFC was checked, none of the capacitors could be turned on, either manually or in auto mode. In our opinion, all the capacitors are connected to the power supply going to the hostel and JDVC. The college has two feeders for the total power supply—one for the hostel and JDVC, and another for the rest of the building. It is recommended that the college get the capacitors repaired and connected to both feeders to maintain the overall Power Factor (P.F.).

7. OVERALL LOAD PROFILE

7.1 TOTAL LOAD PROFILE OF COLLEGE

The total power supply of the college is connected to a **400 kVA transformer.** After stepping down the voltage (HV to LV), two outgoing lines are drawn: one connected to a **630 A Air Circuit Breaker (ACB)** which supplies the Hostel and JDVC, and another LV outgoing line connected to a **160 kVA DG set with an Automatic Mains Failure (AMF) panel**, which supplies the Admin and other areas.

To assess the total load of the college, data was logged for both feeders. The logged data, along with observations and recommendations, are presented in below table and graphical representation of the logged data are shown in Annexure-1.

Table 10 Logged Power Data of Admin Building Feeder (160 kVA DG AMF Panel)

Particulars	Maximum	Minimum	Average
Voltage (R-Phase)	414.1	395.1	406.1
Voltage (Y-Phase)	416.9	397.3	408.4
Voltage (B-Phase)	417.3	396.6	408.4
Current (R-Phase)	186.3	52.4	126.1
Current (Y-Phase)	168.6	65.8	125.1
Current (B-Phase)	203.7	74.9	143.6
Current (Neutral Phase)	99.5	15.6	40.0
Kilowatt (R-Phase)	43.9	12.0	29.5
Kilowatt (Y-Phase)	39.5	14.7	29.0
Kilowatt (B-Phase)	48.2	17.4	33.8
Total Kilowatt	**128.9**	**44.1**	**92.3**
Power Factor (R-Phase)	0.997	0.977	0.993
Power Factor (Y-Phase)	0.996	0.956	0.986
Power Factor (B-Phase)	0.999	0.978	0.996
Vthd (R-Phase)	1.8	0.8	1.1
Vthd (Y-Phase)	1.7	0.6	1.0
Vthd (B-Phase)	1.8	0.7	1.0
Ithd (R-Phase)	**21.5**	7.8	11.2
Ithd (Y-Phase)	**12.4**	4.1	6.6
Ithd (B-Phase)	**13.0**	4.7	7.4
Voltage Unbalance (%)	0.6	0.0	0.4
Current Unbalance (%)	**22.4**	0.3	5.6

Table 11 Logged Power Data of Hostel & JDVC Feeder

Particulars	Maximum	Minimum	Average
Voltage (R-Phase)	408.1	400.8	403.7
Voltage (Y-Phase)	410.1	402.9	405.5
Voltage (B-Phase)	410.0	403.1	405.5
Current (R-Phase)	80.5	47.6	63.6
Current (Y-Phase)	66.9	19.1	40.5
Current (B-Phase)	92.0	58.5	63.1
Current (Neutral Phase)	53.5	19.2	29.4
Kilowatt (R-Phase)	17.6	11.1	14.4
Kilowatt (Y-Phase)	11.8	4.4	8.9
Kilowatt (B-Phase)	15.9	13.4	14.2
Total Kilowatt	**45.2**	**29.9**	**37.5**
Power Factor (R-Phase)	0.996	0.676	0.972
Power Factor (Y-Phase)	0.995	0.452	0.959
Power Factor (B-Phase)	0.982	0.676	0.963
Vthd (R-Phase)	1.4	0.9	1.0
Vthd (Y-Phase)	1.3	0.8	0.9
Vthd (B-Phase)	1.2	0.7	0.8
Ithd (R-Phase)	8.9	4.7	6.4
Ithd (Y-Phase)	13.7	7.2	9.7
Ithd (B-Phase)	19.1	14.1	17.1
Voltage Unbalance (%)	0.5	0.1	0.3
Current Unbalance (%)	**25.3**	**9.9**	**14.4**

7.1.1 Observation & Recommendations on Logged Data For Admin, Hostel & JDVC Feeders

- The average running voltage on both feeders was around **405 volts**, which is satisfactory. The total maximum running load was **173.2 kW**, with an average load of **129.8 kW**. The running average power factor (P.F.) was close to **0.98**. However, due to the presence of single-phase loads, a significant **unbalanced load** was observed in the college, leading to a higher current flow in the **neutral phase**. For the Admin area, the neutral current was **40 amperes** against an average running ampere of **131**, and for the Hostel & JDVC, it was **29.4** amperes against an average running ampere of **55.7**. It is always advisable to balance the load, but due to the nature of single-phase loads, this becomes challenging. Additionally, current harmonics were found to be higher than acceptable levels, which are discussed in the next sub-heading of the report.

7.1.2 Measured Total Harmonics Distortion Level At Hostel, JDVC & Admin Building Feeders

Following table shows the values of V_{THD} and I_{THD} where data has been recorded, details of which are as under.

Table 12: Total Harmonics Distortion Level at Hostel, JDVC & Admin Building Feeder

Particulars	Average Voltage Total Harmonics Distortion (Vthd) (%)	Average Current Total Harmonics Distortion (Athd) (%)
Admin Building Feeder (160 kVA DG AMF Panel)	1.0	8.4
JDVC+Hostel Feeder	0.9	11.0

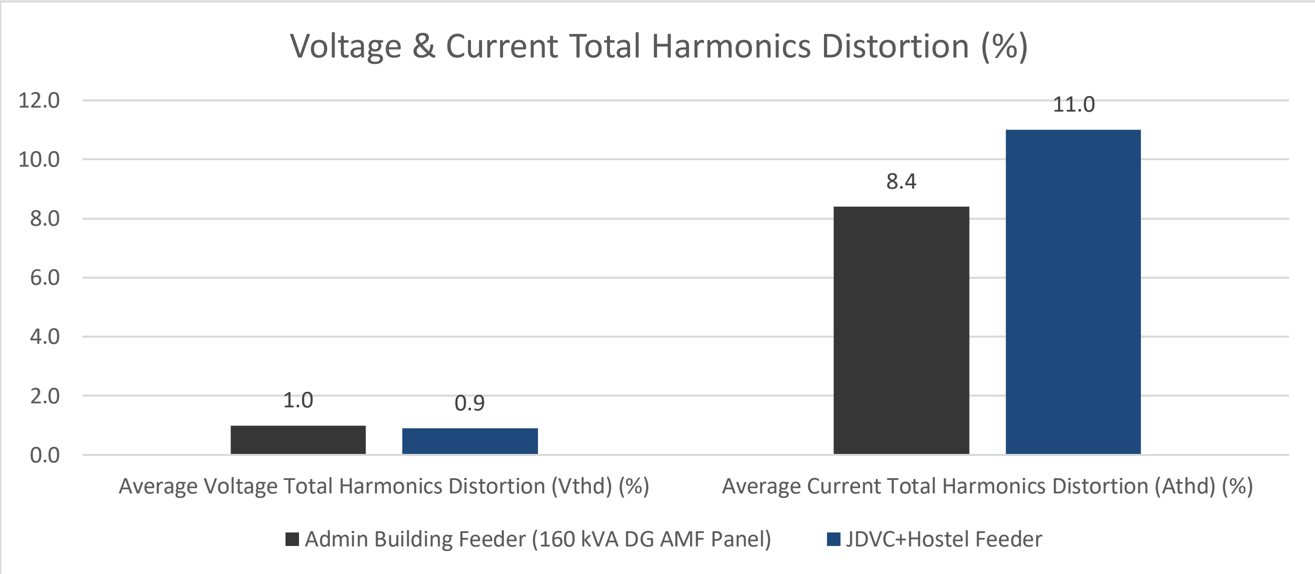


Figure 6: Harmonics Level (Vthd and Ithd) at Hostel, JDVC & Admin Building Feeder

Observation:

- As detailed above, the average voltage harmonics distortion level at Admin & Hostel, JDVC Building Feeder was **1.0% & 0.9% respectively** and average current harmonics distortion level was **8.4% & 11% respectively.** The average voltage harmonic distortion level was well under the limit of **5%,** but average current harmonics distortion of Hostel, JDVC feeder is exceeding the permissible limit of **8%. A suitable sized harmonic filter is needed to mitigate the problem of harmonics.**

7.1.3 MEASURED VOLTAGE & CURRENT UNBALANCE AT HOSTEL, JDVC & ADMIN BUILDING FEEDERS

Following table shows the voltage and current unbalance values where data has been recorded, details of which are as under.

Table 13: Voltage and Current Unbalance Level at Hostel, JDVC & Admin Building Feeder

Particulars	Average Voltage Unbalance (%)	Average Current Unbalance (%)
Admin Building Feeder (160 kVA DG AMF Panel)	0.4	5.6
JDVC+Hostel Feeder	0.3	**14.4**

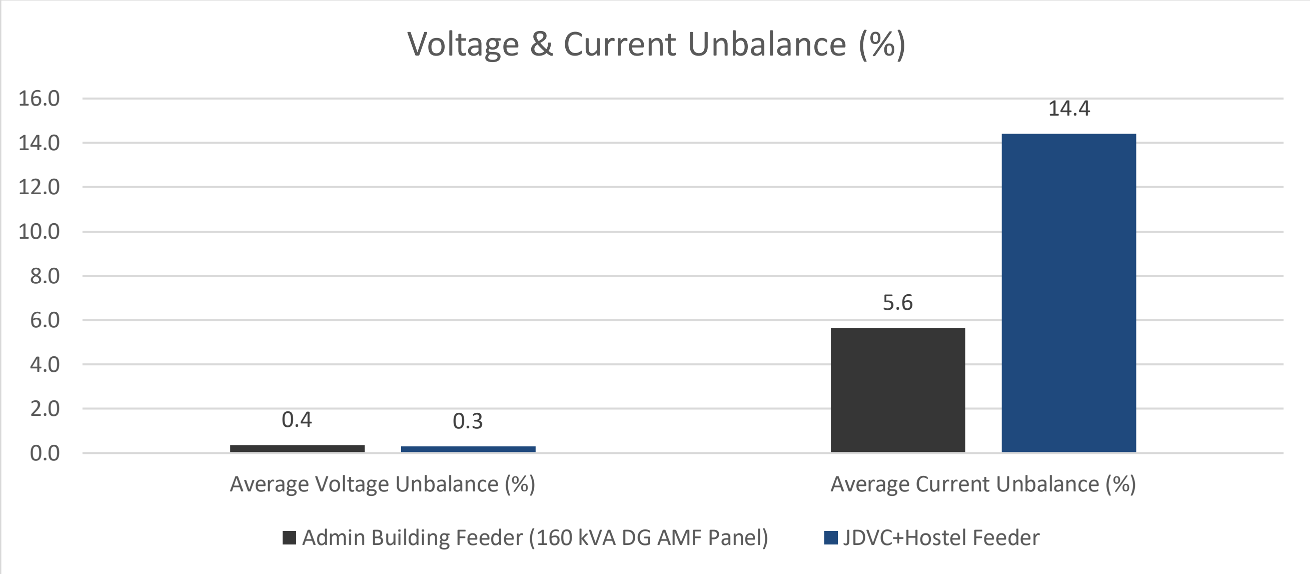


Figure 7: Current and Voltage Unbalance (Aunb and Vunb) at Hostel, JDVC & Admin Building Feeder

Observation

- As detailed above, the average voltage unbalance of Admin & Hostel, JDVC Building Feeder was **0.4% & 0.3% respectively** and the current unbalance was **5.6% and 14.4%.** The average voltage unbalance level was well under the limit but average current unbalance of Hostel, JDVC feeder is exceeding the permissible limit of **10%. It is recommended to balance the load of each phase to reduce the current unbalance.**

7.2 Motor Loading

Table 14 Motor Loading

Sr. No.	Name of Drive	Rated Power	Measured Parameters				% Loading
			Voltage	Current	Load	Power Factor	
		Kilowatt (KW)	V	I	kW	PF	
1	Canteen VRV	10.0	380	15.8	9.6	0.926	96.0
2	Ground Borewell	1.5	387	3.3	2.0	0.905	134.0
3	Parking Borewell	1.5	217	4.6	1.0	0.980	66.1
4	JDVC Borewell	1.5	224	7.6	1.7	0.986	111.3
5	Lab-2 (UPS-1)	10 kVA	221	8.4	1.6	0.831	-
6	Lab-2 (UPS-2)	10 kVA	221	9.6	1.9	0.857	-
7	Lab-3 (UPS)	10 kVA	226	4.2	0.8	0.842	-
8	Transfer Pump-1	3.7	377	5.7	3.7	0.978	97.9
9	JDVC O General Window AC (1.5 Tonne)	-	227	10.1	2.3	0.985	-
10	Solar	-	410	12.5	8.8	0.990	-

8. TRANSFORMER PERFORMANCE STUDY

8.1 Transformer Details

JDMC, New Delhi receives its power supply from BSES Yamuna at a high voltage of **11 kV**. The incoming 11 kV is stepped down to **0.433 kV** using one (1) transformer of **400 kVA which is installed and maintained by BSES Yamuna**. Transformer rated specification are shown below.

8.1.1 Transformer Rated Details

Table 15 TR Rated Details

Sr. No.	Particulars	TR # 1
1	Make	ABB
2	KVA	400
3	Volts at HV/LV	11000/433
4	Ampere at HV/LV	NA
5	Phases	3
6	Cooling	ONAN
7	Frequency	50
8	Impedance Volts	NA
9	Year	2010

8.2 Performance Evaluation Of Transformer

The transformer is a device, which always remains in the circuit. At JDMC, New Delhi the loading on the transformer varies with the operation of College. Estimation of transformer efficiency and load / no load losses are difficult in a continuous running load. Transformer efficiencies nevertheless are in close range of 99% and above. The performance evaluation of both the transformers are shown in below table:

Table 16: Performance Evaluation of Transformer

Performance Analysis of Transformer		
1	Date	08-08-2024
2	Time	11:40 AM to 16:54 PM
3	Transformer Rating in KVA	400
4	Rated NL Loss (kW)	0.64
5	Avg. Load in KVA	130
6	Min. Load in KVA	75
7	Max. Load in KVA	175
8	Present Avg. % Loading	32.6
9	Present Min. % Loading	18.7
10	Present max. % Loading	43.7
11	Rated Full Load Losses of Transformer (kW)	4.5
12	Total Losses of Transformer(kW)	1.1
13	Operating Power Factor	0.992
14	Total Loss (KVA)	1.12
15	**Transformer Efficiency at Avg. Load, %**	**99.14**
16	Transformer Efficiency at Min. Load, %	98.50
17	**Transformer Efficiency at Max. Load, %**	**99.36**

NOTE: Rated No load losses and load losses are taken from BEE Book.

8.2.1 OBSERVATION & RECOMMENDATIONS ON PERFORMANCE EVALUATION OF TRANSFORMER

- The transformer efficiency at an average load of **130 kVA** was **99.14%, which is satisfactory.** This shows that the evaluated transformer efficiency is running at their best efficiency range. However this transformer is operated by BSES Yamuna.

9. DIESEL GENERATOR PERFORMANCE ANALYSIS

For self-generation, College has total three **(3) DG Sets, 62.5 kVA** for girls hostel, while the other **two, 160 kVA and 125 kVA,** supplies to the rest of the building**.** The DG sets are operated only during power failures, serving as a backup power source. Rated specification of DG Sets are shown in below table

DG-160 kVA

DG-125 kVA

DG-62.5 kVA

Table 17 DG Rated Details

Sr. No.	Rated Specifications	DG-1 160 kVA	DG-2 125 kVA	DG-2 62.5 kVA
1	Make	Greaves Cotton Ltd.	Bhaskar Energy Pvt. Ltd.	Greaves Cotton Ltd.
2	Model/Type	GPWI I-PII-160	NA	GPWI I-PII-62.5
3	KVA	160	125	62.5
4	RPM	1500	1500	1500
5	Voltage	415	415	415
6	Current	NA	NA	NA
7	PF	0.8	0.8	0.8
8	Frequency	50	50	50

9.1 PERFORMANCE EVALUATION OF DG SETS FROM THE LOG BOOK DATA

The performance of the DG has not been evaluated because **no energy meter** is installed on the DG. It is recommended that the values of the units generated by the DG be recorded and its performance be evaluated on a monthly basis. To assess the DG's performance, both diesel consumption and kWh readings are required. The DG's Specific Energy Consumption (SEC) can be calculated using the formula kWh/Diesel consumed, which typically ranges from **3.5 to 4**. This means the DG generates **3.5 to 4** units of electricity per liter of diesel consumed.

10. PUMP PERFORMANCE ANALYSIS

10.1 BRIEF ABOUT INSTALLED PUMPS

Total **three (3)** borewell pumps which are used for gardening and two drinking water transfer pumps that are used to distribute the drinking water received from NDMC. The rated specifications of drinking water transfer pumps are shown in belw table:

Table 18: Rated Specifications of Drinking Water Transfer Pumps

Pump Identification	Unit	Drinking Water Transfer pump	
Rated Parameters		Transfer Pump # 1	Transfer Pump # 2
Running Status		Running	Stand By
Pump Make		Crompton Greaves	Crompton Greaves
Speed	RPM	2880	2880
Rated Flow	m^3/hr	2.16 to 22	2.16 to 22
Rated Head	M	36 to 52	36 to 52
Rated Power	KW	3.73	3.73

10.2 PUMP PERFORMANCE EVALUATION

Two pumps are installed for drinking water transfer, with one running and the other on standby. We measured Terminal Voltage, Load Current, Power Consumption and P.F. for Transfer Pump-1. We have also checked throttling, Flow, measured Suction and Discharge Pressure. Performance evaluation of pump is tabulated below:

Table 19 Drinking Water Transfer Pump-1 Performance Evaluation

Pump Identification	Unit	Drinking Water Transfer pump
Rated Parameters		Transfer Pump # 1
Running Status		Running
Pump Make		Crompton
Speed	RPM	2880
Rated Flow	m^3/hr	2.16 to 22
Rated Head	M	36 to 52
Rated Power	KW	3.73
Parameters Measured		
Measured Flow	m^3/hr	5.7
Discharge Pressure (A)	Kg/cm^2	4.4
Suction Pressure (B)	Kg/cm^2	-0.06
Performance Evaluation		
Total Head (=(A-B)X10)	M	44.6
Head Utilization	%	-
Flow Utilization	%	-
Input power	kW	**3.65**
Hydraulic Power	KW	**0.69**
Motor Efficiency	%	86.0
Pump Efficiency	%	**22.1**
Overall (Pump Set) Efficiency	%	**19.0**

10.2.1 Observation And Recommendations on Pumps

- The pipe size of all three borewells are very small, which is why we were unable to measure the flow using instruments on these borewells.

- The evaluated overall pump efficiency of the **drinking water transfer Pump-1 was 19%**. The result is not satisfactory. The pump is exhibiting low overall efficiency. The lower efficiency of the pump is due to its higher capacity against the actual requirement. It is recommended to replace the existing pump with a new, energy-efficient pump. The estimated saving potential is calculated based on replacing only one pump. The management can consider replacing the second pump once they achieve the payback from the first pump. The resultant benefit in terms of energy savings workout by replacing transfer pump-1 of **3.7kW** with new pump of **2.2 kW** is **Rs. 0.21** Lac per annum with an estimated investment of **Rs. 0.22 Lac** with the simple payback period of **12 months.** The estimated saving potential is shown in the table below.

Table 20 Estimated Saving Potential by replacing Transfer Pump-1 with new energy efficient pump

Particulars	Transfer Pump # 1
Measured flow of pump, m3/hr	5.7
Measured Head of Pump, Meter	44.6
Proposed Pump Max Flow Requirement, m^3/hr	**6.8**
Propose Pump Max Pressure Requirement, Metre	**52**
Estimated Average Operating Efficiency of New Energy Efficient Pump, (%)	60
Hydraulic Power of proposed pump, kW	1.0
Estimated Input Power of proposed pump, kW	1.6
Average Input Power of Installed Pump, kW	3.7
Net Reduction in the power Drawn, kW	**2.0**
Working Hours Per Annum, Hr (@ 3 hours, 240 days)	720
Annual Power Saving, KWH	1,465
Estimated Investments, Rs Lakh	**0.22**
Cost Of Power, Rs./ KWH	14.51
Estimated Annual Saving, Rs. Lakh	**0.21**
Overall Simple Pay Back Period in Months	**12**
Proposed Pump and Motor Power, kW	2.2

11. STUDY OF ILLUMINATION

11.1 LIGHTING SYSTEM

Lighting has been studied very critically. It may be pleased to appreciate that for energy efficiency measures management has replaced **most the conventional lights with LED lamps**. Adequate and proper lighting contributes both directly and in directly towards productivity, safety and towards providing an improved atmosphere. Primary considerations to ensure energy efficiency in lighting systems are;

- Selection of the most efficient light source as far as possible to minimize power cost and energy consumption.
- Matching proper lamp type to the intended work task or aesthetic application, consistent with colors, brightness control, and other requirements.
- Establish adequate light levels to maintain productivity improve security and improve safety.

11.2 LIGHTING & FAN LOAD

Installed lighting & fan load of JDMC, New Delhi is shown in below table

Table 21 Light & Fan Load of JDMC, New Delhi

Particulars	Lighting Load, kW	Fan Load, kW	Total Light & Fan Load (kW)
Admin	15.7	33.4	49.1
JDVC	4.8	6.2	10.9
Hostel	6.0	6.2	12.2
Other	1.1	1.0	2.1
Total Load, kW	**27.6**	**46.8**	**74.4**

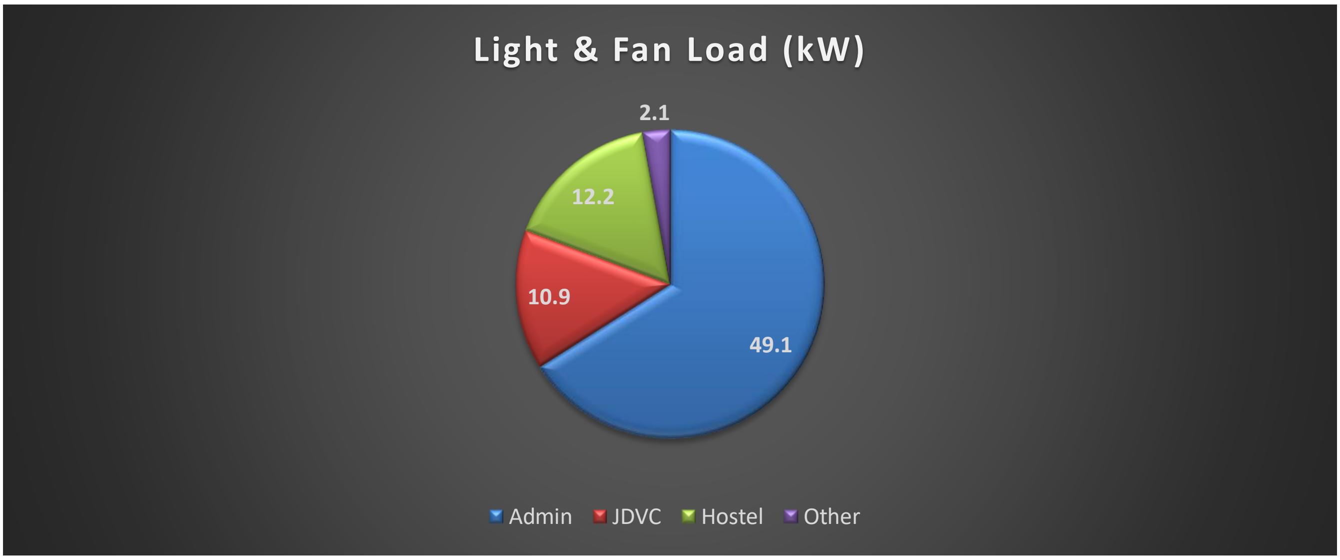


Figure 8 Lighting & Fan Load, New Delhi

11.2.1 OBSERVATION ON LIGHTING & FAN LOAD

- Management has replaced most of the old conventional lights with LEDs, but **JDVC** building is still left with **old conventional tube lights** of **40 Watt**. It is recommended to replace all the tube lights with **20 watt LED tubes.** The resulting benefit in terms of energy savings is **Rs. 0.66 lakhs per annum (4,570 kWH**), with an estimated investment of **Rs. 0.24 lakhs,** resulting in a simple payback period of **4 months**. Estimated saving potential is shown in below table

Table 22 Estimated Saving Potential by replacing Old Conventional Tube light with LED Tube light of 20 Watt

Sr. No.	Particulars	Value
1	Power Consumption of Old Conventional Tube, Watt	40
2	Total No. of Old Fixtures for replacement	119
3	Power Consumption of Proposed LED Tube, Watt	20
4	**Estimated Energy saving by replacement Tube with LED (=40-20), Watt**	**20**
5	Estimated Energy Saving after replacement (=119*20)/1000, kW	2.38
6	Estimated Annual Running Hours, (240*8)	1920
7	**Estimated Annual Energy Saved (=1920*2.38), kWh**	**4,570**
8	Avg. Cost of Power, Rs./ kWH	14.5
9	**Annual Energy Saved, Rs. Lakh**	**0.66**
10	Estimated Cost of One 20 Watt LED Tube, Rs.	200
11	**Total Estimated Investment (=119*200), Rs. Lakh**	**0.24**
12	Simple Payback Period , Months	4

- The washroom lights are always kept ON regardless of whether they are in use or not. Total **13** washrooms has been identified in the college where it is recommended to install occupancy sensors. Each washroom requires a total of two **(2)** occupancy sensors. The resulting benefit in terms of energy savings is **Rs. 0.13 lakhs per annum (922 kWH),** with an estimated investment of **Rs. 0.44 lakhs**, resulting in a simple payback period of **40 months. We have not included this saving in the college's total energy savings due to the high payback period.** Estimated saving potential and identified washrooms for installing occupancy sensors are mentioned in below table:

Table 23 Identified Areas to Install Occupancy Sensor

Sr. No.	Area	No. of LED Tube Lights (20 Watt)	Total Light Load, Watt
1	Admin staff (she/He)	9	180
2	Committees Room	2	40
3	Canteen	1	20
4	CL-II	1	20
5	Auditorium/Music	1	20
6	First Floor student	8	160
7	Staff room (She/He)	5	100
8	First Floor PWD Student	1	20

Sr. No.	Area	No. of LED Tube Lights (20 Watt)	Total Light Load, Watt
9	IInd Floor	5	100
10	IIIrd Floor	9	180
11	IIIrd Floor PWD Student	1	20
12	Library (She/He)	4	80
13	security guard room	1	20
Total		**48**	**960**

Table 24 Estimated Saving Potential by installing Occupancy Sensors in Hostel Washrooms

Sr. No.	Particulars	Value
1	Total No. of Washrooms in College where occupancy sensors are required	13
2	Total Lighting Power Consumption in Washrooms, Watt	960
3	Total Power Consumption in all Hostel Washrooms =960/1000, kW	0.96
4	Estimated Saving Potential by installing Occupancy Sensors (%)	50
5	Estimated Saving Potential by installing Occupancy Sensors (=0.96*50%), kW	0.48
6	Annual Running Hours, (240*8)	1,920
7	Estimated Annual Energy Saving (=0.48*1920, kW	922
8	Avg. Cost of Power, Rs./ kWH	14.5
9	**Estimated Annual Energy Saved, Rs. Lakh**	**0.13**
10	Estimated Cost of Of One Occupancy Sensor, Rs.	1700
11	Total No. of Occupancy Sensors required in each Washroom	2
12	**Total Estimated Investment (=1700*2*13), Rs. Lakh**	**0.44**
13	Simple Payback Period, Months	40

- Two types of fans are installed in the college—one that consumes **70 watts** of power and another that consumes approximately **100 watts**. The 100-watt fans are mostly installed in classrooms in the admin building. It is recommended that all these fans be replaced with new **BLDC fans**, which consume only **30 watts** of power. The resulting benefit in terms of energy savings is **Rs. 2.09 lakhs per annum (14,381 kWH),** with an estimated investment of **Rs. 2.68 lakhs**, resulting in a simple payback period of **15 months.** Estimated saving potential is shown in below table:

Table 25 Estimated Saving Potential by replacing 100 Watt Ceiling Fans with new BLDC fans

Sr. No.	Particulars	Value
1	Power Consumption of Old Ceiling Fan in Class Rooms, Watt	100
2	Total No. of Old Fans for replacement	107
3	Power Consumption of Proposed BLDC Ceiling Fan, Watt	30
4	**Estimated Energy saving by replacement Old Fan with BLDC Fan (=120-30), Watt**	**70**
5	Estimated Energy Saving after replacement (=107*90)/1000, kW	7.49
6	Estimated Annual Running Hours, (240*8)	1920
7	**Estimated Annual Energy Saved (=1920*9.63), kWh**	**14,381**

Sr. No.	Particulars	Value
8	Avg. Cost of Power, Rs./ kWH	14.5
9	**Annual Energy Saved, Rs. Lakh**	**2.09**
10	Estimated Cost of One 40 Watt BLDC Ceiling Fan, Rs.	2500
11	**Total Estimated Investment (=107*2500), Rs. Lakh**	**2.68**
12	Simple Payback Period , Months	15

11.3 LUX SURVEY

During the onsite assessment, the lux levels of the college were measured and found to be satisfactory everywhere except for the JDVC building. We have already recommended replacing the old conventional lights in the JDVC building with LED lights, which will slightly improve the lux level. It is always recommended to maintain a lux level between 200-250 in classrooms.

Table 26 Lux Survey

Sr. No.	Location or Area	Avg. Lux Level	Remarks
Girls Hostel			
1	Common Room	312	
2	GF Corridor	70	
3	Hostel Room # 03	209	
4	Washroom	160	
5	Hostel Room # 33	138	
6	Hostel lift	239	
7	Mess	124	
JDVC			
8	Room # 10 (FF)	56	Low Lux Level.
9	Beauty room, Room # 06 (FF)	349	
10	Room # 07 (FF)	105	Low Lux Level.
11	Room # 08 (FF)	84	Low Lux Level.
12	Room # 09 (FF)	73	Low Lux Level.
13	Room # 05 (GF)	61	Low Lux Level.
14	Room # 04 (GF)	42	Low Lux Level.
15	Room # 03 (GF)	112	Low Lux Level.
16	Room # 02 (GF)	174	
17	Room # 01 (GF)	184	
JDVC (Old Building)			
18	Room # 11 (GF)	128	Low Lux Level.
19	Room # 12 (GF)	76	Low Lux Level.
20	Room # 13 (GF)	97	Low Lux Level.
Library and other area			
21	Magazine Floor	470	
22	Reading Floor	247	

Sr. No.	Location or Area	Avg. Lux Level	Remarks
Girls Hostel			
23	Class Room # 16	206	
24	Room # 69	196	
25	Staff Room	451	
26	Seminar Room	376	
27	Admin Department	365	
28	Principal Room	261	

12. STUDY OF AIR CONDITIONING SYSTEM

12.1 AIR CONDITIONING SYSTEM

At JDMC, New Delhi, **split and window air** conditioners are used, for human cooling purposes. Additionally, there are four **VRV systems** installed: one in the library, one in the seminar hall, and two in the staff and department rooms. The details of the ACs, categorized by location, are mentioned in the table below.

Staff & Department VRV

Library VRV

12.2 AIR CONDITIONING LOAD

The air conditioning load of the college has been segregated into five departments: Admin, Hostel, JDVC, Library, and Others. The college has a total of **41 split ACs, 54 window ACs, and 4 VRV systems**, with a combined total load of **188 kW.** The HVAC load, based on area, is provided in Annexure-1.

Table 27 Total Connected Load of AC's

Location	Split AC	Window	VRV	Total Power (kW)
Admin	16	11	3	70.8
Hostel	5	18		34.5
JDVC		16		27
Library	5	3	1	24
Others	15	6		35
Total	**41**	**54**	**4**	**191**

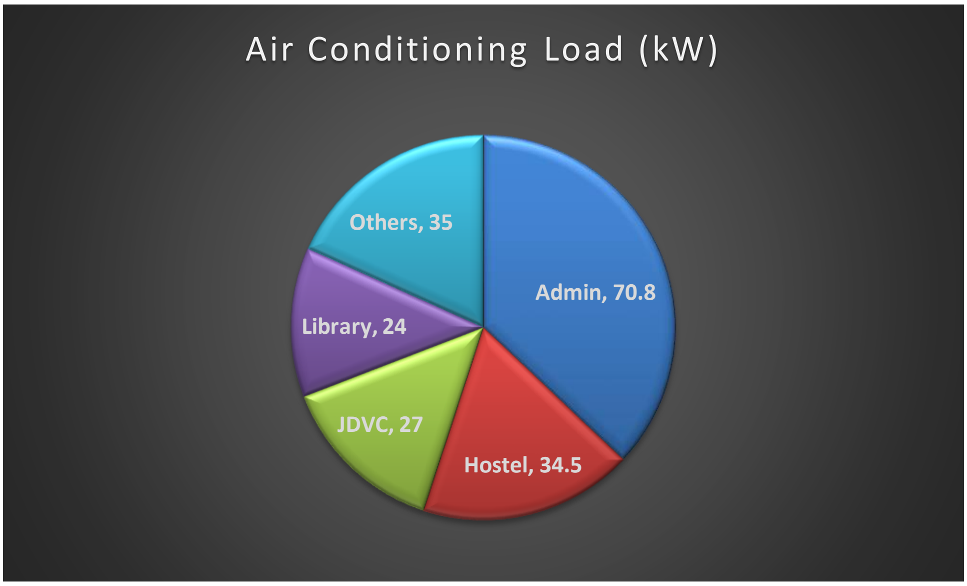


Figure 9 Total HVAC Load

12.3 AIR CONDITIONING PERFORMANCE

12.3.1 PERFORMANCE EVALUATION OF VRV SYSTEM

Measurement of Air-flow, RH, TSA, TRA, and energy consumption of **Staff Department VRV-1 & 2 and Library VRV** were taken during the field trials. The study will help us to evaluate the heat load (TR), specific power consumption (kW/TR) of VRV System. Performance evaluation of VRV System are shown in below tables:

Table 28 Performance Evaluation of Hostel VRV System

Sl. No.	Particulars	Staff and Department Room VRV-1	Staff and Department Room VRV-2	Library VRV
Rated Details				
1	Sr No/Model No	6393	6456	AM140KXMDGH
2	Make	Daikin	Daikin	Samsung
3	Rated TR	9.52	9.52	11.37
4	Motor KW	8.7	8.7	10.0
5	Refrigerant	410A	410A	410A
6	Rated kW/TR	0.91	0.91	0.88
Measured Parameters				
7	Indoor Unit Set Temp (ºc)	22 to 24	22 to 24	22 to 24
8	Running Room Temperature (ºC)	24	24	24
9	Power Consumption, KW	**5.1**	**5.3**	**9.0**
10	Suction Area	0.35	0.35	0.44
11	Air Density (kg/m^3)	1.14	1.14	1.14
12	Specific Heat of Air (kJ/kg-K)	1.01	1.01	1.01
13	Air Velocity (m/s)	4.94	5.89	7.92
14	Mass flow of air (kg/s)	1.99	2.37	3.98
15	Suction Air Temp., ºC	35.0	35.0	34.0
16	Discharge Air Temp., ºC	47.0	45.2	45.0

Sl. No.	Particulars	Staff and Department Room VRV-1	Staff and Department Room VRV-2	Library VRV
17	Suction Air Temp., K (T1)	308.0	308.0	307.0
18	Discharge Air Temp., K (T2)	320.0	318.2	318.0
19	Difference in Temperature (T2-T1), (dT)	12.0	10.2	11.0
20	Heat transfer per hour (kcal/hr)	**20663**	**20941**	**37915**
21	Heat input from the compressor (kcal/hr)	4386.0	4558.0	7722.8
22	Evaporator Heat load (kcal/hr)	16276.7	16382.9	30192.3
23	Heat Rejected (TR)	**5.4**	**5.4**	**10.0**
24	Specific Power Consumption (KW/TR)	**0.95**	**0.98**	**0.90**
25	COP (KW/KW)	3.71	3.59	3.91

12.3.2 Observation and Recommendations on VRV System

- The average performance evaluation i:e **kW/TR of Staff Department VRV-1, 2 & Library VRV was 0.95, 0.98 & 090** respectively. According to the current evaluation, the VRV system is operating within acceptable limits against its rated **kW/TR**. Therefore, no further recommendations are required.

12.4 Split and Window AC's

The College has split and window ACs installed in different areas. In each location, there are a minimum of three-star rated or inverter ACs are installed, but only the JDVC section has **old window ACs**. The old window ACs in JDVC consume **approximately 2.26 kW** of power, while the new 5-star rated inverter ACs consume around **1.3 kW**. Therefore, it is recommended that the college replace all the old ACs with new inverter ACs. There are a total of **15** window ACs installed in the JDVC building, and replacing them with new ACs will result in savings of approximately Rs. **2.5 lakh (17,250 kWh),** with an estimated investment **of Rs. 5.25 lakh**. This will lead to a simple payback period of **25 months**. The estimated savings potential is shown in the table below:

Table 29 Estimated Saving Potential by replacing Old Window AC's in JDVC building with inverter AC

Sr. No.	Particulars	Value
1	Power Consumption of Old O General 1.5 TR Window AC, kW	2.26
2	Total No. of Old AC's	15
3	Power Consumption of Proposed 5 Star Rated AC, kW	1.3
4	**Estimated Energy saving by replacing Old AC with new 5 Star Rated Inverter AC (=2.26-1.3), kW**	**0.96**
5	Estimated Energy Saving after replacement (=0.96*15), kW	14.37
6	Estimated Annual Running Hours, (150*8)	1200
7	**Estimated Annual Energy Saved (=1200*14.37), kWh**	**17,250**
8	Avg. Cost of Power, Rs./ kWH	14.5
9	**Annual Energy Saved, Rs. Lakh**	**2.5**
10	Estimated Cost of 5 Star Rated Window Inverter AC, Rs.	35,000
11	**Total Estimated Investment (=15*35000), Rs. Lakh**	**5.25**
12	Simple Payback Period , Months	25

13. SOLAR PHOTOVOLTAIC (PV)

13.1 INTORDUCTION OF SOLAR ENERGY

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power Colleges and artificial photosynthesis.

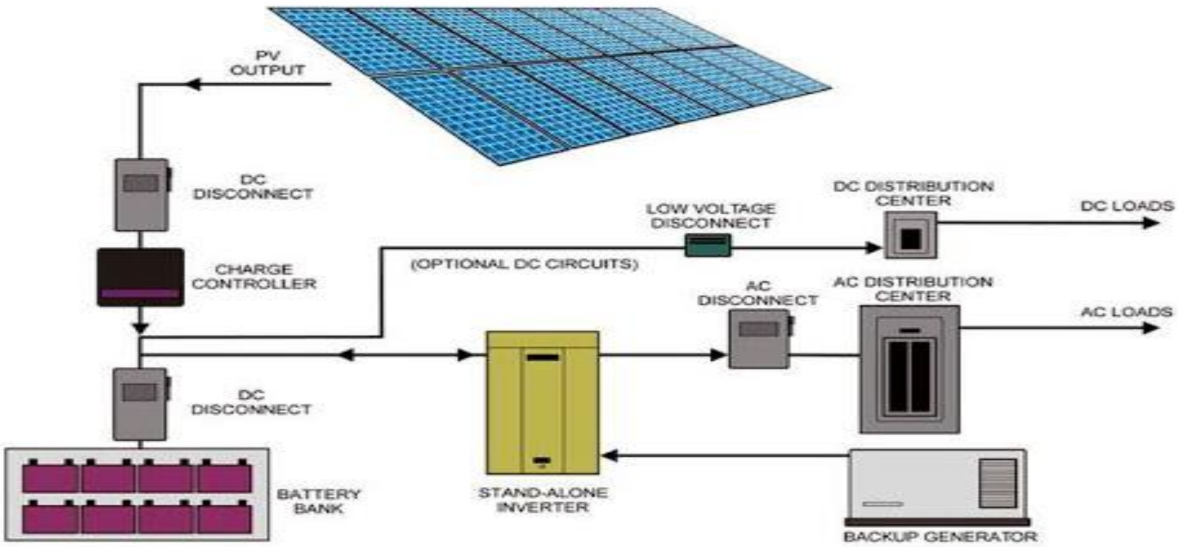
It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.

The large magnitude of solar energy available makes it a highly appealing source of electricity. The United Nations Development Programme in its 2000 World Energy Assessment found that the annual potential of solar energy was 1,575–49,837 exajoules (EJ). This is several times larger than the total world energy consumption, which was 559.8 EJ in 2012. Solar power is the conversion of sunlight into electricity, either directly using photovoltaic (PV), or indirectly using concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light into electric current using the photoelectric effect.

Solar power is anticipated to become the world's largest source of electricity by 2050, with solar photovoltaic and concentrated solar power contributing 16 and 11 percent to the global overall consumption, respectively. In 2016, after another year of rapid growth, solar generated 1.3% of global power.

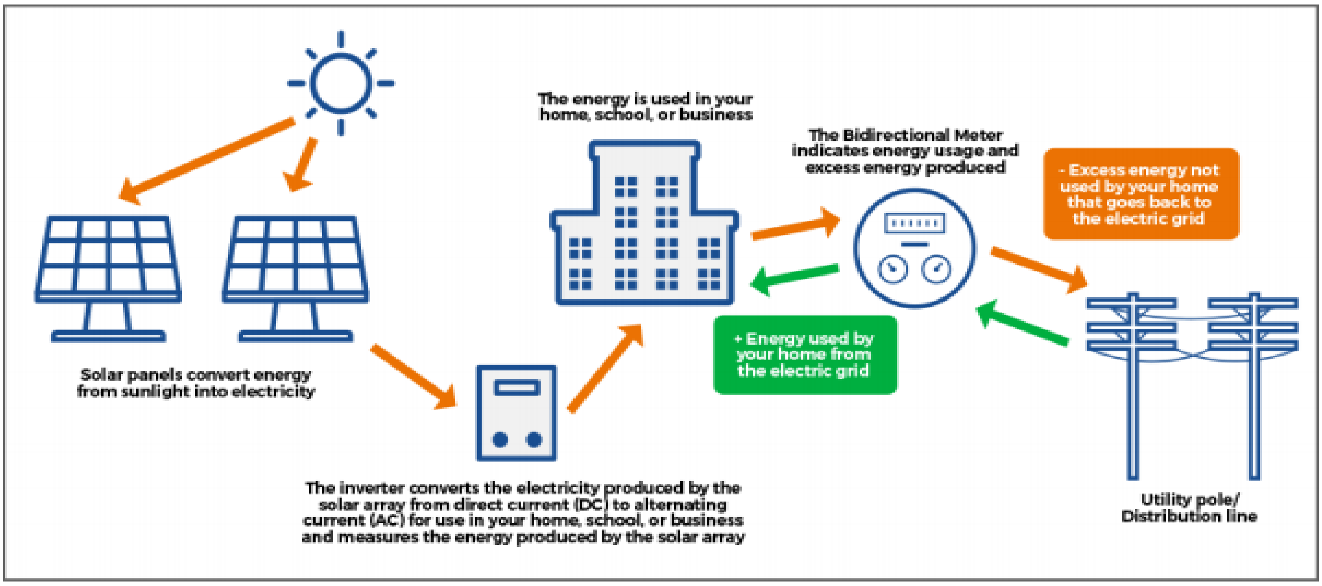
13.2 WORKING OF SOLAR PHOTOVOLTAIC (PV)

When light shines on a photovoltaic (PV) cell, it may be reflected, absorbed, or pass right through it. The PV cell is composed of semiconductor material, which combines some properties of metals and some properties of insulators. That makes it uniquely capable of converting light into electricity. When light is absorbed by a semiconductor, photons of light can transfer their energy to electrons, allowing the electrons to flow through the material as electrical current. This current flows out of these semiconductor to metal contacts and then makes its way out to power your home and the rest of the electric grid.



13.3 Working Of A Grid Connected Solar PV System

A grid-connected photovoltaic system, or grid-connected PV system is an electricity generating solar PV power system that is connected to the utility grid. A grid-connected PV system consists of solar panels, one or several inverters, a power conditioning unit and grid connection equipment. They range from small residential and commercial rooftop systems to large utility-scale solar power stations. Unlike stand-alone power systems, a grid-connected system rarely includes an integrated battery solution, as they are still very expensive. When conditions are right, the grid-connected PV system supplies the excess power, beyond consumption by the connected load, to the utility grid. A schematic diagram of working of a grid-connected solar is given below:



13.4 SOLAR POWER GENERATION

One (1) Solar Rooftop Power Plant of the capacity **50.02 kWP** is installed by the third party and college is purchasing generated electricity at **Rs. 5.30 kWH.** Solar Power generation data is provided by the plant and is shown in below table:

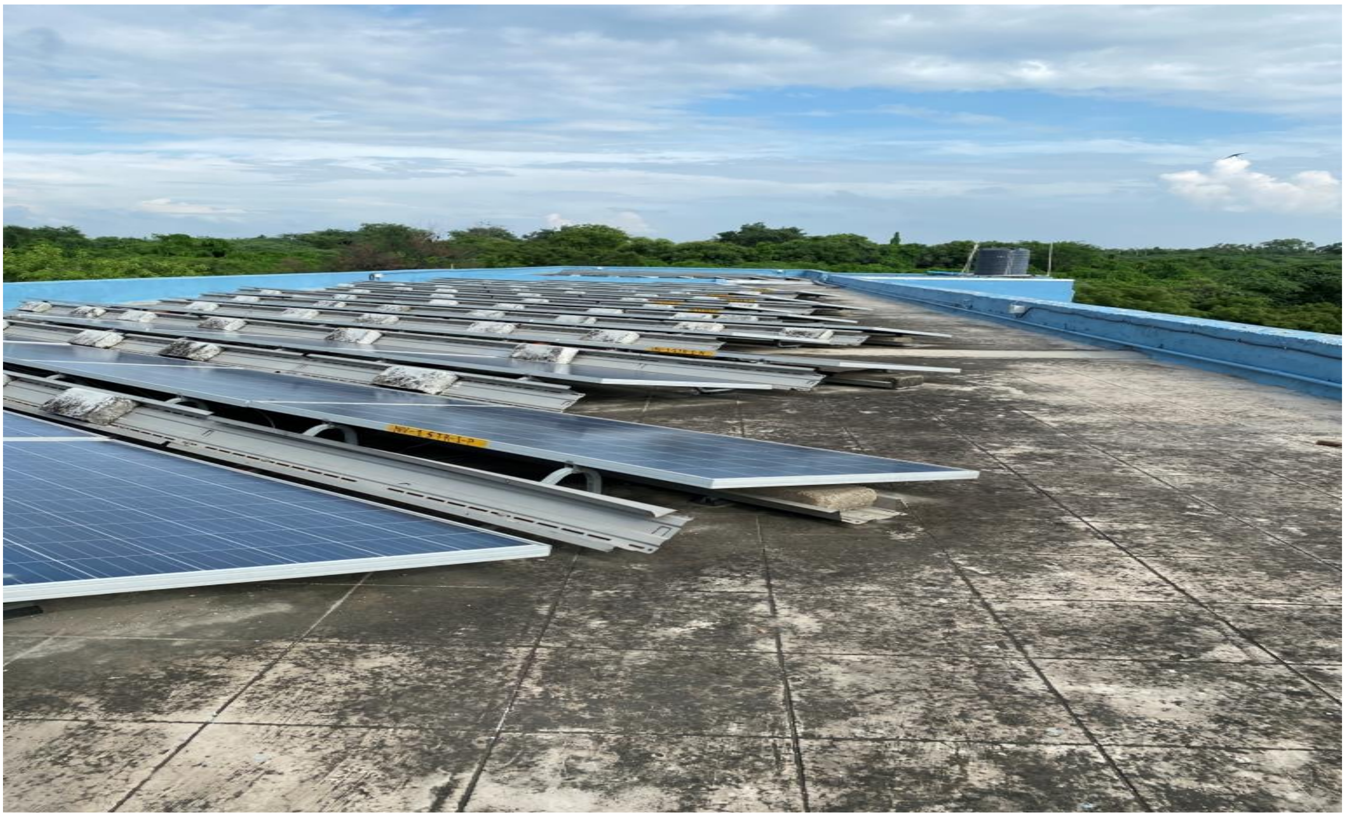


Table 30 Solar Power Generation

Billing Month	Solar Power Generation (kWh)
Jul-23	5012
Aug-23	5927
Sep-23	5622
Oct-23	4666
Nov-23	3376
Dec-23	3195
Jan-24	3574
Feb-24	4703
Mar-24	6365
Apr-24	6511
May-24	6521
Jun-24	5258
Total	**60,730**

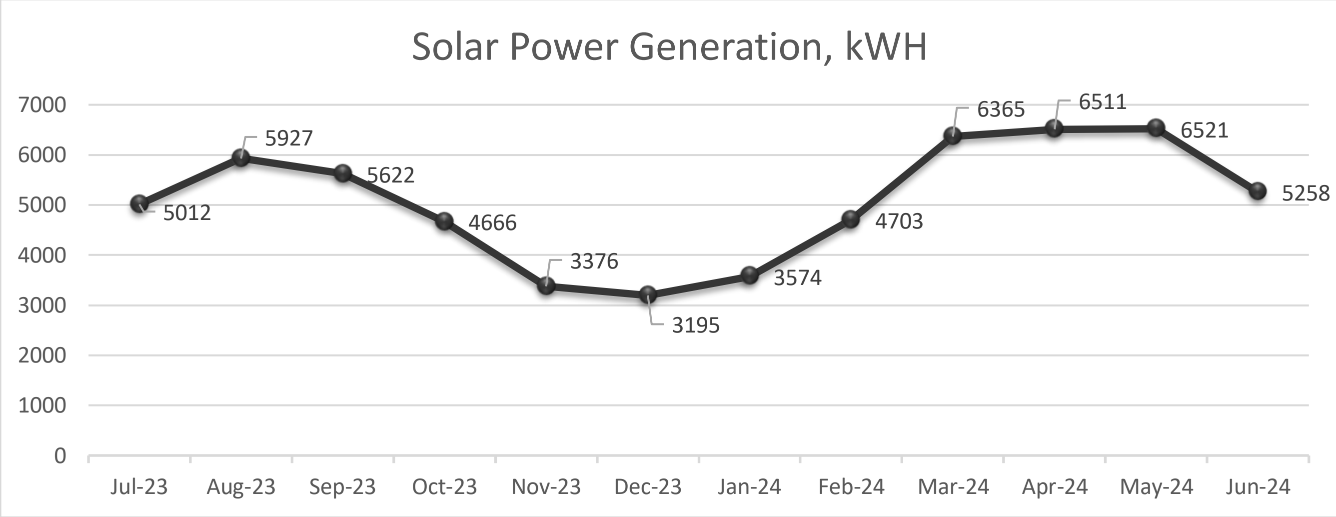


Figure 10 Solar Power Generation, kWH

13.4.1 OBSERVATION AND RECOMMENDATIONS ON SOLAR POWER GENERATION

- **The rooftop solar power plant generated 60,730 kWH** of electricity from **July-2023 to June-2024.** Considering the grid electricity cost of **Rs. 14.5/kWh and Rs. 5.30/kWh** being paid to the third-party vendor for solar power consumption, the college is benefiting by **Rs. 9.2/kWh** when purchasing solar units from the third party. Considering cost of **Rs. 9.2 per kWh**, plant saved approximately **Rs. 5.6** lakh/annum.

13.4.2 PERFORMANCE EVALUATION OF ROOFTOP SOLAR (PLF)

The **Capacity Utilization Factor (CUF)** is a measure of how efficiently a solar power plant or system is being utilized. It represents the ratio of the **actual energy produced** by the system to the maximum possible energy it could have produced if it were running at full capacity all the time. Capacity utilization factor for all the rooftop solar plant has been analysed and is shown in below table:

Table 31 Performance Evaluation/Capacity Utilization Factor of Rooftop Solar

Description	Value
Total Power (kWH) generated for one year (July-23 to June-24)	60,730
Rated Capacity of Rooftop Solar Plant, kWP	50.02
Annual Operating Hours (24 X 365 = 8760)	8760
PLF (Unit/Plant Capacity/R. Hrs.)	**0.14**

- Calculated CUF of the existing rooftop solar system is **0.14.** This indicates that the CUF of the solar panel is **slightly low**. It is always recommended to maintain the PLF at **0.16**, which might indicate factors like shading, inefficiencies, or other operational issues. It is recommended that the college discuss with its vendor to increase the capacity utilization to **0.16**. By doing so, the college could benefit approximately **Rs. 0.86 lakh per annum (9378 kWh)**. The only suggestion is to increase the frequency of cleaning the solar panels. The estimated saving potential is shown in the table below.

Table 32 Estimated Saving Potential by Increasing PLF from 0.14 to 0.16

Particulars	Value
Total Unit (KWH) generated for one year (July-2023 to June-2024)	60,730
Existing Plant Load Factor (July-2023 to June-2024)	0.14
Estimated Solar power generation, considering PLF @ 0.16, kWH	70,108
Estimated Annual Unit Loss if PLF was maintained at 0.16, kWH/annum	**9,378**
Monetary loss as college avg. grid power cost is Rs. 14.5/kWh and Rs. 5.30/KWh for Solar unit consumption from third party. Difference = Rs. 9.2/kWH. Estimated saving if PLF is maintained at 0.16 = (9378 * 9.2)/10^5, Rs./annum	**0.86**

13.5 ROOFTOP SOLAR POWER POTENTIAL AT COLLEGE

The available rooftop spaces have been identified for installing Solar Power Panels. Total **six (6)** locations have been identified where solar panels can be installed. To install a 1 kW solar panel, approximately **10-12 m^2** of free space is required. Approximately **1,307 m^2** of rooftop area is available, where an approximately **100 kWP** solar power system can be installed. The college's hourly average power consumption is **61 kW**, and the average power generation from the rooftop solar plant is **28.1 kW** (data considered from electricity bills from July 2023 to June 2024). Therefore, we recommend that the college install an additional **50 kWP** rooftop solar plant to meet its average power consumption requirements. The average solar power generation and the college's hourly power requirements are shown in the table below.

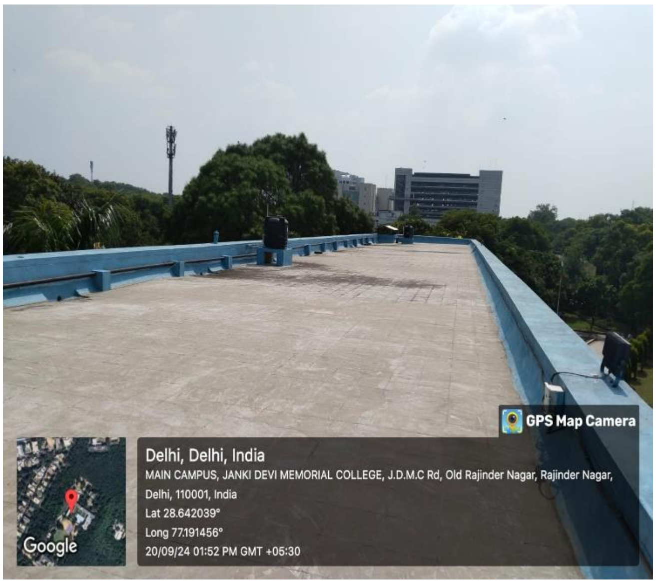
Table 33 Average Hourly Solar Power Generation & College Power Requirement

Billing Month	No. of Days	Total Units Consumed, kWh	Total Solar Unit Generation (kWh)	College Average Power Consumption, kWH/hr	Average Solar Power Generation, kWH/hr
Jul-23	31	47,440	5012	63.8	26.9
Aug-23	31	47,120	5927	63.3	31.9
Sep-23	30	51,260	5622	71.2	31.2
Oct-23	31	36,224	4666	48.7	25.1
Nov-23	30	30,288	3376	42.1	18.8
Dec-23	31	40,056	3195	53.8	17.2
Jan-24	31	40,840	3574	54.9	19.2
Feb-24	28	28,104	4703	41.8	28.0
Mar-24	31	32,640	6365	43.9	34.2
Apr-24	30	53,014	6511	73.6	36.2
May-24	31	69,402	6521	93.3	35.1
Jun-24	30	50,238	5258	69.8	29.2
Total/Average	**365**	**5,26,626**	**60,730**	**60.0**	**27.7**

The estimated energy saving from this installation would be **70,080 kWH/annum (considering PLF of 0.16)**, resulting in an estimated monetary savings of **Rs. 10.2 lakh/annum** with an estimated investment of **Rs. 19 lakh**, resulting in a simple payback period of **22 months**. The **locations**, along with the available roof space, and estimated saving potential are shown in below tables:

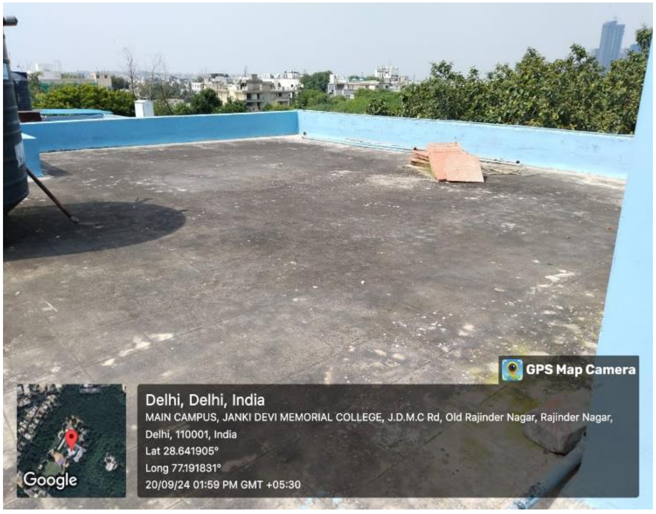
Table 34 Available rooftop area for Solar Installation

Sr. No.	Location	Area (m^2)	Lat	Long
1	JDVC Roof top	240	28.642263°	77.192373°
2	Admin office Roof top	201	28.642039°	77.191456°
3	Class Room roof top area (remaining area)	113	28.641905°	77.191831°
4	Parking near DG	475	28.642555°	77.191553°
5	Mess Roof top	128	28.642312°	77.191643°
6	Auditorium roof top	228	28.641453°	77.192017°
7	**Total Available Rooftop Area**	**1,384**	**-**	**-**

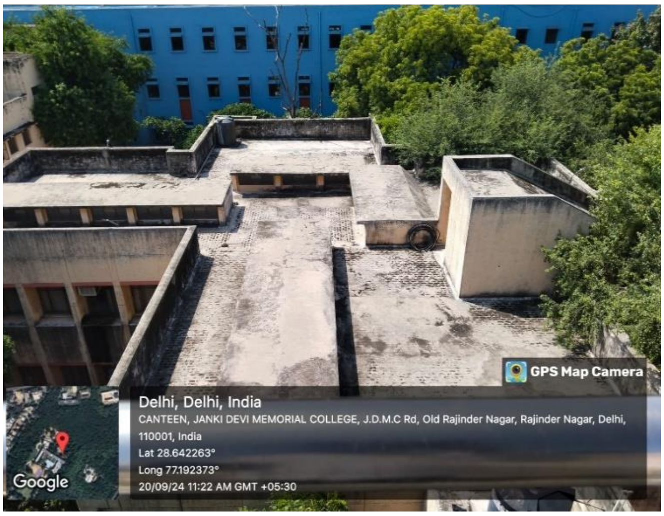


Admin Office Rooftop

Auditorium Rooftop



Class Rooms Rooftop Remaining Area



JDVC Rooftop

Mess Rooftop

Parking Near DG

Table 35 Estimated Annual Energy Saving potential by Installing Solar PV at the Rooftop

Sr. No	Parameter	Unit	Value
1	Proposed Solar Capacity of Plant	kWp	50
2	Estimated Total Area required for 100 kWp (considering 10-12 m2 for 1kWp Solar)	m^2	600
3	CUF/PLF	%	16%
4	**Estimated Annual Power Generation**	**kWh/Year**	**70,080**
5	Cost of Energy Rs./kWH	Rs./kWH	14.5
6	**Estimated Annual Energy Saved**	**Rs. in Lakh**	**10.2**
7	MNRE Benchmark cost (According to the Memorandum published on 21st July 2020)	Rs./kWp	38,000
8	**Initial Cost of Commissioning (Approx.)**	**Rs. in Lakh**	**19**
9	Payback Period	Months	22

While designing the Solar PV Power Plant the following were considered:

- The installation of the Solar Panels on the Shed will require an analysis of the Strength of the Shed. A typical **325 Wp Solar Panel weighs around 20 – 22 kg.** As such strength of the building will play a major role in installation of the panels.

- The orientation of the available area along with its tilt is not considered in the analysis. A thumb-rule outlines that Solar panels are optimum when installed facing South direction with tilt equal to the latitude of the place. As such while installation these two factors too shall play an important role in its feasibility.

14. GENERAL TIPS FOR ENERGY CONSERVATION IN DIFFERENT UTILITIES

14.1 ELECTRICITY

- Schedule your operations to maintain a high load factor
- Minimize maximum demand by tripping loads through a demand controller.
- Use standby electric generation equipment for on-peak high load periods.
- Correct power factor to at least 0.99 under rated load conditions.
- Set transformer taps to optimum settings.
- Shut off unnecessary computers, printers, and copiers at night.

14.2 FANS

- Use smooth, well-rounded air inlet cones for fan air intakes.
- Avoid poor flow distribution at the fan inlet.
- Minimize fan inlet and outlet obstructions.
- Clean screens, filters, and fan blades regularly.
- Use aerofoil-shaped fan blades.
- Minimize fan speed.
- Use low-slip or flat belts.
- Check belt tension regularly.
- Eliminate variable pitch pulleys.
- Use variable speed drives for large variable fan loads.
- Use energy-efficient motors for continuous or near-continuous operation
- Eliminate leaks in ductwork.
- Minimize bends in ductwork
- Turn fans off when not needed.

14.3 PUMPS

- Operate pumping near best efficiency point.
- Modify pumping to minimize throttling.
- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.
- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.
- Use booster pumps for small loads requiring higher pressures.
- Increase fluid temperature differentials to reduce pumping rates.
- Repair seals and packing to minimize water waste.
- Balance the system to minimize flows and reduce pump power requirements.
- Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return.

14.4 HVAC (HEATING / VENTILATION / AIR CONDITIONING)

- Tune up the HVAC control system.
- Consider installing a building automation system (BAS) or energy management system (EMS) or restoring an out-of-service one.
- Balance the system to minimize flows and reduce blower/fan/pump power requirements.
- Eliminate or reduce reheat whenever possible.
- Use appropriate HVAC thermostat setback.
- Use building thermal lag to minimize HVAC equipment operating time.
- In winter during unoccupied periods, allow temperatures to fall as low as possible without freezing water lines or damaging stored materials.
- In summer during unoccupied periods, allow temperatures to rise as high as possible without damaging stored materials.
- Improve control and utilization of outside air.
- Use air-to-air heat exchangers to reduce energy requirements for heating and cooling of outside air.
- Reduce HVAC system operating hoTUV (e.g. -- night, weekend).
- Optimize ventilation.
- Ventilate only when necessary. To allow some areas to be shut down when unoccupied, install dedicated HVAC systems on continuous loads (e.g. -- computer rooms).
- Provide dedicated outside air supply to kitchens, cleaning rooms, combustion equipment, etc. to avoid excessive exhausting of conditioned air.
- Use evaporative cooling in dry climates.
- Clean HVAC unit coils periodically and comb mashed fins.
- Upgrade filter banks to reduce pressure drop and thus lower fan power requirements.
- Check HVAC filters on a schedule (at least monthly) and clean/change if appropriate.
- Check pneumatic controls air compressors for proper operation, cycling, and maintenance.
- Isolate air conditioned loading dock areas and cool storage areas using high-speed doors or clear PVC strip curtains.
- Install ceiling fans to minimize thermal stratification in high-bay areas.
- Relocate air diffusers to optimum heights in areas with high ceilings.
- Consider reducing ceiling heights.
- Eliminate obstructions in front of radiators, baseboard heaters, etc.
- Check reflectors on infrared heaters for cleanliness and proper beam direction.
- Use professionally-designed industrial ventilation hoods for dust and vapor control.
- Use local infrared heat for personnel rather than heating the entire area.
- Use spot cooling and heating (e.g. -- use ceiling fans for personnel rather than cooling the entire area).
- Purchase only high-efficiency models for HVAC units.
- Put HVAC window units on timer control.
- Don't oversize cooling units. (Oversized units will "short cycle" which results in poor humidity control.)

- Install multi-fueling capability and run with the cheapest fuel available at the time.
- Consider dedicated make-up air for exhaust hoods. (Why exhaust the air conditioning or heat if you don't need to?)
- Minimize HVAC fan speeds.
- Consider desiccant drying of outside air to reduce cooling requirements in humid climates.
- Seal leaky HVAC ductwork.
- Seal all leaks around coils.
- Repair loose or damaged flexible connections (including those under air handling units).
- Eliminate simultaneous heating and cooling during seasonal transition periods.
- Zone HVAC air and water systems to minimize energy use.
- Inspect, clean, lubricate, and adjust damper blades and linkages.
- Establish an HVAC efficiency-maintenance program. Start with an energy audit and follow-up, then make an HVAC efficiency-maintenance program a part of your continuous energy management program.

14.5 LIGHTING

- Reduce excessive illumination levels to standard levels using switching, de-lamping, etc. (Know the electrical effects before doing de-lamping.)
- Aggressively control lighting with clock timers, delay timers, photocells, and/or occupancy sensors.
- Install efficient alternatives to incandescent lighting, mercury vapor lighting, etc. Efficiency (lumens/watt) of various technologies range from best to worst approximately as follows: low pressure sodium, high pressure sodium, metal halide, fluorescent, mercury vapor, incandescent.
- Select ballasts and lamps carefully with high power factor and long-term efficiency in mind.
- Upgrade obsolete fluorescent systems to Compact fluorescents and electronic ballasts
- Consider lowering the fixtures to enable using less of them.
- Consider daylighting, skylights, etc.
- Consider painting the walls a lighter color and using less lighting fixtures or lower wattages.
- Use task lighting and reduce background illumination.
- Re-evaluate exterior lighting strategy, type, and control. Control it aggressively.
- Change exit signs from incandescent to LED.

14.6 DG SETS

- Optimize loading
- Use waste heat to generate steam/hot water /power an absorption chiller or preheat process or utility feeds.
- Use jacket and head cooling water for process needs
- Clean air filters regularly
- Insulate exhaust pipes to reduce DG set room temperatures
- Use cheaper heavy fuel oil for capacities more than 1MW

14.7 BUILDINGS

- Seal exterior cracks/openings/gaps with caulk, gasketing, weatherstripping, etc.
- Consider new thermal doors, thermal windows, roofing insulation, etc.
- Install windbreaks near exterior doors.
- Replace single-pane glass with insulating glass.
- Consider covering some window and skylight areas with insulated wall panels inside the building.
- If visibility is not required but light is required, consider replacing exterior windows with insulated glass block.
- Consider tinted glass, reflective glass, coatings, awnings, overhangs, draperies, blinds, and shades for sunlit exterior windows.
- Use landscaping to advantage.
- Add vestibules or revolving doors to primary exterior personnel doors.
- Consider automatic doors, air curtains, strip doors, etc. at high-traffic passages between conditioned and non-conditioned spaces. Use self-closing doors if possible.
- Use intermediate doors in stairways and vertical passages to minimize building stack effect.
- Use dock seals at shipping and receiving doors.
- Bring cleaning personnel in during the working day or as soon after as possible to minimize lighting and HVAC costs.

14.8 WATER & WASTEWATER

- Recycle water, particularly for uses with less-critical quality requirements.
- Recycle water, especially if sewer costs are based on water consumption.
- Balance closed systems to minimize flows and reduce pump power requirements.
- Eliminate once-through cooling with water.
- Use the least expensive type of water that will satisfy the requirement.
- Fix water leaks.
- Test for underground water leaks. (It's easy to do over a holiday shutdown.)
- Check water overflow pipes for proper operating level.
- Automate blowdown to minimize it.
- Provide proper tools for wash down -- especially self-closing nozzles.
- Install efficient irrigation.
- Reduce flows at water sampling stations.
- Eliminate continuous overflow at water tanks.
- Promptly repair leaking toilets and faucets.
- Use water restrictors on faucets, showers, etc.
- Use self-closing type faucets in restrooms.
- Use the lowest possible hot water temperature.
- Do not use a heating system hot water boiler to provide service hot water during the cooling season -- install a smaller, more-efficient system for the cooling season service hot water.

- If water must be heated electrically, consider accumulation in a large insulated storage tank to minimize heating at on-peak electric rates.
- Use multiple, distributed, small water heaters to minimize thermal losses in large piping systems.
- Use freeze protection valves rather than manual bleeding of lines.
- Consider leased and mobile water treatment systems, especially for deionized water.
- Seal sumps to prevent seepage inward from necessitating extra sump pump operation.
- Install pretreatment to reduce TOC and BOD surcharges.
- Verify the water meter readings. (You'd be amazed how long a meter reading can be estimated after the meter breaks or the meter pit fills with water!)
- Verify the sewer flows if the sewer bills are based on them.

14.9 MISCELLANEOUS

- Meter any unmetered utilities. Know what normal efficient use is. Track down causes of deviations.
- Shut down spare, idling, or unneeded equipment.
- Make sure that all of the utilities to redundant areas are turned off -- including utilities like compressed air and cooling water.
- Install automatic control to efficiently coordinate multiple air compressors, chillers, cooling tower cells, boilers, etc.
- Renegotiate utilities contracts to reflect current loads and variations.
- Consider buying utilities from neighbors, particularly to handle peaks.
- Leased space often has low-bid inefficient equipment. Consider upgrades if your lease will continue for several more years.
- Adjust fluid temperatures within acceptable limits to minimize undesirable heat transfer in long pipelines.
- Minimize use of flow bypasses and minimize bypass flow rates.
- Provide restriction orifices in purges (nitrogen, steam, etc.).
- Eliminate unnecessary flow measurement orifices.
- Consider alternatives to high-pressure drops across valves.
- Turn off winter heat tracing that is on in summer.

15. ANNEXURES

ANNEXURE-1 (Air Conditioning Load Area Wise)

Admin Building

Location	Split AC	Window	VRV	Rated TR	Total Power (kW)
Seminar	1	4	1 (12.9kW)	1.5, 13	20.4
Committee	2	0		1.5	3.0
Principal Anty Room	1			1.5	1.5
Admin	2			1.5	3
AO	1			1.5	1.5
SO	1			1.5	1.5
Music	1	1		1.5	3
Staff Room	2	2		1.5	6
PA-1	1			1.5	1.5
Principal OffIce	2			1.5	3
Accounts	1	2		1.5	4.5
PIO		1		1.5	1.5
Department		1		1.5	1.5
Staff & Department Room			2 (8.7 kW)	9.5	17.4
Research Room staff room	1			1.5	1.5
Total	**16**	**11**	**3**		**70.8**

JDVC Building

Room No.	Department	Window Ac	Rated TR	Rated Power
1	CO-ORDINATOR	1	1.5	1.5
2	OFFICE	1	1.5	1.5
3	INTERIOR DESIGNING	1	1.5	1.5
4	COMPUTER LAB-2	1	1.5	1.5
5	COMPUTER LAB-1	2	1.5	3
6	BEAUTY LAB	1	1.5	1.5
7	FASHION DESIGNING LAB-1	2	1.5	3
8	FASHION DESIGNING LAB-2	1	1.5	1.5
9	LIBRARY	1	1.5	1.5
10	TEXTILE DESIGNING	1	1.5	1.5
11	NURSERY TEACHER TRAINING	1	1.5	1.5
12	NURSERY & PRIMARY TEACHER TRAINING	1	1.5	1.5
13	FINE ART	1	1.5	1.5
14	OFFICE MANAGEMENT	1	1.5	1.5
15	DIGITAL MARKETING	1	1.5	1.5
16-a	COOKING LAB	1	1.5	1.5
Total		**18**	**24**	**27**

Hostel Building

Location	Split AC	Window	VRV	Total Power (kW)
Hostel	5	18		34.5

Library Building

Location	Split AC	Window	VRV	Total Power (kW)
Library	5	3	1 (10kW)	24

Other Building

Location	Split AC	Window	VRV	Rated TR	Total Power (kW)
GCR		1		1.5	1.5
Medical	1			1.5	1.5
Audi Control room		1		1.5	1.5
Bank	2			1.5	3
Union Room		1		1.5	1.5
Lab II,III	3	2		1.5	7.5
Server room	2			2	4
Audio Video Room	2			2	4
STA Room	1			1.5	1.5
Sports	1	1		1.5	3
Research Room Lib	3			2	6
Total	**15**	**6**	**0**	**18**	**35**

Lighting Load

(Hostel)

Room No	Round Light (18 Watt)	Tube light (20 Watt)	Fan (70 Watt)	Table Lamp (9 Watt)
1		5	2	3
2		5	2	3
3		5	2	3
4		5	2	3
5		5	2	3
6		5	2	3
7		5	2	3
8		5	2	3
9		5	2	3
10		5	2	3
11		5	2	3
12		5	2	3
13		5	2	3
14		5	2	3
15		5	2	3
16		5	2	3
17		5	2	3
18		5	2	3
19		5	2	3
20		5	2	3
21		5	2	3
22		5	2	3
23		5	2	3
24		5	2	3
25		5	2	3
26		5	2	3
27		5	2	3
28		5	2	3
29		5	2	3
30		5	2	3
31		5	2	3
32		5	2	3
33		5	2	3
34		5	2	3
35		5	2	3
1st Floor Corridor	13			
2nd Floor Corridor	13			
3rd Floor Corridor	13			
4th Floor Corridor	12			
1st Floor Crache R.		2	2	

Room No	Round Light (18 Watt)	Tube light (20 Watt)	Fan (70 Watt)	Table Lamp (9 Watt)
2nd Floor Comm R.		2	2	
3rd Floor Comm.R.		2	2	
4th Floor Comm.R.		2	2	
Total Load (kW)	**0.918**	**3.66**	**5.46**	**0.945**

(Hostel Outer Area)

Area	Focus Light (8 Watt)	Fan (70 Watt)	Tublelights (20 Watt)	Round Light (18 Watt)	Night Bulb (9 Watt)
Hostel Garden	2			6	
Hostel Terrace	1				1
Hostel Outer Area	3	1	1		
Hostel Mess		10	13		
Mess Store Room			2		
Total Load (kW)	**0.048**	**0.77**	**0.32**	**0.108**	**0.009**

(Other)

Area	Focus Light (8 Watt)	Fan (70 Watt)	Tublelights (20 Watt)	Round Light (18 Watt)	Night Bulb (9 Watt)	Bulkhead Light (28 Watt)
Office		1	3			
Gate(Porta Cabin)		2		10	8	8
Reception		2	2			
Asst. Warden Room		1	7			
Common Room		4	8			
Store Room		1	1			
G.F. Corridor		3	7	4		
G. Floor Security Staff Room			1			
Garden Shutter Room			1			
Total Load (kW)	**0**	**0.98**	**0.6**	**0.252**	**0.072**	**0.224**

Admin

Room	LED (20 Watt)	Watt	New Fan (80 Watt)	Watt	Old Fan (120 Watt)	Watt	Total Load, kW
1	4	80		0	4	480	0.56
2	4	80		0	4	480	0.56
3	5	100	1	80	1	120	0.3
4	5	100	1	80	1	120	0.3
5	5	100		0	2	240	0.34
6	3	60		0	2	240	0.3
7 AV	7	140		0	4	480	0.62
8	7	140		0	4	480	0.62
11(ncweb)		0		0		0	0

Room	LED (20 Watt)	Watt	New Fan (80 Watt)	Watt	Old Fan (120 Watt)	Watt	Total Load, kW
12	11	220		0	7	840	1.06
13	11	220		0	7	840	1.06
13A	3	60	1	80	1	120	0.26
14	11	220		0	7	840	1.06
15 A/V	11	220	2	160	5	600	0.98
16 A/V	11	220		0	7	840	1.06
17	4	80	1	80	4	480	0.64
17A	4	80		0		0	0.08
18Tut	2	40	1	80		0	0.12
19Tut	2	40	1	80		0	0.12
20Tut	2	40	1	80		0	0.12
21Tut	2	40	1	80		0	0.12
22Tut	2	40		0	1	120	0.16
23Tut	2	40		0	1	120	0.16
24Tut	2	40		0	1	120	0.16
25Tut	2	40		0	1	120	0.16
26Tut	2	40		0	1	120	0.16
27Tut	2	40		0	1	120	0.16
28Tut	2	40		0	1	120	0.16
29Tut	2	40		0	1	120	0.16
30Tut	2	40		0	1	120	0.16
31Tut	2	40	1	80		0	0.12
32Tut	2	40	1	80		0	0.12
33Tut	2	40		0	1	120	0.16
34Tut	2	40		0	1	120	0.16
35Tut	2	40		0	1	120	0.16
36Tut	3	60	1	80	1	120	0.26
60Tut		0		0		0	0
38	2	40		0	1	120	0.16
39A	6	120	1	80	2	240	0.44
39	5	100		0	3	360	0.46
40 A/V	11	220		0	6	720	0.94
41A	6	120		0	3	360	0.48
41	6	120	2	160	1	120	0.4
42 A/V	8	160		0	5	600	0.76
43	4	80	2	160	1	120	0.36
43A	8	160	1	80	4	480	0.72
56		0		0		0	0
PIO		0		0		0	0
Admin	45	900	9	720	5	600	2.22
Account	8	160	2	160	3	360	0.68
52	2	40	2	160		0	0.2

Room	LED (20 Watt)	Watt	New Fan (80 Watt)	Watt	Old Fan (120 Watt)	Watt	Total Load, kW
53	2	40	2	160		0	0.2
54	2	40	2	160		0	0.2
55	6	120	4	320		0	0.44
NCC	2	40	1	80		0	0.12
57	2	40		0	2	240	0.28
58	3	60		0	1	120	0.18
59	4	80		0	1	120	0.2
44	8	160		0	5	600	0.76
45	8	160		0	5	600	0.76
46	8	160		0	5	600	0.76
47	8	160	1	80	4	480	0.72
48	8	160	1	80	4	480	0.72
49	8	160		0	3	360	0.52
L1-20	3	60		0	2	240	0.3
L2-20	3	60		0	2	240	0.3
L3-20	4	80		0	2	240	0.32
L4-20	2	40		0		0	0.04
corry door lib	5	100		0		0	0.1
Music room		0		0		0	0
1		0		0		0	0
2		0		0		0	0
3		0		0		0	0
Computer Lab		0		0		0	0
I -	18	360	7	560		0	0.92
II -	9	180	9	720		0	0.9
III - AV	16	320	8	640	1	120	1.08
Sports Room	16	320		0	4	480	0.8
Sports Changing	5	100	1	80		0	0.18
61	4	80	2	160		0	0.24
62	4	80	2	160		0	0.24
63	6	120	4	320		0	0.44
64	6	120	4	320		0	0.44
65	12	240	8	640		0	0.88
66 A/V	12	240	8	640		0	0.88
67	12	240	8	640		0	0.88
68 A	12	240	8	640		0	0.88
69 A/V	12	240	8	640		0	0.88
Library	209	4180	15	1200	17	2040	7.42
Principal	4	80		0	3	360	0.44
Committee	10	200	3	240		0	0.44
Seminar		0		0		0	0
Staff Room	53	1060	7	560	5	600	2.22

Room	LED (20 Watt)	Watt	New Fan (80 Watt)	Watt	Old Fan (120 Watt)	Watt	Total Load, kW
Research room	14	280	9	720		0	1
FF Toilet		0		0		0	0
Prta cabin	10	200	4	320		0	0.52
Total	**786**	**15,720**	**158**	**12,640**	**173**	**20,760**	**49.1**

JDVC

Room	Department	Light (20 Watt)	Fan (80 Watt)	Total Load
1	CO-ORDINATOR	2	1	0.16
2	OFFICE	4	2	0.32
3	INTERIOR DESIGNING	6	4	0.56
4	COMPUTER LAB-2	2	4	0.4
5	COMPUTER LAB-1	6	6	0.72
6	BEAUTY LAB	28	4	1.44
7	FASHION DESIGNING LAB-1	4	6	0.64
8	FASHION DESIGNING LAB-2	2	4	0.4
9	LIBRARY	2	4	0.4
10	TEXTILE DESIGNING	4	6	0.64
11	NURSERY TEACHER TRAINING	11	4	0.76
12	NURSERY &PRIMARY TEACHER TRAINING	8	7	0.88
13	FINE ART	9	6	0.84
14	OFFICE MANAGEMENT	6	4	0.56
15	DIGITAL MARKETING	8	7	0.88
16-a	COOKING LAB	7	4	0.6
16-b	TYPING AND SHORTHAND			0
17	MEDIA ROOM	2	1	0.16
18	HALL(COVERED AREA FOR EVENTS)	8	3	0.56
Total		**119**	**77**	**10.9**