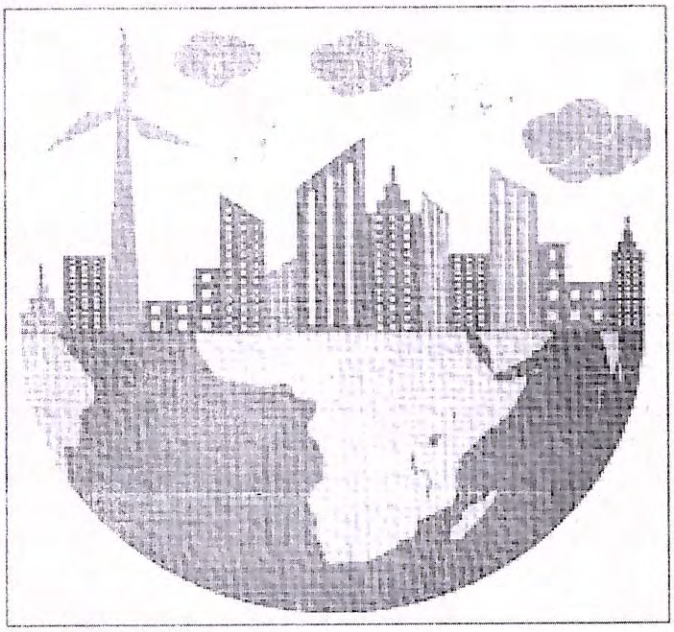
GREEN AUDIT REPORT



2020-21

Submitted to

Hindi Vidya Prachar Samiti's

Ramniranjan Jhunjunwala College of Arts, Science & Commerce

(R.J. College of Arts, Science & Commerce)

Ghatkopar West, Mumbai - 400086

Prepared by

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Ramniranjan Jhunjhunwala College of Arts, Science & Commerce ★ Ghatkopar (W), Mumbai-400 086, INDIA ★ Est. 1963 AUTONOMOUS NAAC Re-accredited 'A' Grade

RU&A ROSHNI UDYAVAR & ASSOCIATES

ARCHITECTURE . INTERIORS . ENERGY . ENVIRONMENT

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Preface

A Green Audit is the first step to reducing a **building's water, waste, energy and carbon footprint and environmental impact.** The analysis of consumption of water and energy as well as generation of waste, is used to provide recommendations on solutions such as rainwater harvesting, water and waste management, energy management including addition of renewable energy. *The objective of the green audit is to transform to be self-reliant and self-sustainable in water and energy and create a zero-waste campus.*

In the long run, such a building will have greatly reduced its operating costs, carbon footprint and impact on the city's infrastructure. Upcoming and future regulations for buildings will require to follow green norms and energy efficient measures including the Energy Conservation Building Code (ECBC). Hence, Green Audits will help buildings to achieve the norms.

The methodology of the Green Audit involves evaluation of the **water, energy and waste** consumption in the building or premises through online surveys, walk-through and detailed audit (where required). The results are analysed against existing Indian and international benchmarks and standards.

An **Environmental Management Plan** is prepared as an outcome of the Audit based on detailed analysis of data collected. This has a potential to reduce consumption of resources through use of appropriate technologies, design and planning without affecting the process or quality of an Institute's functioning. The investment and pay back calculations are provided such that the plan can be implemented in whole or phases as desired.

The benefits of conducting green audit is a better understanding of the building systems, along with recommendations for improvement with a goal of self-reliance in resources and reduce load on public infrastructure.

Through the audit report, our endeavour is to provide cost-effective and long-term solutions in a continuous process of conservation of resources. The data collected over a period of a month has been presented through appropriate visual representations for easy understanding of the technical information. Glossary, abbreviations, units of

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measurements and references are provided for those who are further interested. Any suggestions or edits in the report are welcome and can be sent to roshniudyavar@gmail.com

This Green Audit Report is meant for academic and research purpose only. For legal issues separate study is required, and hence the results of this report cannot be used as evidence for any legal case within India or abroad.



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Acknowledgement

We extend our sincere thanks to Hindi Vidya Prachar Samiti, the Management of Ramniranjan Jhunjhunwala College for taking up the initiative to conduct Green Audit, We are grateful to the Director of Hindi Vidya Prachar Samiti Trust, Dr. Usha Mukudan for her support and enthusiasm in taking up this venture. We acknowledge the initiative of the College, especially Incharge Principal, Dr. Himanshu Dawda, Dr. Bhushan Arekar - IQAC Co-ordinator, Dr Karishma Rajbhar (Green Audit College Co-ordinator), IQAC team in assessing the conduct and feasibility of the green audit.

We extend our sincere thanks to Teaching staff, Vice Principal - Captain Pravin Nayak, Dr. Kiran Kolwankar, Mr. Deviprasad Shetty, and non-teaching staff – Mr. K Somnath, Mr Bahadur Agri, Electrician – Mr Yuvraj and A.C. technician – Jawar electricals for providing us with detailed information for the Audits and their presence during the days of the visit.

We would also like to thank the support staff for their help as and when required during the audit visits.

Green Audit Team

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Abbreviations

- **BEE** - Bureau of Energy Efficiency
- **BLDC** - Brushless Direct Current
- **BUA** - Built up area
- **CFL** - Compact Fluorescent Lamps
- **CMH** - Cubic Meters Per Hour
- **DBT** - Dry Bulb Temperature
- **DEF** - Daylight extent factor
- **DG** - Diesel Generator
- **EER** - Energy efficiency ratio
- **ECBC** - Energy Conservation Building Code
- **ECMs** - Energy Conservation Measures
- **EPI** - Energy Performance Index
- **FTLs** - Fluorescent Tube Lights
- **HT** - High Tension
- **HVAC** - Heating, ventilation, and air conditioning
- **LED** - Light Emitting Diodes
- **LPD** - Lighting Power Density
- **LPG** - Liquefied petroleum gas
- **MNRE** - Ministry of New and Renewable Energy
- **MRT** - Mean Radiant Temperature
- **NAAC** - The National Assessment and Accreditation Council
- **NBC** - National Building Code
- **NCEF** - National Clean Energy Fund
- **PPA** - Power Purchase Agreement

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- **RA CHARGE** - Regulatory Asset Charge
- **RPM** - Revolutions Per Minute
- **RH** - Relative Humidity
- **SEC** - Specific Energy Consumption
- **SECI** - Solar Energy Corporation of India
- **Solar PV** - Solar Photovoltaic
- **TOD** - Time of Day
- **TR** - Tons of refrigeration
- **WBT** - Wet Bulb Temperature
- **WWR** - Window to Wall Ratio

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Units of Measurements

- **C-** Celsius
- **cm -** Centimetre
- **Ft -** Foot
- **H -** Hour
- **kW -** Kilowatt of electricity
- **kWh -** kilowatt-hour
- **kWh/m²/year-** kilowatt per square meter per year
- **kVA -** kilovolt-ampere
- **lm -** Lumens
- **lm/W -** Lumens per Watt
- **lux -** Illuminance
- **m -** Meter
- **mm -** Millimetre
- **W -** Watt
- **W/m² -** Watts per square meter
- **Wh -** Watthour

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Executive Summary 2020-21

The Hindi Vidya Prachar Samiti's Ramniranjan Jhunjhunwala College of Arts, Science & Commerce (R.J. College of Arts, Science & Commerce) premises has an energy consumption of **1,15,133.00 kWh** for the year 2020-2021 as per metered electricity bill. This is almost 50% of the average annual consumption of the college and can be accounted to the lockdown imposed due to the Covid-19 Pandemic. The main areas of electricity consumption are Lighting, Fans, Air Conditioning and Equipment. Of this, **Equipment** load is the highest at **52%** (27,066.00 kWh) followed by **Lighting** load at **25%** (13,193.28 kWh), **AC** at **16%**, (8,164.80 kWh), and **Fans** at **7%** (3,513.60 kWh). Only 10% of the College space is air-conditioned. The building is mostly naturally ventilated with minimal conditioned spaces. The building also has a 10 KWp Solar PV system installed on its terrace which can generate an estimated output of 14.6 Mwh or 7%. Currently this is not being metered by the Utility – Adani.

The Energy Performance Index (EPI) of the building is **13.92 kWh/sq. m/ year** which is well below the Bureau of Energy Efficiency (BEE), Govt. of India's national benchmark of **150 kWh/ sq. m/ year** for institutional buildings in warm-humid climate. The BEE's benchmark for nearly zero energy buildings is **15.00 kWh/sq. m/ year** which is achievable by energy-efficiency measures.

69 % of spaces within the college comply with the maximum allowable Lighting Power Density (LPD) as per the **Space Function method of ECBC 2017**. However, the lighting levels meet the NBC standard in most of the spaces.

The water bill shows that the average monthly consumption is around **2964 KLD** which comes to about **395 KLD** per day which is around 37% less than the standards prescribed by the NBC.

The **organic waste** generated by the college can be composted in the on-site organic waste facility created by them, which can be used as organic fertiliser for gardening. E-waste and Multi-layer plastic (MLP), recycling facility has been provided for collection and an incentive-based credit system has been generated for awareness among the students and faculty.

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The college is adjacent to a major suburban Railway station (Ghatkopar) and like most station areas it is highly congested with noise and air pollution issues. However, the college has made an effort by planting trees in the front open spaces within and outside the college along the compound wall.

A summary of the key recommendations from the green audit are provided in the Table 1 here along with savings, cost and simple payback period.

Key Recommendations for Green Campus at Jhunjhunwala College				
Recommended Measure	**Potential Savings per year (kWh/ Litres)**	**Potential Financial Savings Per year (Rs)**	**Estimated Investment (Rs)**	**Simple Pay Back Period (months)**
Energy				
Replacement of T8 (40W) Fluorescent Tube Lights (FTLs) along with electromagnetic ballast with 18W LED Tube Lights having lumen output of 1800 (efficacy = 100 Lumens per Watt)	**49,222.08**	**6,39,887.04/-**	**3,13,605/-**	6 months
Replacement of T8 (40W) Fluorescent Tube Lights (FTLs)and LED lights with sensor based dimmable lights in passages	**1976.56**	**25695.28/-**	**24750/-**	1 year
Optimization of outdoor lights operation based on Astronomical timer			10,000/-	1 year 2 months
Replacement of regular fans with BEE star rated fans and Brushless Direct Current (BLDC) fans	**14898.24**	**193677.12/-**	**994520/-**	5 years and 2 months
Total	**66,096.88**	**2,19,372.4/-**	**10,29,270/-**	
Water				
Wash basin faucet to water saving aerators	50%	NA		NA
Renewable Energy				
Net metering to be arranged with Utility Adani	NA	NA		NA

Table 1: Key Recommendations for improving environment at Jhunjhunwala College

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1. Introduction

Hindi Vidya Prachar Samiti's Ramniranjan Jhunjhunwala College came into existence in 1963, enabling a larger section of the society to take advantage of the facilities provided for higher education. From 1999-2000 the College has added a number of self-financing courses like BMS, B.B.I, B.Sc. in C.S., I.T., Biotechnology, M.Sc. in Computer Science and Biotechnology which further hone the special skills of the students. In 2014 they started skill-based program supported by University Grants commission known as Bachelor in Vocation.

The college has been reaccredited with 'A' Grade by NAAC in 2014 with a CGPA 3.50 and received the Best College Award (2007-2008) of the University of Mumbai. The College has been bestowed with IMC **RAMKRISHNA BAJAJ PERFORMANCE EXCELLENCE TROPHY, 2010.** The principal of the college was awarded **"Best Teacher"** by Government of Maharashtra in 2011. Government of Maharashtra conferred the college with **"JAAGAR JAANIVANCHA"** (First in Mumbai Suburban- in 2013 and second in Mumbai Suburban- in 2014) for safety of girls.

The College has been granted Autonomous Status by University Grants Commission (UGC) for a period of Ten Years w.e.f. 2018-2019 to 2027-2028. However, the college will remain affiliated to University of Mumbai with an autonomous status.

The College has been awarded **Certificate of Responsible Recycling** by E-Incarnation Recycling Private Limited (for E-waste Management) and **Safai Bank of India** by the Kulkarni Foundation (for Multi-layer plastic Management (MLP)) for proactively contributing to the waste management. They have devised a module in which students are given credits for the amount and size of MLP they collected. They also have compost pit for leaf and canteen waste (Wet waste).

The college has also QR code all the trees on the campus, to create awareness about the types of trees and their benefits amongst the students and the visitors.

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1.1 Objectives of the Green Audit

The objective of the green audit are as follows

- Quantify energy, water and waste consumption;
- Identify energy saving opportunities resulting in lowered energy bills, less use of fossil fuel-based energy and lower carbon footprint;
- Identify wastages in use – and devising solutions such as smart / automated equipment to reduce consumption;
- Introduction of renewable energy to reduce operational energy cost (if required)
- Introducing measures to reduce water consumption and optimise rain water harvesting potentials.
- Suggesting measures to waste management.

1.2 Scope of Work

Energy:

- Overview of existing facilities and electric appliances (lights, fans, heater, air conditioner etc.), operating system like electrical distribution system, metering system, tariff, electricity and Power consumption etc. by use of appropriate instrumentation.
- Establishing a baseline of energy consumption and identify major causes of low operating efficiency and recommended improvements / better operating practices.
- Summary of findings and recommendations and energy conservation measures (ECMs)
- Assessment of Building Envelope energy efficiency and possible retrofit solutions
- Estimation of the costs associated with the implementation of each of the proposed energy conservation measure (ECMs).
- Quantifying the extent of energy savings / performance improvement that can be achieved by upgrading and/or replacing the existing electrical appliance with the best efficiency electrical appliance available in the market and other energy efficiency / conservation measures based on the analysis of the measurements.
- Scope of renewable energy applications

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Water:

- Data collection on water usage, storage capacity, daily consumption patterns, infrastructure and equipment.
- Data analysis to provide scope of improvement in water usage.
- Solutions for rainwater harvesting – storage or ground water recharge
- Possibility of waste water (black or grey water recycling)

Solid Waste:

- Survey of waste in the premises – categorization and quantification
- Analysis and research on possible methods of waste disposal and treatment (of organic waste)
- Solutions for recycling – E-waste and recyclables

Environmental Quality:

- Assessment of IEQ - Visual, Thermal and Acoustic comfort, IAQ (Ventilation)
- Survey of noise and vegetation in the premises – levels and extent
- Analysis and possible solutions to reduce the noise levels and enhance the greenery and biodiversity within the campus

1.3 Understanding of the Audited Area

The total built up area of **89,018 sq. ft. (8270 sq. m)**, is considered for the audit, was evaluated on the basis of existing drawings, information as well as on-site measurements as this forms the basis of assessment of the energy, water and waste consumption with respect to existing benchmarks.

The campus basically includes 2 buildings namely the school building and College building having Ground to sixth floors. The audit was conducted for college building only.

Categorization of the spaces as administrative spaces (offices, staff rooms, etc.), common spaces (Toilets, storage, common classrooms, library, etc.), circulation spaces (staircases,

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corridors) and conditioned vs. non-conditioned spaces (classrooms and computer labs) was then carried out.

The analysis shows that 26% of the total built up area of the college are for common passage. The college building has classrooms for Junior and Senior Degree college, computer labs, admin offices, staff rooms, conference rooms, auditorium, library, common passages, staircase, lift etc.

The description of facilities and activities on each floor are given in Table 2 :

S. No.	Floor	Name of the Facility
1	Ground Floor	Chemistry labs, Gymnasium, Canteen, Seminar Hall Toilets
2	First Floor	Accounts office, Principal's cabin, Conference room, Girls common room, Classrooms, Biology labs, Toilets
3	Second Floor	Classrooms, Staffroom, Physics labs, Toilets
4	Third Floor	Computer lab, Library, Classroom, Biotechnology lab, Toilets
5	Fourth Floor	Staff room, Class room, Maths's lab, Toilets
6	Fifth Floor	Statistics lab, Classrooms, Staff room, Toilets, computer lab
7	Sixth Floor	Classrooms, Staff room

Table 2: Floor wise facility distribution in the college

Some sample photographs taken during the audit showing different spaces and equipment are provided in the following pages.

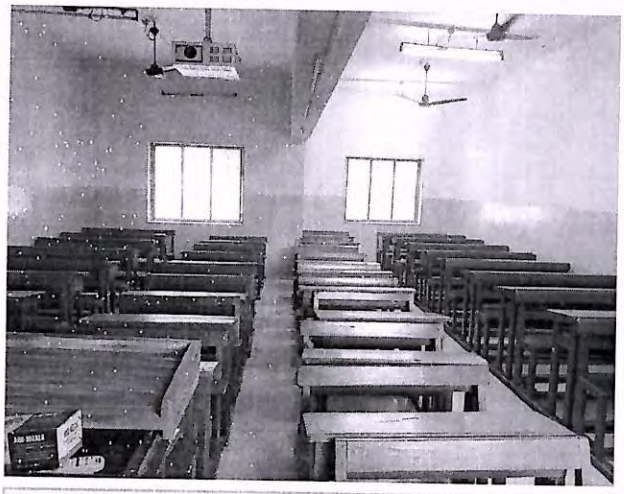

Plate 1 : Fourth floor classroom



Plate 2 : Library

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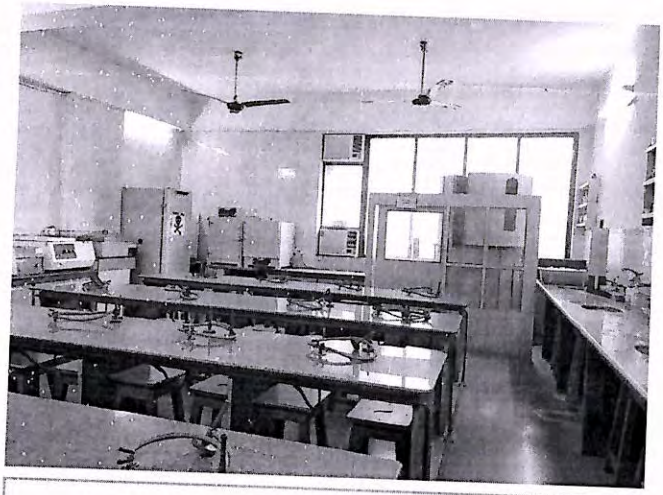

Plate 3 : Biotechnology lab



Plate 4 :Staffroom



Plate 5 : Chemistry lab

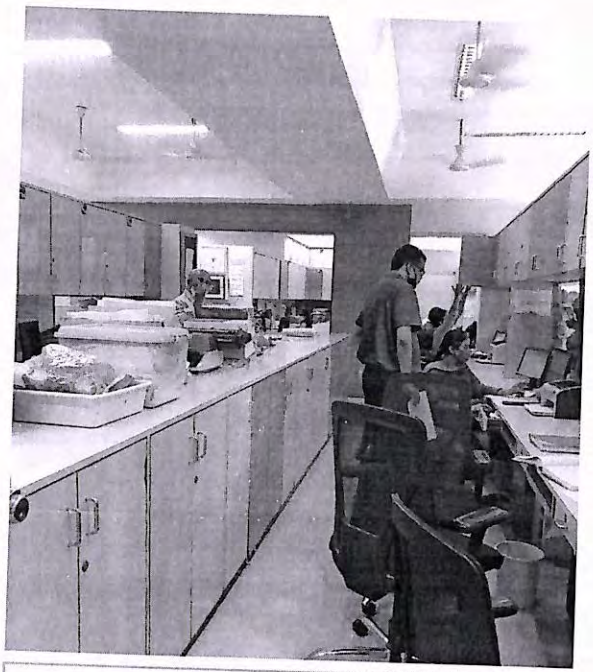

Plate 6 :Office area

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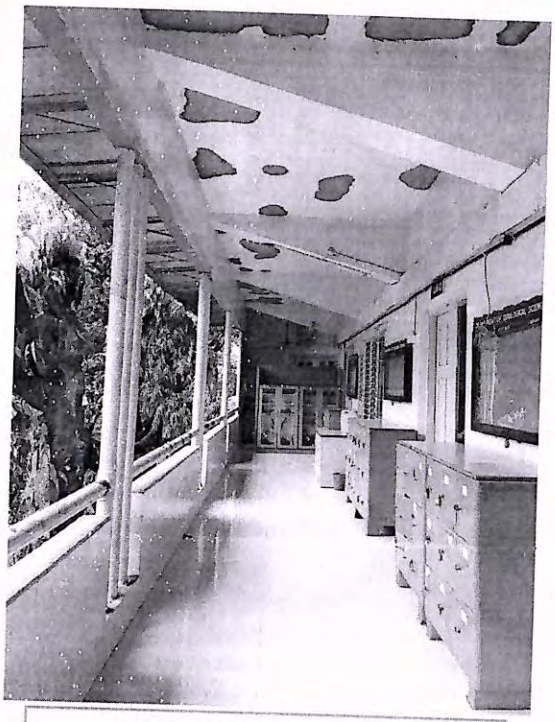

Plate 8 : First floor Corridor



Plate 7 :Staircase mid landing and flight



Plate 9:Drinking water cooler in corridor corner



Plate 10 : Lab

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2. Audit Methodology

Five steps involved in the audit process are as follows:

Step	Objective	Activities
Step 1	Audit of historical data	• Online data collection • Building drawings, utility bills
Step 2	Screening survey or walk-through audit	• Random check of inventory of all electrical and electro-mechanical devices including lights, fans, motors, pumps, ACs, water equipment, • Inspection of site for water, waste and environment information
Step 3	On-site investigations	• Verification of online data submitted through ground survey and observations • Measurement of various equipment efficiencies, specific power consumption (SPC) kW/TR of equipment w.r.t. manufacturer's data. • Monitoring of actual energy consumption of AC and other electrical loads • Observe operation of equipment and evaluate their performance w.r.t. manufacturer's data • Conduct random lighting audit of habitable spaces and compare with National Building Code (NBC) 2016 standards. • Study of air conditioning loads and performance • Study of power system and performance • Study of illumination system – LUX levels, Lighting Power Density (LPD) • Inspection of water, waste and environmental issues including flooding, stormwater system
Step 4	Data Analysis	• Analysis of all criteria and comparison with standards and benchmarks • Recommendations
Step 5	Documentation and Report	• Preparation of detailed report with documentation, calculation and all technical information, summary and recommendations

Table 3: Steps in the Green Audit

A diagrammatic representation of the methodology is provided in the flow chart below:

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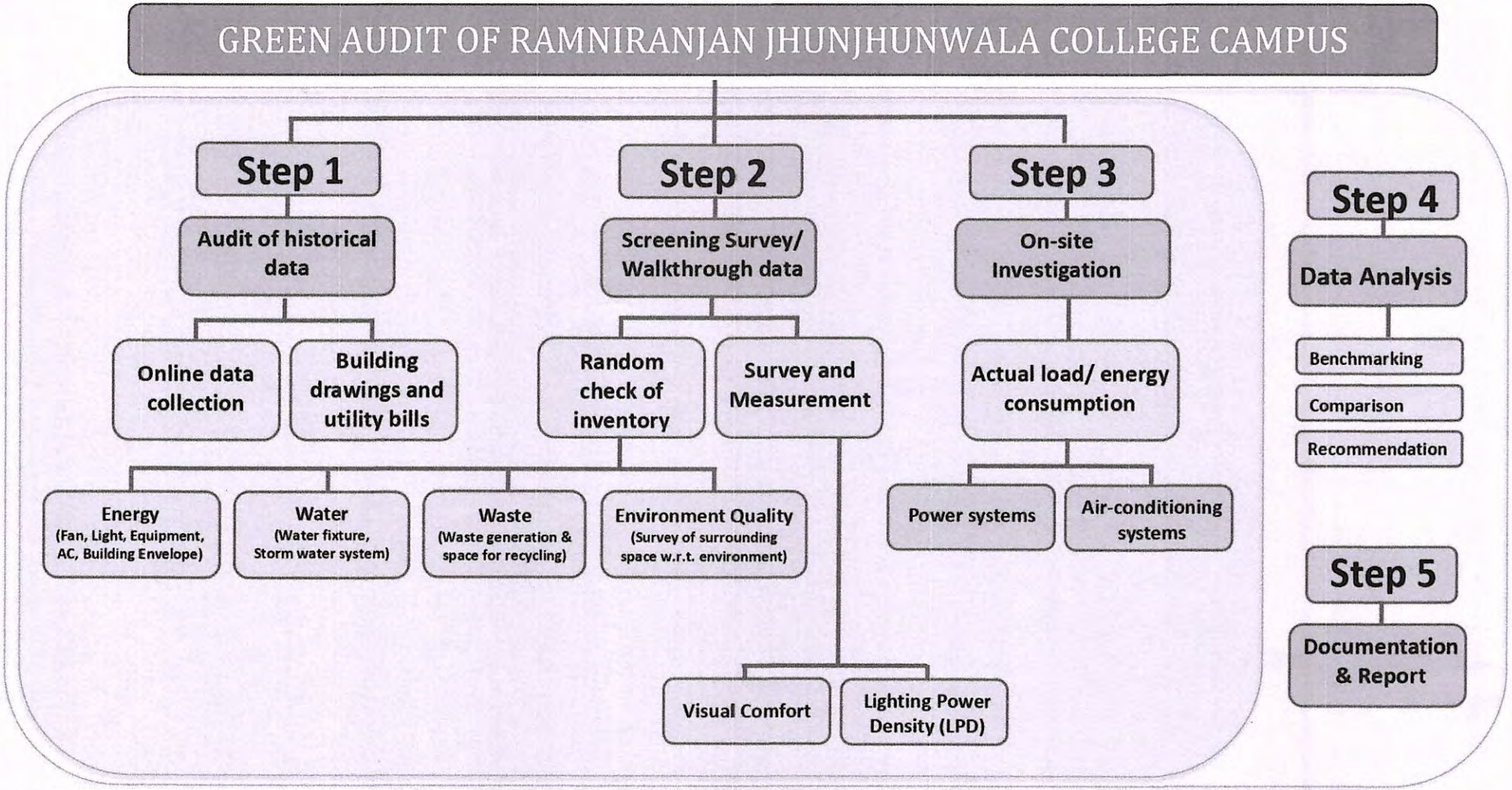

Figure 1: Methodology of the Green Audit at Jhunjhunwala College

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2.1 Data Collection

General Data collection such as year of establishment of college, number of students and staff, inclusion and exclusion of spaces and equipment for the audit were obtained through one-to-one interviews and discussions with key informants who also assisted in the collection of building drawings and electricity bills for the past 3 years (2018 to 2020).

Walk-through Audit

A walk-through Audits were conducted by the Team which were followed up by a few more visits to review the accuracy of data. Special guided visits of the campus were conducted along with Dr Usha Mukundan, IQAC member and Mr K Somnath.

Detailed Audit and Measurements

Detailed audit of the air conditioning system (window and spit units) as well as the electrical system was conducted by BEE certified energy auditor team. The indoor and outdoor units of the AC's were tested for refrigerant flow and pressure, refrigerant temperature, actual energy consumption and cooling capacity. These are elaborated in section 3.1.3 and compared with standards in the analysis section.

The energy audit study was carried out during lockdown period, and hence the building had limited occupancy and load on the systems, as only administrative staff was present in the college. For the audit purpose, some of the air-conditioning systems were switched ON to generate load on the system. Below are some pictures of the detailed audit in process.

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Plate 11 : Audit of AC in process



Plate 12: Audit of AC in process



Plate 14: Audit of AC in process

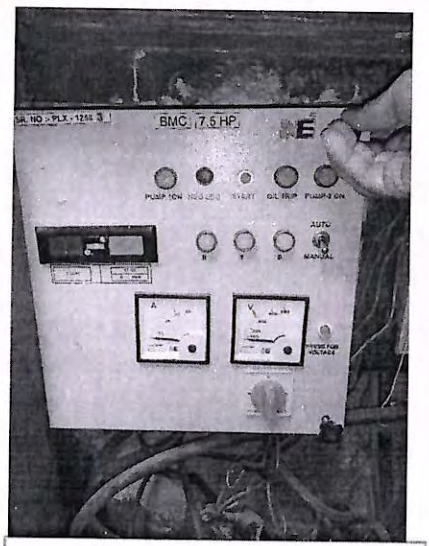

Plate 13: Audit of pump in process

Observation Check-list was used during the walk-through audits to gather information on location of windows, Window Wall Ratio (WWR), number and type of lights, fans, air conditioners and equipment.

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Instruments Used

For the energy audit, the following instruments were used:

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Instrument	Name
	Clamp – on type Power/Energy meter
	Clamp On Earth Tester Meggar Make.
	Thermal Imager Fluke Make Tis-10 Series.
	Anemometers – to measure velocity of gases Luthron Make.
	Digital Thermometers for liquid /surface temperature.

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	Lux meter Luthron Make.

Table 4: Instruments used for the study

Measurement of Illuminance

Lux levels were measured at 40 different spaces by using a Lux Meter over a grid of 9 points measured at working plane height with artificial light between 1100 to 1700 hours. The average reading was then compared with the mid-point reading of the recommended levels in the National Building Code, 2016.

Schedule of Data Collection

S. No.	Audit Activity	Person	Date
1.	Online data form link provided to college	Dr. Roshni U. Yehuda	03.06.2021
2.	Online data submission	Dr Usha Mukundan	27.07.2021
3.	Walk through and detailed audit	Ar. Twishi Shah	25.08.2021
4.	Detailed audit of air conditioning, meters and power systems	Mr. Mahesh Harad Mr. Aseem	25.08.2021 and 26.08.2021
5.	Detailed audit of Solar PV panels	Dr. Roshni U. Yehuda Mr. Rumi Engineer	27.09.2021

Table 5: Schedule of data collection based on actual visits

2.2 Data Analysis

The collected data was analysed and visually represented using pie-charts, bar graphs, tabulations in each of the audit areas. They were assessed against existing benchmarks and standards such as Energy Performance Index (EPI), Lighting Power Density (LPD) as per ECBC 2007, appropriate illuminance levels (Lux) for visual comfort, and Specific Energy Consumption (SEC) as specified by National Building Code 2016, Window Wall Ratio (WWR) and several others.

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Calculation of Wattage

Wattage of lights, fans, AC and equipment were made on the basis of data submitted online by the college verified through random survey during on-site investigation. The complete consolidated data is provided in the Annexure A.

Information on Population and Area for Energy Performance Index (EPI) and Specific Energy Consumption (SEC)

Information on number of people using a specific space was obtained from the online questionnaire and interpolated to obtain occupancy for fresh air calculations. For area calculations, total built up area provided in online questionnaire and building drawings were utilized. As per online data submitted, approximate total population of the college is **6950 persons.** This will be used for SEC calculation. The total built up area of the college considered for EPI is **89,017.54 sq. ft. (8270 sq. m).**

Sr no.	Category	No. of Person
1	Students	6666
2	Teachers	134
3	Non-Teaching Staff	125
4	Administrative Staff	25
Grand total		**6950**

Table 6 : Break up of total population of college

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3. Analysis and Benchmarking

3.1 Energy

3.1.1 Overall Energy Consumption

The overall electricity load at Jhunjhunwala College can be divided among four major sections viz. Lights, Fans, Air conditioners and Equipment. The break-up of energy consumption among the four major contributors end-use-wise, floor-wise and as per connected load is shown in Figure 2, Figure 3, and Figure 4 respectively.

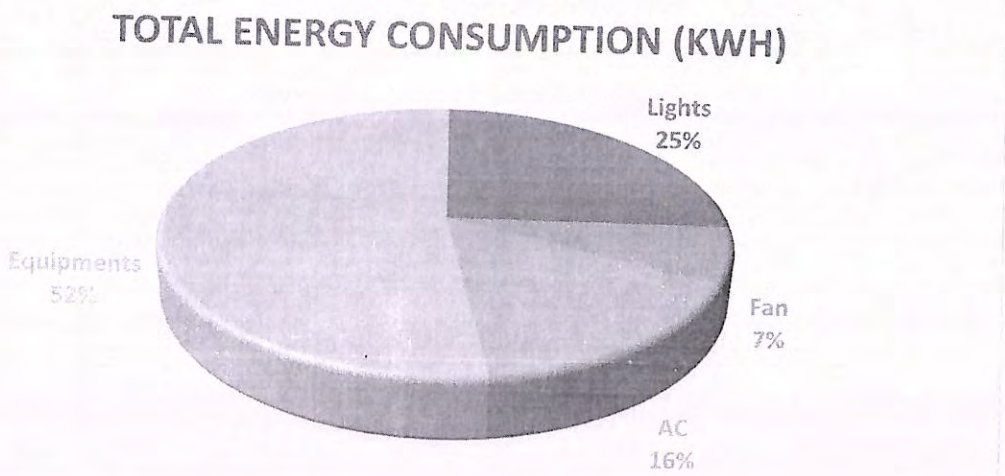

Figure 2: Distribution of Annual Energy Consumption based on end use

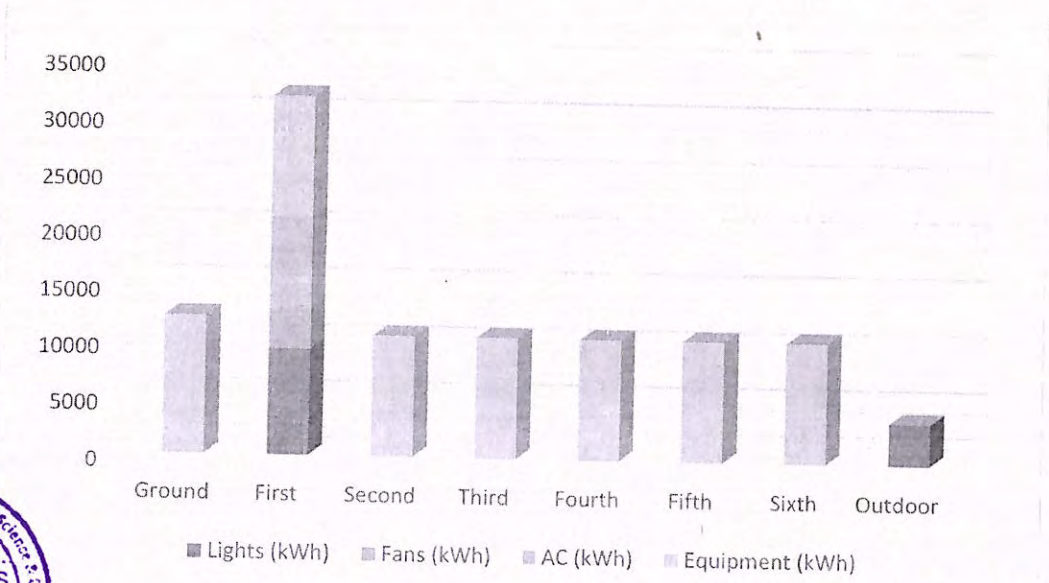

Figure 3 :Distribution of Annual Energy Consumption Floor-wise

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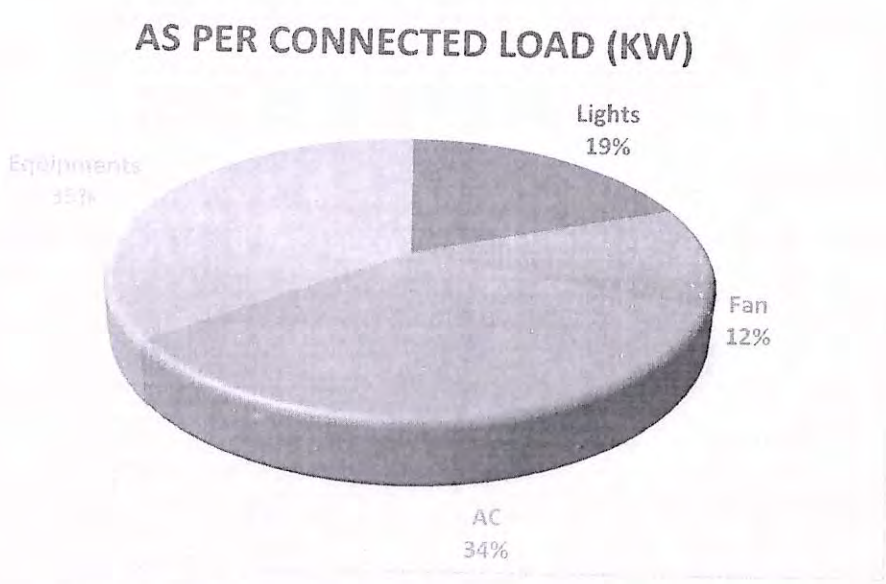

Figure 4 : Distribution of Annual Energy Consumption as per Connected Load

3.1.1.1 Summary of observations – overall energy consumption:

1. The total calculated annual energy consumption of the campus is **51,937.68 kWh.**
2. The total billed electricity for the college for June 2020 to May 2021 is **1,15,133 kWh.**
3. Diversity factor is **0.45**
4. The contribution of **Equipment is 27,066 kWh (52%), Lights is 13193.28 kWh (25%), AC is 8,164.80 kWh (16%),** and **Fans is 3,513.60 kWh (7%)**
5. As per the total connected load, contribution **of Equipment is 34%, AC is 34%, Lights is 19% and Fan is 12%.**
6. **The total conditioned area in the college is 12%** while the overall **AC load corresponding to this conditioned area is 19%**
7. The floor-wise consumption shows that only first floor had majority consumption as compared to all other floors. This was mainly due to the Covid-19 Pandemic, as the college was not fully functional and only the administration and research areas were functioning.
8. The Jhunjhunwala College has office area, conference room, principal room, computer labs which are fully air conditioned and have high number of computers and lights. Most spaces are unconditioned including the passages, classrooms.

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9. **Circulation spaces** i.e. corridors and staircases, attribute to 26% **of the area while consuming minimal energy**. Circulation spaces are also naturally ventilated with a parapet wall.

3.1.2 Lighting Energy Consumption

3.1.2.1 Artificial lighting

Artificial lighting contributes to **25% of the total consumption** in Jhunjhunwala College – mainly due to the use of non-LED tube lights and longer duration of usage (due to working in 3 shifts). The types of lamps used in the campus are shown in Fig. 5. The number and wattage of lamps used is shown in Table 7.

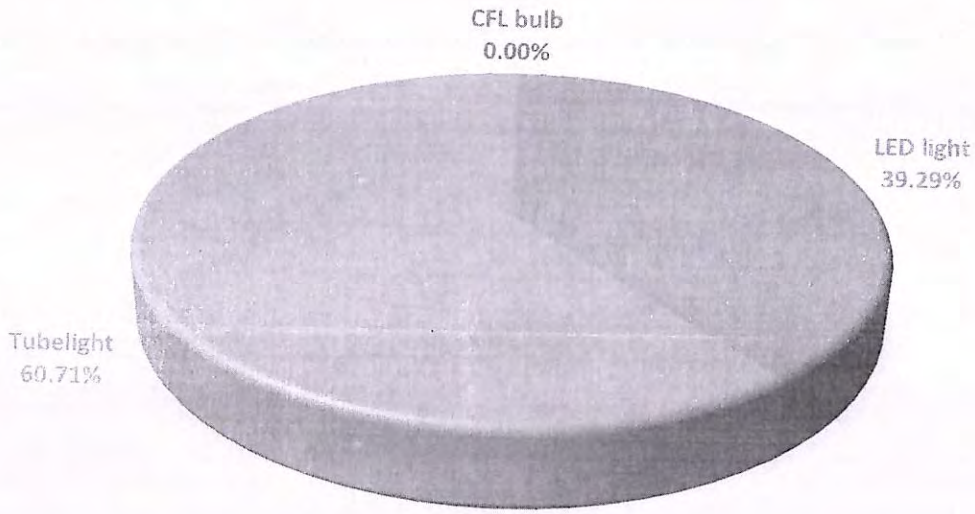

Figure 5: Types of lights and their wattage

S. No.	Lamp Type	Approximate wattage per lamp (W)	Numbers	Total Consumption (kWh)
1.	Tubelight	54	909	8009.28
2.	CFL	18	4	0
3	LED	24	308	5184

Table 7: Number and kWh distribution of all Lights

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12	Fourth Floor	Research Lab. DST	160	200 – 300 - 500	No
13	Fourth Floor	Statistics Lab	154	200 – 300 - 500	No
14	Fourth Floor	Room-44	180	200 – 300 - 500	No
15	Fourth Floor	Room-36 BBI	210	200 – 300 - 500	Yes
16	Fourth Floor	BMS Room	220	200 – 300 - 500	Yes
17	Fifth Floor	Room-55	230	200 – 300 - 500	Yes
18	Fifth Floor	Room-56	205	200 – 300 - 500	Yes
19	Fifth Floor	Computer Science Lab 3	270	200 – 300 - 500	Yes
20	Fifth Floor	Lab-2 Bsc 5th Flr	280	200 – 300 - 500	Yes
21	Fifth Floor	Lab-2 Bsc 5th Flr	195	200 – 300 - 500	No
22	Fifth Floor	Staff Room 5th Flr	330	200 – 300 - 500	Yes
23	Fifth Floor	Lab-1 5th Flr	320	200 – 300 - 500	Yes
24	Fifth Floor	It Staff Room	340	200 – 300 - 500	Yes
25	Fifth Floor	It Lab-1 5thflr	305	200 – 300 - 500	Yes
26	Fifth Floor	It Lab-2 5thflr	295	200 – 300 - 500	Yes
27	Fifth Floor	Room 53	280	200 – 300 - 500	Yes
28	Fifth Floor	Room 54	270	200 – 300 - 500	Yes
29	Fifth Floor	Room 55	264	200 – 300 - 500	Yes
30	Sixth Floor	Staff Room	380	200 – 300 - 500	Yes
31	Sixth Floor	Room 63	280	200 – 300 - 500	Yes
32	Sixth Floor	Computer Lab	320	200 – 300 - 500	Yes
33	Second Floor	Studio	350	200 – 300 - 500	Yes
34	Fourth Floor	Staff Room	340	200 – 300 – 500	Yes
35	First Floor	Trust Office 1st Floor	290	200 – 300 – 500	Yes
36	First Floor	Conference Room	310	200 – 300 – 500	Yes
37	First Floor	Principal Office	285	200 – 300 – 500	Yes

Table 11: Summary of lux levels comparison with NBC

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Sr. No.	Lamp Type with Wattage	Efficacy Range (Lumens/ Watt)	Rated Life (Hours)	EOL Toxic effects
1.	Fluorescent Tube Lights (T12 & T8)	34 – 57	5000-10000	Mercury
2.	Compact Fluorescent Lamps	25 - 70	10000	Mercury
3.	Light Emitting Diode	60 - 76	Upto 50000	NIL
4.	Incandescent Halogen filament (low voltage)	31 – 35	2000-3000	NIL
5.	Incandescent Tungsten filament	6 – 15	1000	NIL

Table 10: Comparative efficacies and environmental impacts of lamps

3.1.2.4 Wall Window Ratio and Day lighting

The overall **Wall to window ratio (WWR) is observed to be 25%.** During detail energy audit, Daylight was measured in some rooms randomly, to verify weather lighting level are in accordance to NBC.

The results of the survey of Lux levels are shown below:

Sr. No	Floor	Space	Lux	Lux level as per NBC	Is the LUX level matching with standard? Yes/ No
1	Ground Floor	Chemistry Staff Room	210	200 – 300 - 500	Yes
2	Ground Floor	Seminar Hall	220	200 – 300 - 500	Yes
3	Ground Floor	Gymkhana	210	200 – 300 - 500	Yes
4	Ground Floor	Store Room	205	200 – 300 - 500	Yes
5	Second Floor	Physics Lab 2	215	200 – 300 - 500	Yes
6	Third Floor	Maths Lab	216	200 – 300 - 500	Yes
7	Third Floor	English Lab	198	200 – 300 - 500	No
8	Third Floor	Biotechnology Lab	205	200 – 300 - 500	Yes
9	Third Floor	Microbiology lab	215	200 – 300 - 500	Yes
10	Third Floor	Library	230	200 – 300 - 500	Yes
11	Fourth Floor	Staff Room	180	200 – 300 - 500	No

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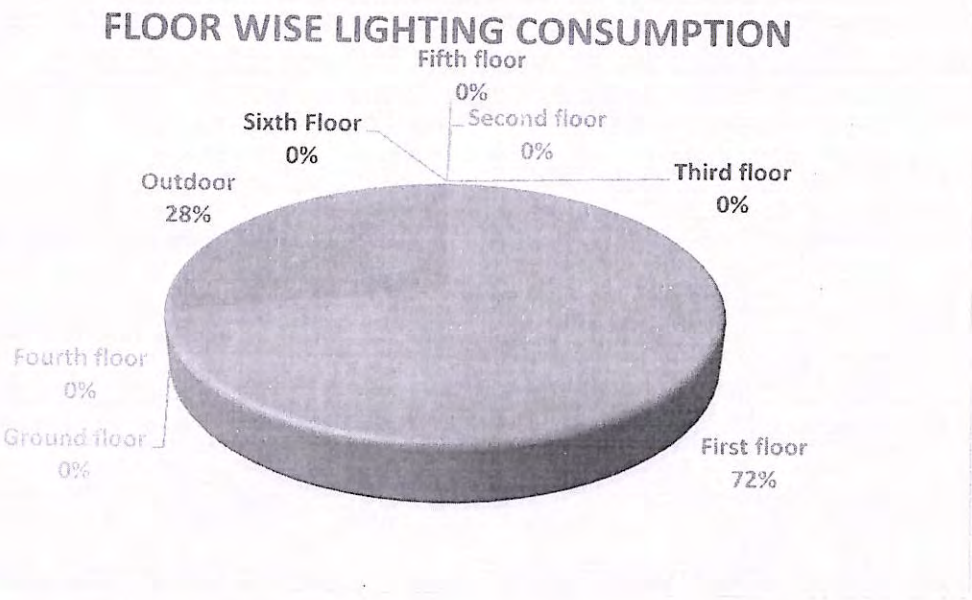

Figure 6: Percentage breakup of Floor-wise Annual Energy Consumption of Lights

Sr no	Floor	Sum of Total usage kWh/year
1	Fifth floor	0
2	First floor	9460.8
3	Fourth floor	0
4	Ground floor	0
5	Second floor	0
6	Sixth Floor	0
7	Third floor	0
8	Outdoor	3732.48
	Grand Total	13193.28

Table 8: Total floor-wise Light Consumption (kWh)

3.1.2.2 Lighting Power Density (LPD)

The Energy Conservation Building Code 2017 defines Lighting Power Density (LPD) as the maximum lighting power per unit area of a space as per its function or building as per its classification.

LPD is a benchmark for the maximum allowable light per unit area provided in the ECBC 2017 and has been used here to compare with the lighting power allowance of each area

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in the college. The LPD using the 'Space Function Method' for some important activity areas has been calculated and compared with ECBC 2017 in Table 9.

S. No.	Space	LPD as per ECBC 2017 (W/sq. m)	Calculated LPD (W/sq. m)	Meeting with ECBC Standard
1.	Library – reading Area	10.00	10.14	Yes
2.	Classroom	13.8	9.11	Yes
3.	Lab- Physics, chemistry	15.1	8.5	Yes
4.	Computer lab	15.1	17.18	No

Table 9: LPD for some important activity areas using 'Space Function Method'

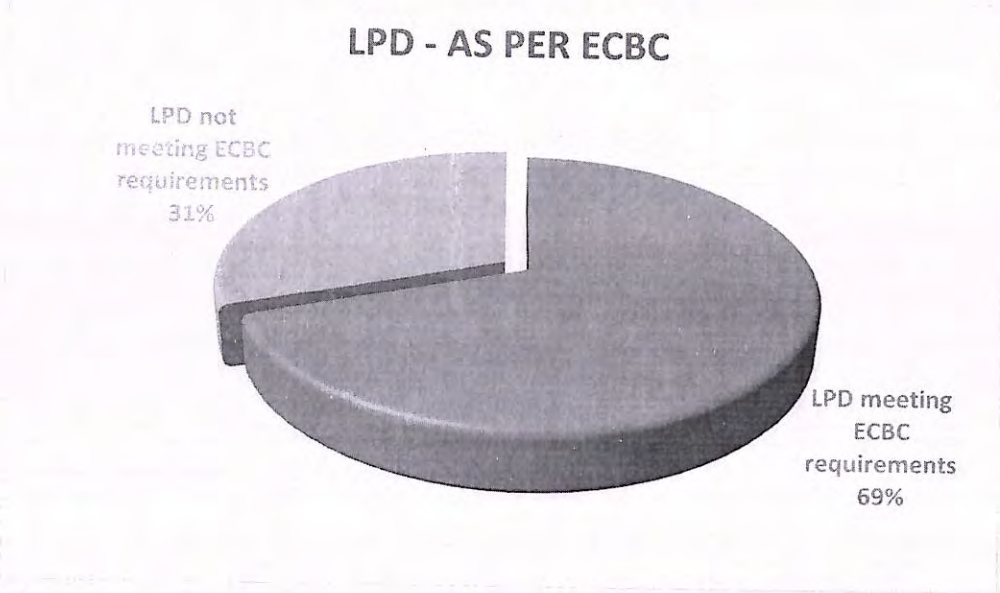

Figure 7: Percentage of areas complying with LPD norms as per ECBC using Space Function Method

3.1.2.3 Efficacy of Lamps

The Efficacy of a lamp is defined as the lumens produced by a lamp plus ballast system divided by the total watts of input power (including the ballast), expressed in lumens per watt. The higher the efficacy, lesser is the energy consumed by the lamp.

The comparative efficacies and environmental impacts of the lamps is provided in the table below:

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- Summary of Observations: Lighting

1. There are in all 1221 lamps (artificial light sources) in the campus amounting to annual energy consumption of **13,193.28 kWh** constituting **25 % of total energy consumption**.
2. **15 % of lights are LED.**
3. Building envelope has **Window Wall Ratio (WWR) of 25%,** which is within ECBC's allowable norms of up to 60%.
4. **69 %** of the spaces comply with the LPD norms of ECBC. By the Space Function method, most of the key activity spaces meet the ECBC norms.
5. In the random survey of lux levels at different places, it was found that 90% of the lux level measurements are matching with the NBC norms.
6. The highest lighting consumption is by the **First floor** (72%), **Outdoor lights** (28%) and rest all floors was 0%. This was mainly due to the Covid-19 Pandemic, as the college was not fully functional and only the administration and research areas were functioning.
7. Currently there are 82 outdoor lights manually switched off and switched on.

3.1.3 Energy Consumption for Thermal Comfort

Fans and Air Conditioning together consume 23% of the energy consumption of the campus. Both these are required for thermal comfort of occupants. Only 12% of the college space is conditioned.

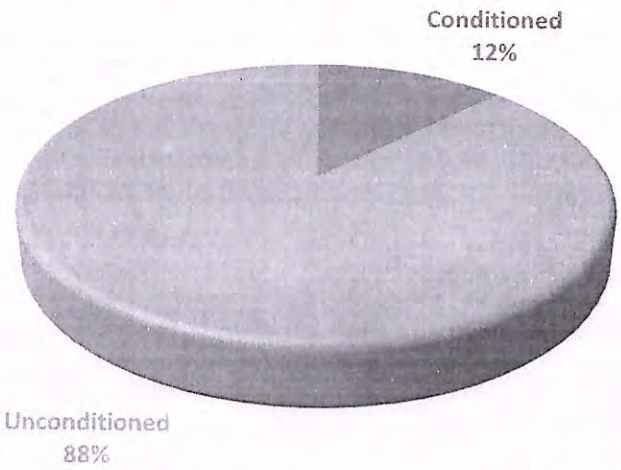

Figure 8: Conditioned and un-conditioned areas in Jhunjhunwala College

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There are a total 529 ceiling fans fitted along with 60 exhaust fans and 5 wall mounted fan.

Fans contribute 7% of the energy consumption. Break up of energy consumed by fans is provided in Fig. 9 and Table 12. The floor wise break up of fan consumption is provided in Figure 10 and Table 13.

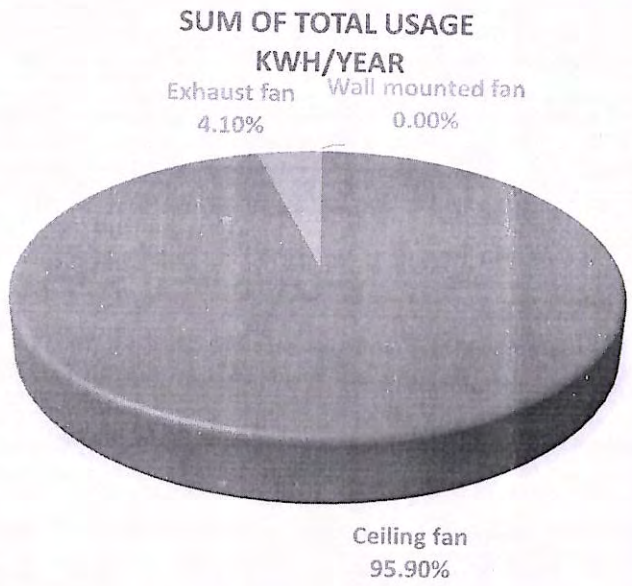

Figure 9: Types of Fans

S. No.	Fan Type	Numbers	Total Consumption (kWh)
1.	Ceiling Fan	529	3369.6
2.	Exhaust fan	60	144
3.	Wall Mounted Fan	5	0
	Grand Total	594	**3513.6**

Table 12: Types of Fans and their wattages Consumption (kWh)

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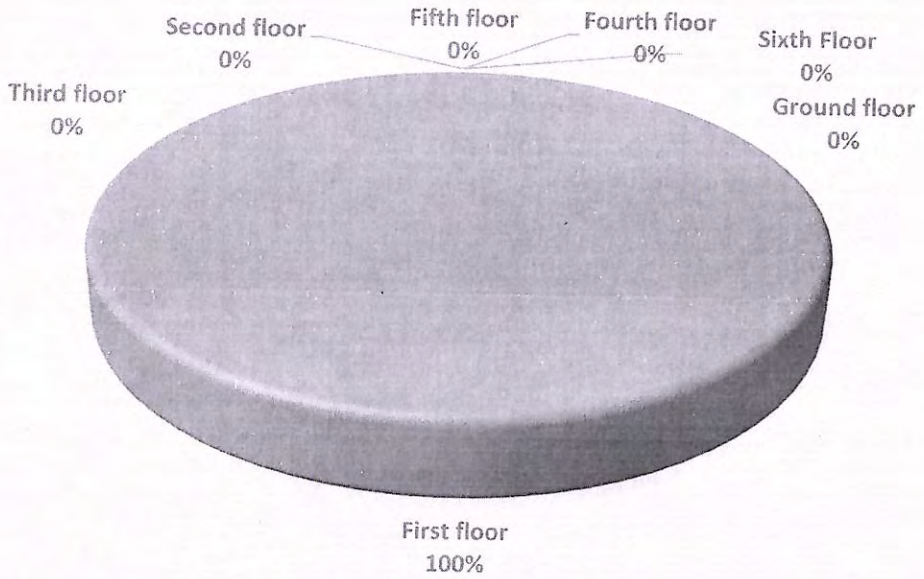

Figure 10: Percentage breakup of Floor-wise Annual Energy Consumption of Fans

Sr. No.	Floor	Total Consumption (kWh)
1	Ground floor	0
2	First floor	3513.60
3	Second floor	0
4	Third floor	0
5	Fourth floor	0
6	Fifth floor	0
7	Sixth Floor	0

Table 13: Total floor-wise Fans consumption (kWh)

Air conditioning is the third largest consumption for the overall college amounting to 16% of total energy consumption, 111.8 TR of refrigeration and 8,164.80 units of electricity annually (2020-2021). The comfort air-conditioning system at college mainly comprises of split and window units. The breakup of different indoor units and the floor wise consumption of AC is shown in Fig 11, Table 14 and Table 15.

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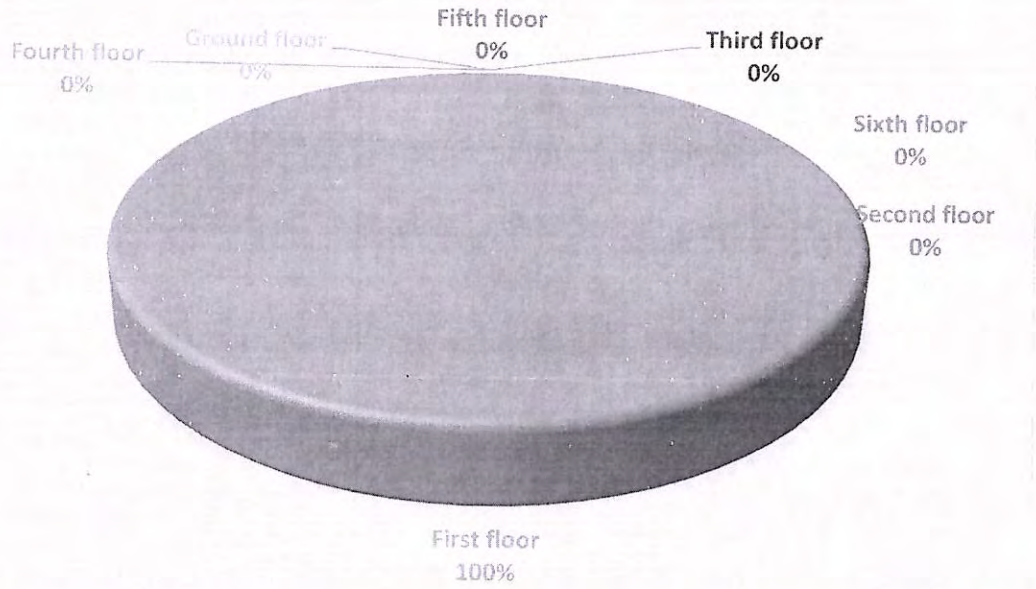

Figure 11: Percentage breakup of Floor-wise Annual Energy Consumption of AC

Sr. No.	Building	Total Consumption (kWh)
1	Ground floor	0
2	First floor	8164.80
3	Second floor	0
4	Third floor	0
5	Fourth floor	0
6	Fifth floor	0
7	Sixth Floor	0

Table 14: Total floor-wise AC consumption (kWh)

Split AC- 1st floor						
Sr. No.	**Parameters**	**Units**	**Chemistry Research Lab**	**Chemistry Staff Lab**	**Seminar Hall**	**Seminar Hall**
1	Make	-	Mitsubishi	Daikin	Daikin	Daikin
2	Capacity	TR	1.5	2	2.2	2.2
3	Specific volume of Air	m3/kg	0.85	0.85	0.85	0.85
4	Air Flow rate	m3/sec	0.175	0.224295	0.22823	0.24397
5	Power Consumption	kW	1.39	1.67	1.86	1.75
6	Overall kW/TR	kW/TR	1.454	1.363	1.492	1.313
7	Energy Efficiency Ratio	kW/kW	2.4138	2.5750	2.3525	2.6728

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Split AC- 2nd and 3rd floor						
Sr. No.	Parameters	Units	2nd floor Lab-2	Micro Biology lab	Micro Biology lab	Computer Lab
1	Make	-	Daikin	Panasonic	Panasonic	Panasonic
2	Capacity	TR	1	1.5	1.5	1.5
3	Specific volume of Air	m3/kg	0.85	0.85	0.85	0.85
4	Air Flow rate	m3/sec	0.1536	0.1575	0.203	0.1995
5	Power Consumption	kW	1.1	1.25	1.79	1.84
6	Overall kW/TR	kW/TR	1.311	1.453	1.614	1.689
7	Energy Efficiency Ratio	kW/kW	2.6771	2.4157	2.1743	2.0787

Table 15: Details of AC units with their design parameters

The campus also has 67 AC's in total which include 46 split units and 21 window units installed in principal's cabin, computer lab, director's cabin, server room and Gymkhana etc.

- **Summary of Observations: HVAC**

1. Ceiling fans account for almost **91% and exhaust fans amount for 8% and wall mount fans account for 1% of the total energy consumed by fans.**

2. The overall fan consumption shows that **first floor uses highest number – 100% followed by all the other floors – 0%,** mainly due to the Covid-19 pandemic.

3. The overall air conditioning consumption shows that maximum usage is by the **First floor– 100%, followed by all the other floors – 0%**. Due to the Covid-19 Pandemic, only the administration areas were functioning and hence the major fans and air conditioning consumption was observed here.

4. As per the audit conducted, all the 67 air conditioners were found to be in a good condition.

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3.1.4 Equipment Energy Consumption

Equipment contributes 52% of the total energy consumption. Major equipment includes CPU, UPS, lifts, copier, projector, xerox machine, water pump, TV, computer desktops. The detailed break up of energy consumed by equipment is shown below.

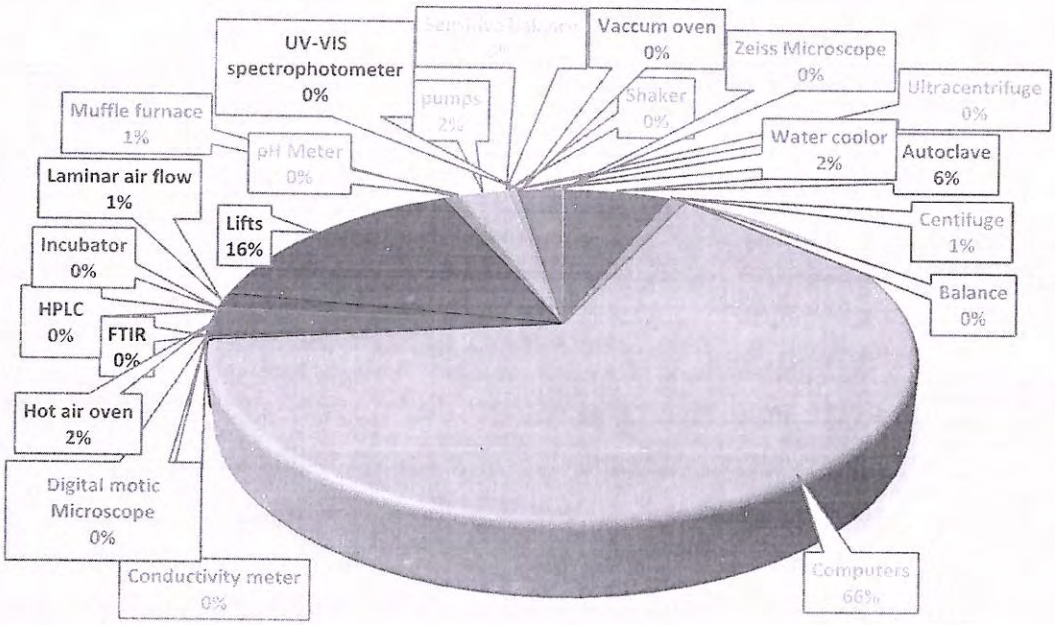

Figure 12: Types of equipment

S. No.	Equipment	Number	Wattage (kWh)
1	Autoclave	3	5400
2	Balance	1	36
3	Centifuge	3	756
4	Computers	562	75096
5	Conductivity meter	1	36
6	Digital motic Microscope	1	108
7	FTIR	1	108
8	Hot air oven	4	2160
9	HPLC	1	180
10	Incubator	2	234
11	Laminar air flow	8	1296
12	Muffle furnace	1	720
13	pH Meter	3	108

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14	Sensitive balance	4	144
15	Shaker	1	108
16	Ultracentrifuge	1	360
17	UV-VIS spectrophotometer	2	72
18	Vaccum oven	1	180
19	Water cooler	9	1944
20	Zeiss Microscope	1	108
21	Lift	2	10080

Table 16: Type of Equipment and their Wattage

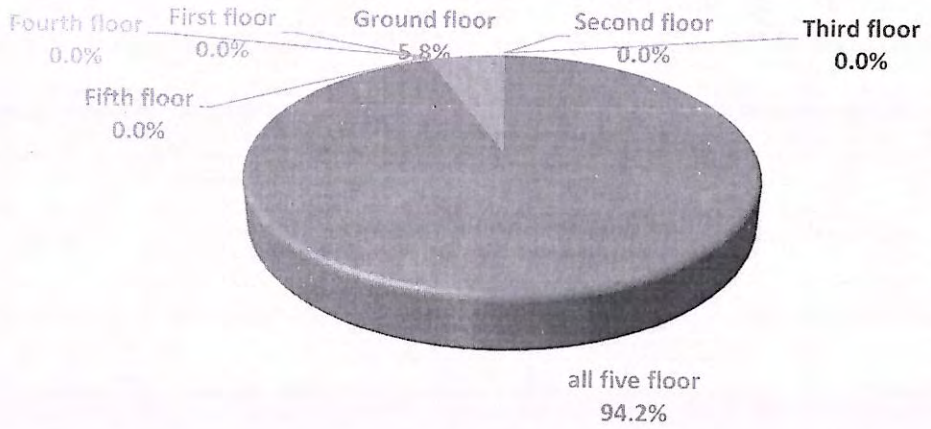

Figure 13: Percentage breakup of Floor-wise Annual Energy Consumption of Equipment

S. No.	Building	Total Consumption (kWh).
1	Ground floor	1566
2	First floor	0
3	Second floor	0
4	Third floor	0
5	Fourth floor	0
6	Fifth floor	0
7	Computers (all floors)	25500
Total		**27066**

Table 17: Total floor-wise Equipment consumption (kWh)

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Pumps

S. No.	Item Description	Capacity	Quantity	Total Load kWh/year
1	Water Pump	5 HP	3	2238

Table 18: Detail of the pumps

Some of the equipment used in the college are shown in the pictures below:



Plate 15: Autoclave machine



Plate 16: Incubator shaker

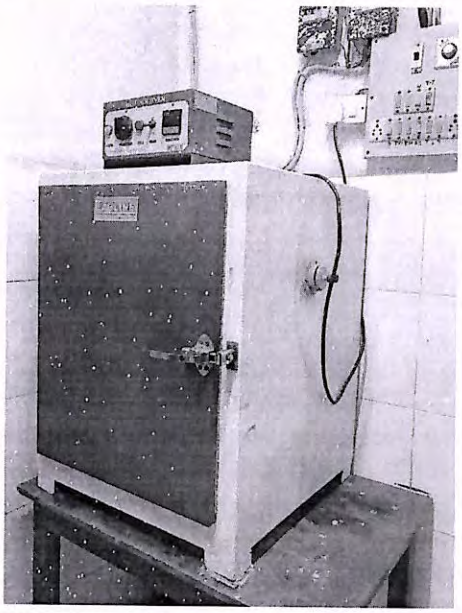

Plate 18: Hot air oven of chemistry lab

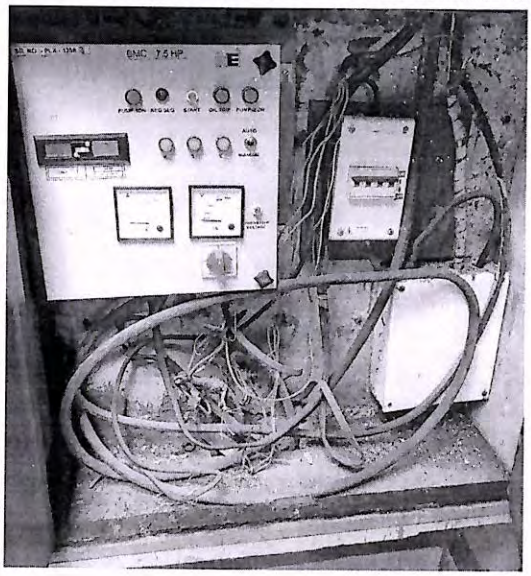

Plate 17: Pump Panel

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Summary of Observations: Equipment

1. Total energy consumption by equipment is 34%.
2. The energy consumption by equipment is primarily through **computers** across all five floors which is around **62%, Lift is 16%, Autoclave is 6%, Lamination machine is 4%, projector Is 4%, monitor is 3%, water pumps is 3%, microwave is 2%, and AV system, blowers, server, wifi routers is 1%.**
3. The largest consumption of energy with respect to equipment is by all the computers combined at al floors together at **82.2%.** This was mainly due to the Covid-19 Pandemic, as the college was not fully functional and only the administration and research areas were functioning.

3.1.5 Electrical system study, Earthing and leakage currents

3.1.5.1. Electrical System Study

The Neutral Earth Voltage was checked in the following locations and all 56 were found to be within permissible limit.

N-E Voltage Details			
Sr. No	**Description**	**N-E voltage (Volt)**	**Remarks (Acceptable limit is less than 2 Volts)**
1	Chemistry staff room	2.2	Within Permissible Limit
2	Seminar hall	2.1	Within Permissible Limit
3	Gymkhana	2	Within Permissible Limit
4	Central instrument facility	1.9	Within Permissible Limit
5	2nd floor lab 2	2.2	Within Permissible Limit
6	3rd floor laboratory 2	2.1	Within Permissible Limit
7	3rd floor laboratory 3	2.3	Within Permissible Limit
8	3rd microbiology lab	2.4	Within Permissible Limit
9	3rd computer admission help desk	2.1	Within Permissible Limit
10	4th staff room	2.4	Within Permissible Limit
11	4th research lab dst-fist-DBT	2.5	Within Permissible Limit
12	Statistics lab 4th	2.6	Above Permissible Limit
13	Room-44 4th flr	2.7	Above Permissible Limit
14	Room-36 4th floor BBI	1.2	Within Permissible Limit
15	Bms room 4th floor	1.8	Within Permissible Limit

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16	Room-55 5th floor	1.9	Within Permissible Limit
17	Room-56 5th floor	2.1	Within Permissible Limit
18	Computer science lab no-3 5th	2.2	Within Permissible Limit
19	Lab-2 BSC 5th floor	2.4	Within Permissible Limit
20	Lab-2 BSC 5th floor	0.95	Within Permissible Limit
21	Staff room 5th floor	1.3	Within Permissible Limit
22	Lab-1 5th floor	1.4	Within Permissible Limit
23	IT staffs room	1.8	Within Permissible Limit
24	It lab-1 5thflr	2.2	Within Permissible Limit
25	It lab-2 5thflr	2.5	Within Permissible Limit
26	64 6th flr	2.4	Within Permissible Limit
27	64 6th flr	2.3	Within Permissible Limit
28	65 6th flr	2.7	Above Permissible Limit
29	Staff room 6th floor	2.5	Within Permissible Limit
30	63 6th flr	2.4	Within Permissible Limit
31	Computer lab-6th flr	2.3	Within Permissible Limit
32	C1	2.1	Within Permissible Limit
33	C2	2.1	Within Permissible Limit
34	Studio 2nd floor	2.4	Within Permissible Limit
35	Staff room	2.4	Within Permissible Limit
36	Trust office 1st floor	2.3	Within Permissible Limit
37	Server cabin	2.2	Within Permissible Limit
38	Conference room	2.1	Within Permissible Limit
39	Principal office	2.5	Within Permissible Limit
40	Vice principal cabin	2.5	Within Permissible Limit
41	Vice principal cabin	2.3	Within Permissible Limit
42	Vice principal cabin	1.9	Within Permissible Limit
43	Vice principal cabin	1.8	Within Permissible Limit
44	MIS centre	1.5	Within Permissible Limit
45	Chemistry lab	1.2	Within Permissible Limit
46	Gymnasium	1.2	Within Permissible Limit

Table 19: Earth- Neutral Voltage

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3.1.5.2. Earthing and Leakage Currents

Earthing And Leakage Currents were also measured during the Audit. As per observations most of the earth pit resistance is above permissible limit.

Earthing & Leakage current Details				
Sr. No	**Description**	**Resistance in Ohm**	**Leakage in mA**	**Remark**
1	Main Panel Earthing	960	24.2	Above Permissible Limit
2	Main Panel Earthing	0.95	17	Within Permissible Limit
3	Main Panel Earthing	3.4	70.1	Above Permissible Limit
4	Solar System	970	0.35	Above Permissible Limit
5	Main Panel Earthing	550	0.05	Above Permissible Limit
6	Main Panel Earthing	440	32.6	Above Permissible Limit
7	Main Panel Earthing	230	60.8	Above Permissible Limit

Table 20: Earthing and Leakage Current Table

3.1.6 Benchmarking - Energy Performance Index (EPI)

The **Energy Performance Index (EPI) of Jhunjhunwala College is 13.92 kWh/sq. m/year in 2020-2021 as the billing data**. As per the **Bureau of Energy Efficiency's (BEE) EPI benchmark for institutional** buildings in **warm-humid climate zone (such as Mumbai) is 150 kWh/sq. m/year.** The energy consumption of the college is well below this benchmark.

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	150
Composite	117
Hot & Dry	106
Moderate	129

Table 21: EPI bench mark by BEE for Institutes

3.1.7 Benchmarking – Specific Energy Consumption (SEC)

Specific Energy Consumption (SEC) is defined as the energy consumption per unit product. The specific energy consumption taking into account students, faculty and staff members were calculated to form a benchmark of **13.92 kWh/ person/ year** and **Rs. 784.47 per person per annum (considering 2020-2021 data).**

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3.1.8 Billing Analysis and Metering system

1. The energy consumption in the college is mainly in the form of electricity which is supplied through **Adani Electricity Utility company** and 10 KW solar PV panels on the terrace
2. The College is billed under category **LT IX (B)** for all 9 meters. This category is applicable for Public services which includes Government and private hospitals and educational institutions.
3. The Monthly electricity bill for all the meters with **LT IX (B)** has the basic rate of energy as **Rs. 6.45 per unit (kWh)** in addition to fixed demand charge of **Rs. 330** per connection per month, Wheeling charge of **Rs. 1.74 per unit.** The Tariff Structure of Adani Electricity Utility company along with additional Time of Day (TOD) tariff is summarized in tables below:

Tariff Category	Fixed Demand charge ₹/Month	Energy charge ₹/Unit	Electricity duty	Wheeling charge ₹/Unit	RA charge ₹/Unit	FAC rate Paise / Unit
LT IX B	Rs. 330 per connection per month	6.45	@21%	1.74	0.43	50.63

Table 22: Tariff Structure as per the Adani for FY 2019 - 20

4. The overall per unit charge is Rs. **25.87 per unit.**
5. It is observed that the annual energy consumption of the college as per electricity bills is **1,15,133.00 kWh for the Year June 2020 – May 2021.** The average monthly consumption is approximately **9594 units.** It can be seen that the months of March, July, August, September and November have the highest consumption. This could be attributed to excessive discomfort and use of fans and ACs due to higher insolation and relative humidity. It may also be related to activities in the college. February has the lowest energy consumption. May is lowest due to summer vacation.

3.1.9 Pumps and Motors

- The college has 3 main water pumps in the passage of ground floor. These two pumps are used to pump the water from UG tank and ring well to OHT. At present the pumps are

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run in auto mode of 5 hp capacity each as controllers are installed for running of the pump. The photos of the Pumps and their performance is provided in Plates 16 and Table

Sr no	Location of the Pumps & Lift Motors	Capacity in (hp)	Number	Time	Days	KW	Total usage Kwh/year
1	Passage of Ground floor	5 hp	3	2 hours	300	7.5	2250

Table 23: Performance details of pumps

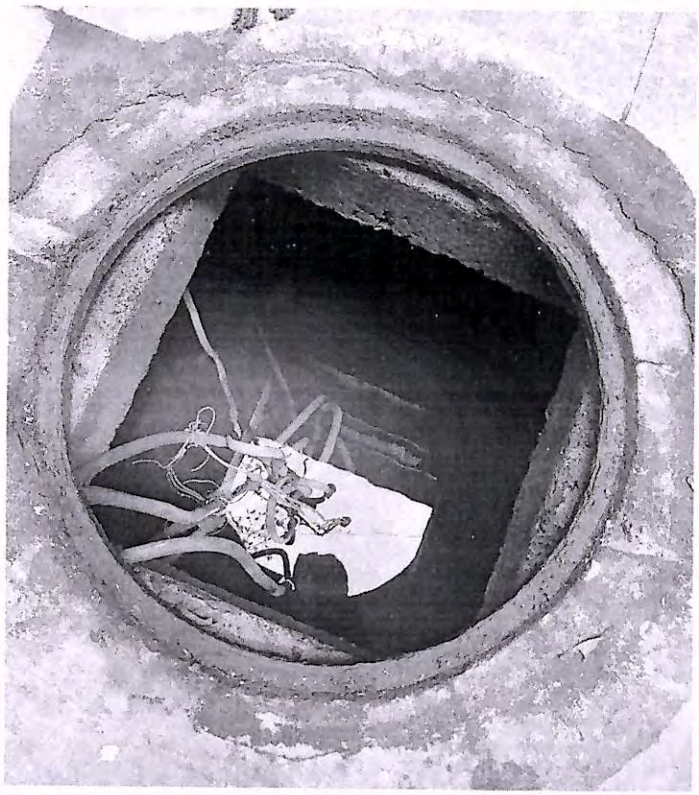

Plate 19: Underground water pump

3.1.10 Renewable Energy- Rooftop Solar PV

The College has 34 nos. of Solar PV panels installed on the Rooftop in 2017which have capacity of 10 kWp. These panels were installed by Hon. MP Dr. Kirti Somaiya as per the guidelines of MPLADS Administrative Approval in 2016-17. These panels are laid on the Sloping roof, based on the slope of the roof and not as per the best orientation for higher solar gain. A separate energy meter and inverter is also attached to the system.

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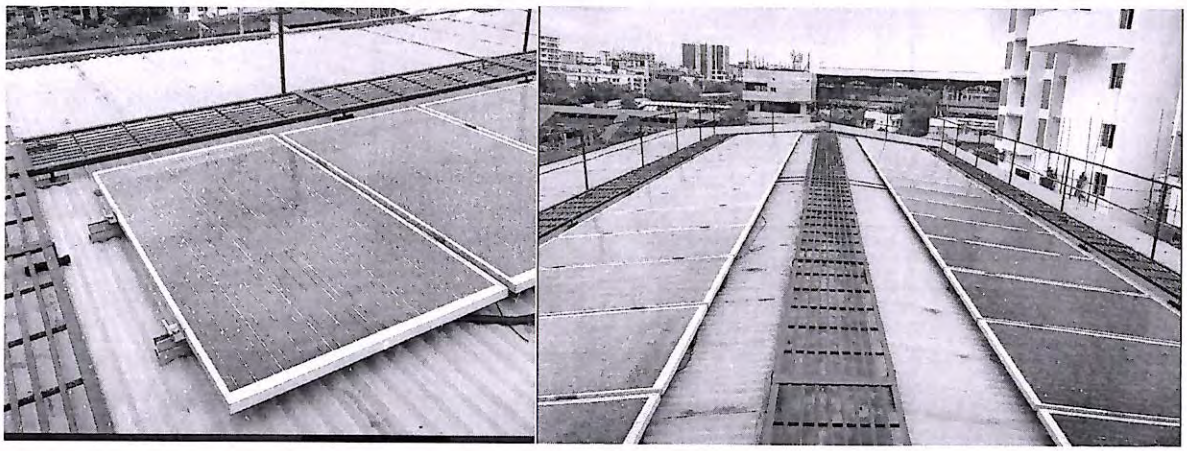
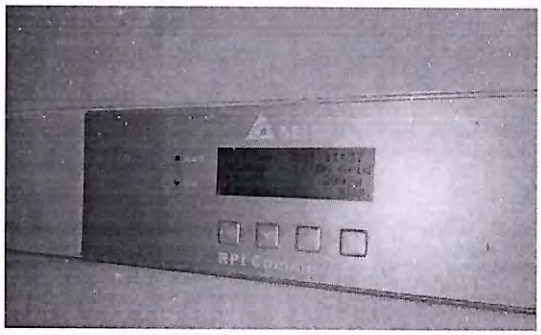


Plate 20 : Installed Solar PV panels on the sloping roof of the college



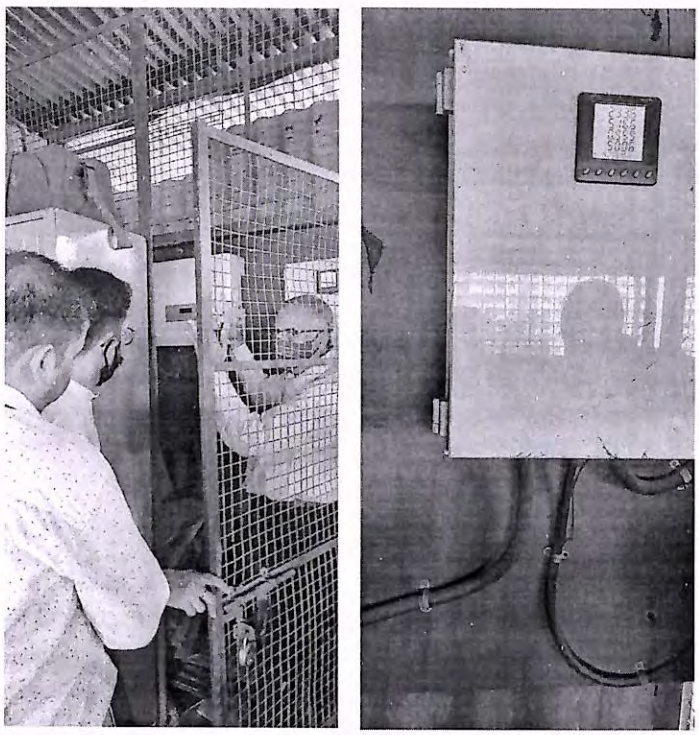


Figure 14:Picture showing Solar meter, Inverter and Mr. Rumi Engineer inspecting the system on site.

1. Based on meter readings from Energy meter recorded from 1st to 9th October 2021, it was recorded that power generated is 35.17 kWh. As per the current energy

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generation thumb rules, a 10kWp system should generate 40kWh/day. So the system was generating power on lower side.

2. The solar PV manufacturing data could not be obtained and hence it is not possible to comment on the deterioration rate considered on Y-O-Y basis for ageing of the Solar Panels.

3. As being given to understand this Solar power is consumed fully on fourth floor wherein considerable power demand is present at any given point of time.

Make	Selectron	Model
Meter No.	5118667	MFM384
Date	**Meter Reading (kWh)**	**Consumption (kWh)**
27-09-2021	42585.22	
01-10-2021	42669.37	28.05
02-10-2021	42702.75	33.38
03-10-2021	42737.83	35.08
04-10-2021	42772.48	34.65
05-10-2021	42806.98	34.50
06-10-2021	42840.36	33.38
07-10-2021	42875.36	35.00
08-10-2021	42913.35	37.99
09-10-2021	42950.71	37.36
Average		**35.17**

Table 24: Table showing Solar Meter reading for study period 1st to 9th October 2021

3.2 Water

The College has an OHT of capacity **1,000 litres** and an UGT of capacity **5,000 litres**. There 135 wash basins (some located in labs and others are in washrooms), 8 WC have single flush type flushing tank while the rest of the toilet units have only ablution taps, and a total of 12 drinking water coolers. There are around 9 individual taps, of which 7 are used for gardening (on ground floor and terrace),

and 2 are near temple.

Considering 6950 persons at the rate of 45 litres per person per day (as per NBC), the maximum total **daily** requirement of the college is **625.5** kilo litres. This is shown in table no. 26. Monthly requirement should be **14386.5 kilo litres** considering **23 days** of operation per month.

However, as per water bills submitted by the college, average monthly water consumption is **2964.17 kilo litres**, which means daily consumption is around 130 **kilo**

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litres. This amounts only 21% of the calculated daily water consumption. The exact daily consumption can be observed in figure 14.

The college pays Rs. 5.09 per kilo litres of water in addition to the 70% of water charges as sewerage charges according to the tariff specified in the water bills.

The College campus water bill shows that the average monthly water charges are **Rs. 24783/-**, accordingly the per litre of water cost is around **Rs. 9/-**. Table no. 25 gives details of the faucets, flushing devices and water coolers in the College.

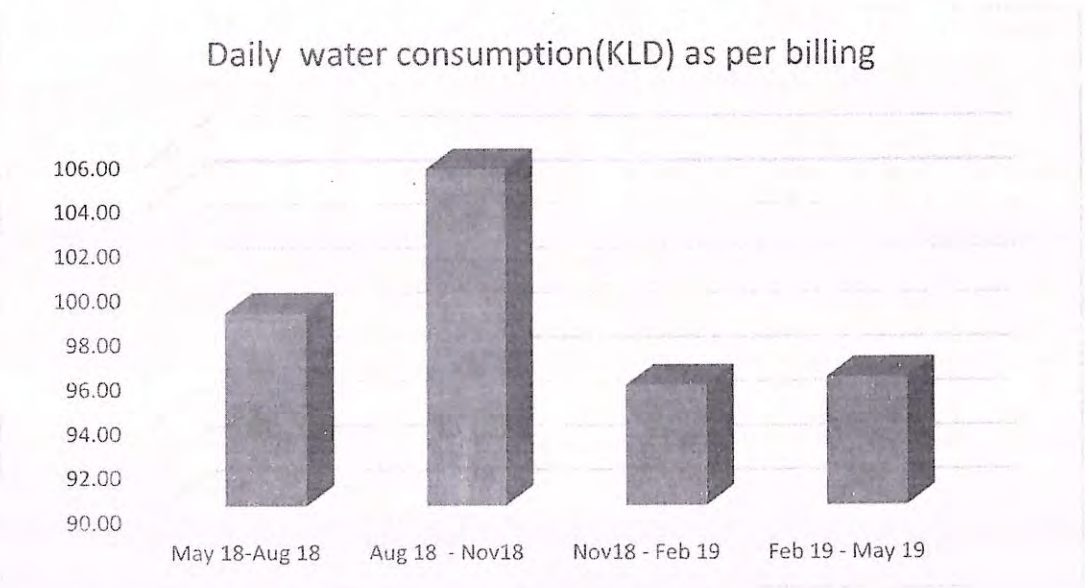

Figure 15: Chart showing Quarterly water consumption as per the water bill

S. No	Building	Floor	Total No.	Total No. of Toilet Blocks	Drinking Water/ Cooler	Water Closet (WC)	Wash Basin	Wash basin taps	Type of Flushing Tank (Dual Flush/ Single Flush)
1	Garden	Campus	6					Tap	
2	Chem Lab 1	Ground floor	17				Basin Tap		
3	Chem Lab 2	Ground floor	21				Basin Tap		
4	Chem Lab 3	Ground floor	9				Basin Tap		
5	Research lab	Ground floor	2				Basin Tap		
6	Chem Jr lab	Ground floor	14				Basin Tap		
7	Canteen	Ground floor	5				Basin Tap		
8	Canteen	Ground floor	2		Water cooler				
	Ground floor	Ground floor	2		Water cooler				

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10	LCR	1st Floor	5					Tap	
11	1st floor	1st Floor	2		Water cooler				
12	Office Toilet	1st Floor	3						Single Flush
13	Office toilet	1st Floor	3				Basin Tap		
14	Pantry	1st Floor	1				Basin Tap		
15	Panty	1st Floor	2		Water cooler				
16	Biology Lab	1st Floor	9				Basin tap		
17	Biology Lab	1st Floor	3		Water cooler				
18	2nd floor	2nd floor	4		Water cooler				
19	Physics	2nd floor	9				Basin tap		
20	Boys Washroom	2nd floor	3						Single Flush
21	Boys Washroom	2nd floor	4				Basin tap		
22	Boys Washroom	2nd floor	2					Tap	
23	3rd floor	3rd floor	2		Water cooler				
24	Boys Washroom	3rd floor	3	3 push				Tap	
25	Boys Washroom	3rd floor	2				Basin tap		
26	Boys Washroom	3rd floor	1					Tap	
27	Library	3rd floor	1				Basin tap		
28	Biotech Lab	3rd floor	24				Basin tap		
29	Biotech	3rd floor	3		Water cooler				
30	Stats	4th floor	1				Basin tap		
31	Research lab	4th floor	2				Basin tap		
32	Staff room	4th floor	2		Water cooler				
33	Staff room Gents washroom	4th floor	6					Tap	
34	Staff room Ladies washroom	4th floor	4					Tap	
35	Girls washroom	4th floor	2					Tap	
36	Lunch room	4th floor	1				Basin tap		

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37	Lunch room	4th floor	2		Water cooler				
38	Temple	4th floor	2					Tap	
39	Research preparation room	4th floor	2				Basin tap		
40	4th floor	4th floor	2		Water cooler				
41	BMS Washroom	4th floor	1						Single Flush
42	BMS Washroom	4th floor	1				Basin tap		
43	5th floor	5th floor	3		Water cooler				
44	CS Washroom	5th floor	1						Single Flush
45	CS Washroom	5th floor	3				Basin tap		
46	BVOC Washroom	5th floor	2					Tap	
47	BVOC Washroom	5th floor	1				Basin tap		
48	61-62 room no.	5th floor	1					Tap	
49	Garden	Terrace	1					Tap	
50	Beauty parlour	Terrace	2				Basin tap		

Table 25: Toilet details in college

Category	Number of Occupants	Water requirement per person (LPCD)			Total water requirement (LPCD)		
		Domestic	Flushing	Total	Domestic	Flushing	Total
Students	6666	20	25	45	133320	166650	299970
Teachers	134	20	25	45	2680	3350	6030
Non-teaching staff	125	20	25	45	2500	3125	5625
Administrative staff	25	20	25	45	500	625	1125
Total	6950				139000	173750	312750
					278	**347.5**	**625.5**

Table 26: Total water usage of the Campus

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3.2.1. Rain Water Harvesting

The college has successfully installed a rainwater harvesting system collecting water from the rooftop catchment through down take pipes fitted with filter which is used to recharge a 20 feet deep ring well. This water is used for Landscaping and watering the plants as the quality of water is not feasible for drinking.





Figure 16: Rainwater harvesting down-take pipe and Recharge Ring well provision in campus

3.3 Solid Waste

The college generates approximately half kg of waste per day which amounts to 100 kg/year, which is organic / food waste from canteen. The waste is not segregated at source as per information submitted by college. There is scope to include various segregation, recycling and composting concepts in the campus. The college has already marked out a place on campus for a compost pit.

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Figure 17: Compost pit provided in campus

The college has developed an E-waste collection system in collaboration with Eincarnation Recycling Pvt. Ltd. that collects the E-waste periodically.

An incinerator for medical waste is provided in one of the toilets on 3rd and 4th floor.

3.4 Environment Quality

As the college is located right next to the major railway station (Ghatkopar), there are several sources of noise and air pollution due to food stalls, railway line and associated activities. However, the college has created green buffer within and outside college along the compound. They have also created a green house on the roof top which has mist irrigation and hydroponic technology of growing plants. These efforts taken by the college are commendable. The college already has identified and listed the number of trees on campus. As they have botany department all the trees are listed by their scientific name and the information is already. All identified trees in the campus have QR code plate, scanning which the basic information of the tree can be read.

The list of trees along with their location submitted and displayed in the college is given below:

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Sr. No	Common name	Scientific name	Type of plant	No. of Trees	Location
1	Sacred Fig	*Ficus religiosa*	*Tree*	2	Ground floor
2	Cluster Fig	*Ficus racemosa*	*Tree*	1	Ground floor
3	Mango tree	*Mangifera indica*	*Tree*	4	Ground floor
4	Yellow flametree	*Peltophorum pterocarpum*	*Tree*	4	Ground floor
5	Kasah	*Sterculia alata*	*Tree*	1	Ground floor
6	Indian Beech	*Ponngamia pinata*	*Tree*	1	Ground floor
7	Rain tree	*albizia saman*	*Tree*	1	Ground floor
8	Indian mast tree	*Polyalthia longifolia*	*Tree*	49	Ground floor
9	Pinwheel Flower tree	*Tabernaemontana divaricata*	*Shrub*	1	Ground floor
10	Areca palm	*Dypsis lutescens*	*Shrub*	9	Ground floor
11	Dumb cane	*Dieffenbachia seguine*	*Shrub*	5	Ground floor
12	Indian screw tree	*Helecteris isora*	*Tree*	1	Ground floor
13	Wild plantain	*Heliconia sp.*	*Shrub*	4	Ground floor
14	Crane Flower	*Sterlitzia reginae*	*Shrub*	2	Ground floor
15	Flame of woods	*Ixora coccinea*	*Tree*	3	Ground floor
16	Chinese chaste tree	*Vitex negundo*	*Tree*	2	Ground floor
17	Sandpaper vine	*Petrea volubilis (Liana)*	*Creeper*	1	Ground floor
18	Sago Palm	*Cycas sp.*	*Tree*	1	Ground floor
19	Rangoon Creeper	*Combretum indicum*	*Creeper*	1	Ground floor
20	Monkey brush vine	*Combretum rotundifolium*	*Creeper*	1	Ground floor
21	Ceylon Ironwood	*Messua ferrea*	*Tree*	1	Ground floor
22	Bitter cassava	*Manihot esculanta*	*Shrub*	1	Ground floor
23	White frangipani	*Plumeria alba*	*Tree*	1	Ground floor
24	Bridal Bouquet	*Plumeria pudica*	*Tree*	1	Ground floor

Table 27: List of Trees Species in the Campus





Plate 21: Trees and Shrubs in the campus

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4. Recommendations for Green Campus and Feasibility for Jhunjhunwala College

4.1 Visual Comfort and Energy Efficiency

The LPD values in educational spaces such as classrooms are found to be meeting the maximum norms as prescribed by ECBC 2017. However, few spaces correspond to lower illumination levels as measured during the random lux level survey of spaces. The overall lighting consumption is meeting the ECBC norms. It is therefore prescribed to improve the illumination levels in some spaces which have low illumination levels.

4.1.1 Replacement of T8 (40W) Fluorescent Tube Lights (FTLs) along with electromagnetic ballast with 18W LED Tube Lights having lumen output of 1800 (efficacy = 100 Lumens per Watt)

Since 40W Fluorescent Tube Lights (FTLs) are the largest source of lighting energy consumption, they should be replaced with efficient 18W LED T8 tube lights of 1800 lumens output (efficacy of 100 L/W) with long life of 40,000 hours, diffused uniform light output, better color rendering (CRI>83) suitable for learning spaces and built in protection circuit.



Plate 23: Existing 36W Fluorescent Tube Lights



Plate 22: Proposed 18W LED Tube Lights of 1800 Lumens output (efficacy = 100 L/ W)

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Areas applicable: All classrooms, staffroom, conference, computer lab, cabins

Existing Type of Light	Existing Quantity	Existing Wattage (kWh)	Proposed type of Light	Proposed Quantity	Estimated Wattage (kWh)	Rate per unit (Rs)	Total Cost (Rs)	Annual Savings (kWh)	Annual Savings* (Rs)	Payback
40 W Fluorescent tube light	909	66293.28	18W LED (t8) of 1800 Lumens	909	24691.7	345/-	313605	41601.60	540820.8	6 months

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4.1.2 Replacement of T8 (40W) Fluorescent Tube Lights (FTLs)and LED lights with sensor based dimmable lights in passages

Replacement : Tubelights and LED lights with dimmable motion sensor-based LED lights										
Areas applicable: Passage										
Existing Type of Light	Existing Quantity	Existing Wattage (kWh)	Proposed type of Light	Proposed Quantity	Estimated Wattage (kWh)	Rate per unit (Rs)	Total Cost (Rs)	Annual Savings (kWh)	Annual Savings* (Rs)	Payback
Tube light 40 W	19	1581	18 W - 2 Feet Dimmable motion sensor-based LED tube light	19	790.56	550/-	*10450*	790.56	10277.28	1 year
LED light 24 W	24	1924	18 W - 2 Feet Dimmable motion sensor-based LED tube light	24	764	550/-	13200	1160	15080	11 months
Passage LED light 18 W	2	52	18 W - 2 Feet Dimmable motion sensor-based LED tube light	2	26	550/-	1100	26	338	3 years 3 months
Total					1259		24750	2298.12	29875.56	1 year

Table 28: Table for calculation of Replacement of tubelights and LED lights with dimmable motion sensor-based LED lights in passage area

4.1.3 Optimization of outdoor lights operation based on Astronomical timer

ECM No.	Energy efficiency improvement measures	Investment Rs. In Lakh	Estimated saving Electricity kWh	Estimated Savings Rs. In Lacs	Estimated Payback Years
4	Optimization of street light operation based on Astronomical timer	0.10	735	0.08	1.2

Table 29 Energy efficiency improvement measures

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At many of the switching points, Analog and digital times are provided to switch ON and OFF the lighting system. At most of the place's timings are in the range as per table mentioned below

Sr No	Season	Switch ON time	Switched OFF time
1	Summer	6.30 PM	6.00 AM
2	Winter	5.30 PM	7.00 AM
3	Monsoon	6.00 PM	6.30 AM

Time Switches are used to control events with respect to real time clock (RTC) whereas timers are used to control processing times. Therefore, RTC forms the basic difference between timer and time switch functionality.

With the help of Time switches it is possible to switch ON and OFF devices like lights, heaters, etc. automatically at desired time of the day / night thereby giving the advantage of convenience and reduction in power wastage or substantial energy savings. The need of automation in street light system is for accurate switching of lights at sunset or twilight sunset and switch OFF at sunrise or twilight sunrise with energy savings.

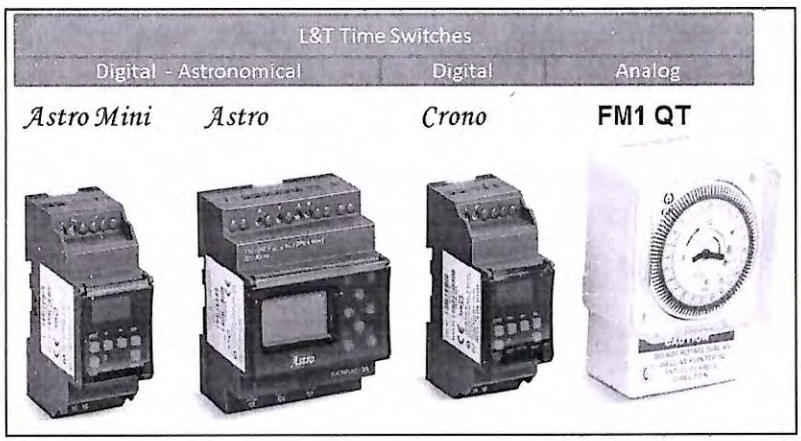

Figure 18 Time Switches

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4.2 Thermal Comfort and Energy Efficiency

4.2.1 Replacement of regular fans with BEE star rated fans and Brushless Direct Current (BLDC) fans

Replacement Details: Regular fans with BEE star rated fans or Brushless Direct Current (BLDC) fans										
Areas applicable: Classrooms, office, computer lab, staff room, cabins										
Existing Type of Fan	Existing Quantity	Existing Wattage (kWh)	Proposed type of Fan	Proposed Quantity	Estimated Wattage (kWh)	Rate per unit based on exchange policy of Utility (Rs)	Total Cost (Rs)	Annual Savings (kWh)	Annual Savings* (Rs)	Payback
Ceiling Fans 60 W	529	31924.8	Atomberg Gorilla 32W	529	17026.56	1,880/-	994520	14898.24	193677.12	5 years 2 months

Table 30: Replacement of Regular fans with BEE star rated fans and Brushless Direct Current (BLDC) fans

The Power Utility Adani under its DSM Scheme provides for exchange of old fans with energy efficient fans at subsidized rates. Below is the table of rates as provided on their website.

Brand	Models***	power Consumption (watts)**	Price Rs. (Inclusive of Delivery & Installation)				
			MRP	With Exchange	Discount %*	New Purchase	Discount %*
Usha	Energia 32	32	3750	2290	39	2390	36
Atomberg	Gorilla	32	3600	1880	48	2048	43
Versa (Superfan)	Super E1	35	3570	1870	48	1990	44
	Super X1	35	3690	2070	44	2170	41
	Super A1	35	4050	2820	30	2920	28
* Actual discount will be more considering free delivery and installation.							
** Conventional ceiling fan consumes 75 - 80 watts.							
*** Prices & Models subject to change							

Table 31: Rates of Brushless Direct Current (BLDC) fans

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However, an enquiry will need to be made with the utility to understand whether the policy is still in place, the subsidized cost and the number of fans that could be replaced under the Policy and the process for exchange.

In case, DSM policies are not applicable or partially applicable, the college can purchase fans directly. Cost and payback period will be double for fans directly purchased from vendor. Vendor list is provided in the Annexure G.

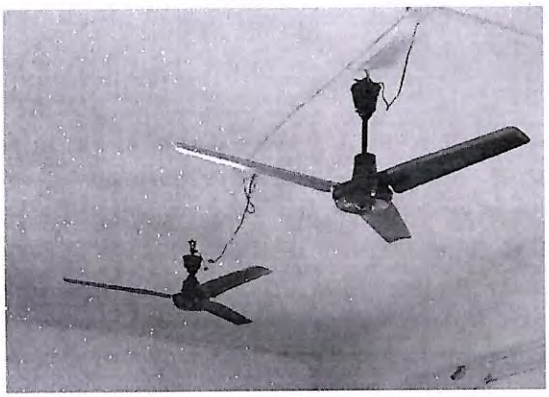

Plate 25: Existing Ceiling Fan of 60 W



Plate 24: Existing Ceiling Fan of 60 W Proposed Ceiling Fan of Atomberg Gorilla 32W

4.2.2 AC maintenance

Currently the ACs are performing in good condition as per the audit. However, regular maintenance is necessary. In case any AC is being replaced or new ACs are purchased, the college should opt for BEE 3 or 5-star rated ACs only for superior performance and energy efficiency. We recommend the use of Airtron AC energy saving devices for all split and window AC units, especially those which are being used frequently. With its patented dual-sensor driver microprocessor technology, it can save up to 35% of energy consumption of an AC unit. Details of vendor are provided in Annexure H.

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4.3 Recommendations for Solar PV system

- College should collaborate with Utility (Adani) to introduce a net metering system so that there is scope of wheeling the power back to the Grid by way and accounting for it in the College electricity bills. **This can provide reduction in electricity bills by 15-20% to the College.**
- Cables of the solar panels should be properly ducted through a PVC pipe with openings to inspect connectors. This is required from fire safety point of view.
- Manual or sprinkler cleaning is essential to maintain efficiency of the solar panels.
- Painting and maintenance of the structure supporting the solar panels and the gangway is important from the safety perspective.



Figure 19: Picture showing the current gangway and open cables of the Solar PV panels

- College should contact the supplier and do health check-up of the entire system (Panel and Inverter).
- Clean the panels regularly.
- Check the Energy meter's calibration (Energy meter may show incorrect reading due to drifting of accuracy over period of time).
- Get further clarity on the distribution of the Solar power in the Electrical power distribution system in the college.
- The college can appoint a vendor for maintenance of Solar panels. Details are attached in Annexure H.

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4.4 General Recommendations and best practices for energy conservation

General recommendations:

- **A separate energy meter** for each floor is also recommended. In the long run separate meter for light, fan, equipment and AC is recommended. This can also be connected to an IOT system to make it online so that energy consumption can be monitored on real-time basis. Vendor details are shared in Annexure H
- **Clean the AC filter** at least once a fortnight. A choked filter means poorer quality of cooling and more power consumed.
- **Replace old regulators with Electronic regulators** to help reduce electricity consumption significantly
- Whenever existing AC units are replaced or new ones to be purchased, **BEE 3-star or 5-star rated machines** should be purchased.
- For lights, fans and other equipment, it is recommended to engage with a service provider rather than purchase individual lights and fans. An **AMC Contract** should be signed with the service provider with clause on **'Performance Guarantee'** with penalty / incentive clause for maintaining the System's output. This will result in bringing in accountability from Project Developer/ service provider.

Best Practices:

- Consider **Using the AC optimally** – for an hour or two less everyday. An AC switched off for an hour can keep a 20 W tube light on for 100 hours!
- **Maintain the A/c Temperature around 24°C - 25°C** (human comfort level).
- **Keep windows shut** after switching off the AC to keep the room cool for some more time. You would be saving significantly on power consumption.
- Switch off the PCs when not in use.
- Switch off lights and fans when leaving a room.
- The above points may also be displayed in important spaces such as classrooms, computer labs, staff rooms, etc.

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4.5 Recommendations for Electrical system and Earthing

Earth pit maintenance and tightening of earthing joints is required.

It is also recommended to attend the panel where the leakage current is more than 30mA (acceptable higher limit) and earth resistance of 5 ohms.

4.6 Retrofit of Water Efficient Equipment

Replacement with water efficient equipment can lead to considerable water savings:



Plate 26: Existing Single Flush



Plate 27: Proposed Dual Flush

Replacement with water efficient equipment can lead to considerable water savings:



Plate 28: Proposed water saving aerators for the wash basin faucets

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S. No.	Existing equipment	Replacement of existing equipment with energy efficient equipment	No. of units	Current Water consumption (liters)	Projected Water savings with efficient equipment (liters) - Annual	Unit rate (Rs)	Total Cost (Rs)
1	Single Flush	Dual Flush	8	5,07,35,000	3,55,14,500	3840	30720
2	Regular Wash basin faucet	Water saving aerator faucet	134	134	67	8.5/-	1139

Table 32: Retrofit for Water Efficient Equipment

4.7 Waste Segregation and Composting

Waste segregators to be provided in the lobby of each floor for wet / organic waste, metal, wood, paper, glass.

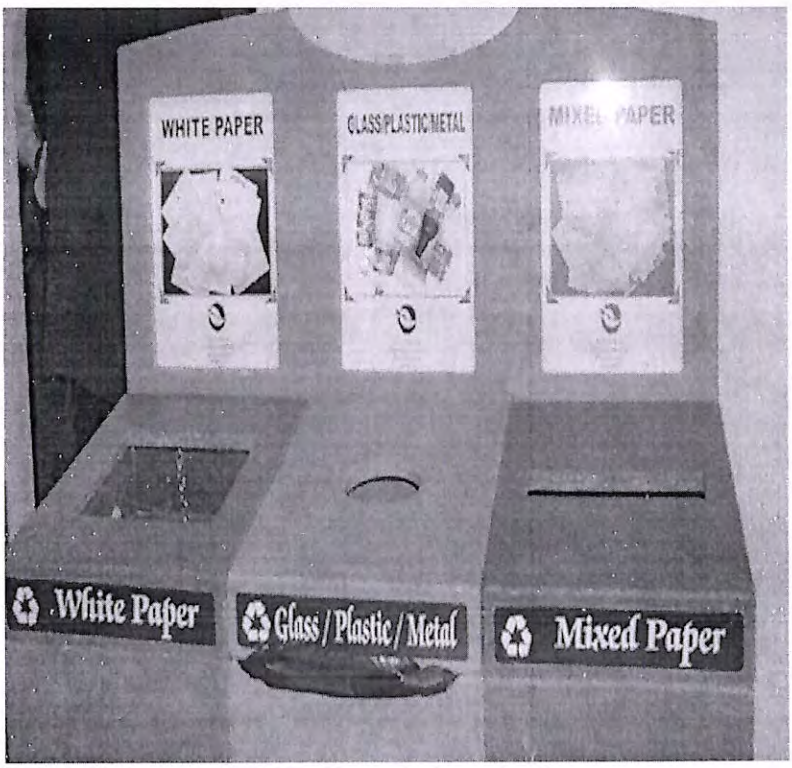

Plate 29: Waste segregator to be installed at each floor level

Organic composting and maintenance of the same can be undertaken by contract with NGO such as Stree Mukti Sanghatana (contact details provided in appendix H).

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4.8 Indoor Air Quality

Since the building is naturally ventilated, indoor air quality is not a major concern. Indoor plants can be added in administrative areas and hanging pots in corridors can be added to increase biodiversity improve air quality can be provided in the administrative areas on all floors.

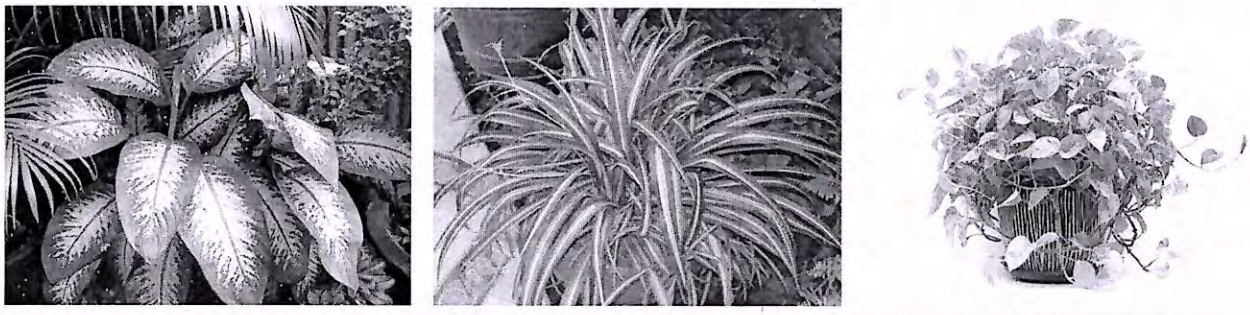

Plate 30: Indoor plants - Dieffenbachia amoena, Chlorophytum comosum and Epimnum auries

4.9 Environment Improvement

Plant and tree species that attract birds and butterflies can be planted to increase biodiversity of the campus.



Plate 31: Plant species attracting birds and butterflies

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4.10 Green Rating

The college can apply for following green building rating for evaluating performance and getting green rated:

Sr. No.	Rating	Provided by	Performance Evaluation	Registration / Rating fees
1.	EDGE	IFC, World Bank	Water, Waste and Energy	Pre-certification plus final EDGE certification – INR 1,20,000 + INR 9 per each additional sq m above 5,000 sq m.
2.	IGBC – Existing buildings	CII, IGBC	Whole building	Registration fees – INR 25,000 and certification fees – INR 50,000
3.	BEE star rating	BEE, Govt. of India	Energy	Application to BEE
4.	GRIHA – Existing buildings	Green Rating for Integrated Habitat Assessment (GRIHA) Council	Whole Building	INR 2,00,000 + INR 3.5 per additional sq. m over 5,000 sq. m
5.	GEM Sustainability (Green) Certification Program - Campus (Educational/Corporate and Others)	ASSOCHAM Green & Eco-friendly Movement (GEM)	Site Area (Acres) - Less than 10 Acres	Pre-certification fee INR 1,75,000 + ASSOCHAM Certification fee INR 2,50,000

Table 33: Green Building Rating Systems

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5. Glossary

- **Ballast:** A device used in conjunction with an electric-discharge lamp to cause the lamp to start and operate under proper circuit conditions of voltage, current, waveform, electrode heat, etc.
- **Built up area (BUA):** Sum of the covered areas of all floors of a building, other than the roof, and areas covered by external walls and parapet on these floors.
- **Common area:** Areas within a building that are available for use by all users in a building (i.e. lobbies, corridors, restrooms, etc.).
- **Connected load:** The sum of the rated wattage of all equipment, appliances and devices to be installed in the building or part of building or building complexes, in terms of kilowatt (kW) that will be allocated to all applicants for electric power consumption in respect of the proposed building or building complexes on their completion.
- **Contract demand:** The maximum demand in kilo Volt Ampere (kVA) (within a consumer's sanctioned load) agreed to be supplied by the electricity provider or utility in the agreement executed between the user and the utility or electricity provider.
- **Colour Rendering Index (CRI):** Colour Rendering Index (CRI) — Measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation.
- **Correlated Colour Temperature (CCT) (K):** The temperature of the Planckian radiator whose perceived colour most closely resembles that of a given stimulus at the same brightness and under specified viewing conditions.
- **Demand:** Maximum rate of electricity (kW) consumption recorded for a building or facility during a selected time frame.
- **Demand factor**: Is the ratio of the sum of the maximum demand of a system (or part of a system) to the total connected load on the system (or part of the system) under consideration. Demand factor is always less than one.
- **Diversity factor**: The ratio between the actual power (Pact) and the rated power (P max) of systems.

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- **Dry Bulb Temperature:** The temperature of the air, read on a thermometer, taken in such a way so as to avoid errors due to radiation.
- **Efficacy:** The lumens produced by a lamp plus ballast system divided by the total watts of input power (including the ballast), expressed in lumens per watt.
- **Energy:** Power derived from renewable or non-renewable resources to provide heating, cooling and light to a building or operate any building equipment and appliances. It has various forms such as thermal (heat), mechanical (work), electrical, and chemical that may be transformed from one into another. Customary unit of measurement is watts (W).
- **Energy Conservation Building Code (ECBC):** The Energy Conservation Building Code as updated from time to time by the Bureau and displayed on its website. (www.beeindia.gov.in).
- **Energy Efficiency Ratio (EER):** the ratio of net cooling capacity in watt to total rate of electric input in watts under design operating conditions.
- **Energy Performance Index (EPI):** of a building means its annual energy consumption in kilowatt-hours per square meter of the area of the building which shall be calculated in the existing or proposed building as per the formula annual energy consumption in kWh/total built-up area (excluding storage area and the parking in the basement) in m^2
- **EPI Ratio:** of a building means the ratio of the EPI of the Proposed Building to the EPI of the Standard Building.
- **Equipment:** Mechanical, electrical or static devices for operating a building, including but not limited to those required for providing cooling, heating, ventilation, lighting, service hot water, vertical circulation.
- **Equipment, existing:** Equipment previously installed in an existing building.
- **Illuminance:** At a point on a surface, the ratio of the luminous flux incident on an infinitesimal element of the surface containing the point under consideration to the area of the element.
- **Interior Lighting Power**: LPD x Gross Lighted Floor Area.
- **Kilowatt (kW):** The basic unit of electric power, equal to 1000 W.
- **Lighting system:** A group of luminaires circuited or controlled to perform a specific function.

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- **Lighting power allowance:**

  (a) Interior lighting power allowance: the maximum lighting power in watts allowed for the interior of a building

  (b) Exterior lighting power allowance: the maximum lighting power in watts allowed for the exterior of a building

- **Lighting Power Density:** Maximum lighting power per unit area of a space as per its function or building as per its classification.
- **Lumen (lm) :** SI unit of luminous flux. The luminous flux emitted within unit solid angle (one steradian) by a point source having a uniform intensity of one candela.
- **Luminaires:** A complete lighting unit consisting of a lamp or lamps together with the housing designed to distribute the light, position and protect the lamps, and connect the lamps to the power supply.
- **Lux:** The unit of illuminance (the measurement of illumination) is lux which is 1 lumen per m^2.
- **National Building Code 2016 (NBC):** model building code that provides guidelines for design and construction of buildings. In this code, National Building Code 2016 refers to the latest version by the Bureau of Indian Standards.
- **Reflectance:** The ratio of the light reflected by a surface to the light incident upon it.
- **Space:** An enclosed area within a building. The classifications of spaces are as follows for purpose of determining building envelope requirements:

  (a) Conditioned space: a cooled space, heated space, or directly conditioned space.

  (b) Semi-heated space: an enclosed space within a building that is heated by a heating system whose output capacity is greater or equal to 10.7 W/m2 but is not a conditioned space.

  (c) Non-conditioned space: an enclosed space within a building that is not conditioned space or a semi-heated space. Crawlspaces, attics, and parking garages with natural or mechanical ventilation are not considered enclosed spaces.

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- **Specific Energy Consumption:** The Specific Energy Consumption (SEC) is defined as the energy consumption per unit of product output.
- **Unconditioned buildings:** Building in which more than 90% of spaces are unconditioned spaces.
- **Unconditioned space:** Mechanically or naturally ventilated space that is not cooled or heated by mechanical equipment.
- **Uniformity Ratio:** Minimum illuminance divided by average illuminance levels.
- **Ventilation:** The process of supplying or removing air by natural or mechanical means to or from any space. Such air is not required to have been conditioned.
- **Watt:** The unit of power.
- **Wall Window Ratio:** The ratio of vertical fenestration area to gross exterior wall area. Gross exterior wall area is measured horizontally from the exterior surface; it is measured vertically from the top of the floor to the bottom of the roof.
- **Wet Bulb Temperature:** The steady temperature finally given by a thermometer having its bulb covered with gauze or muslin moistened with distilled water and placed in an air stream of not less than 4.5 m/s.
- **Working Plane:** A horizontal plane at a level at which work will normally be done.

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7. Annexure

A. Usage data collection template

S. No	Name of the Space	Floor	Area	Height	Type of Light (LED/ Halogen/ Tubelight/ Twin tubelight/ Incandescent)	LED/NON-LED	Total no.	Approximate Wattage(W)	Ballast wattage	Usage hours/ day	Total no. of days used	Total usage Wh/year	Total usage KWh/year	Total wattage	LPD	Connected Load
1	Chemistry Lab 2	Ground floor	198.19	3.5	Tubelight	NON-LED	35	40	14	10	180	3402000	3402	2034	10.2629	1.89
	Chemistry Lab 2	Ground floor			LED light	LED	6	24	0	10	180	259200	259.2			0.144
2	Chemistry Lab 1	Ground floor	113.46	3.5	Tubelight	NON-LED	12	40	14	10	180	1166400	1166.4	744	6.55738	0.648
	Chemistry Lab 1	Ground floor			LED light	LED	4	24	0	10	180	172800	172.8			0.096
3	Staff room	Ground floor	35.34	3.5	Tubelight	NON-LED	5	40	14	8	180	388800	388.8	270	7.64007	0.27
4	Balance room	Ground floor	21.3	3.5	Tubelight	NON-LED	2	40	14	8	100	86400	86.4	108	5.07042	0.108
5	Store room	Ground floor	28.48	3.5	Tubelight	NON-LED	6	40	14	8	200	518400	518.4	324	11.3764	0.324
6	Chem Lab 3	Ground floor	35.65	3.5	Tubelight	NON-LED	6	40	14	8	180	466560	466.56	372	10.4348	0.324
	Chem Lab 4	Ground floor	44.15	3.5	LED light	LED	2	24	0	8	180	69120	69.12			0.048
7	Chem Lab 4	Ground floor			Tubelight	NON-LED	9	40	14	8	180	699840	699.84	486		0.486
8	Research Lab	Ground floor	21.4	3.5	Tubelight	NON-LED	6	40	14	4	100	129600	129.6	324	15.1402	0.324
9	Canteen	Ground floor	74.8	3.5	Tubelight	NON-LED	10	40	14	5	60	162000	162	924	12.3529	0.54
10	Seminar Hall	Ground floor	58.5	3.5	LED light	LED	16	24	0	4	100	153600	153.6			0.384
11	Gymkhana	Ground floor	139	3.5	Tubelight	NON-LED	60	40	14	5	100	1620000	1620	3240	23.3094	3.24
12	Gymnasium	Ground floor	139	3.5	Tubelight	NON-LED	4	40	14	4	60	51840	51.84	216	1.55396	0.216
13	Hindi centre, counselling room, Extension activities, Mcom centre NSS, NCC,	Ground floor	25.88	3.5	Tubelight	NON-LED	6	40	14	2	100	64800	64.8	780	30.1391	0.324
14	Passage	Ground floor	169.42	3.5	LED light	LED	19	24	0	8	300	1094400	1094.4			0.456
	Passage	Ground floor			Tubelight	NON-LED	2	40	14	8	300	259200	259.2	108		0.108
15	Office	First floor	201.13	3.5	Tubelight	NON-LED	103	40	14	8	300	13348800	13348.8	6378	31.7108	5.562
	Office	First floor			LED light	LED	34	24	0	8	300	1958400	1958.4			0.816
16	Bio Lab 1	First floor	151.64	3.5	LED light	LED	6	24	0	8	300	345600	345.6	1116	7.35954	0.144
	Bio Lab 1	First floor			Tubelight	NON-LED	18	40	14	8	300	2332800	2332.8			0.972
17	Bio Lab 2	First floor	70.67	3.5	Tubelight	NON-LED	9	40	14	8	180	699840	699.84	486	6.87703	0.486
18	Bio Lab 3	First floor	67.53	3.5	Tubelight	NON-LED	11	40	14	8	180	855360	855.36	834	12.3501	0.594
19	Bio Lab 4	First floor	30.25	3.5	LED light	LED	10	24	14	8	180	547200	547.2		0	0.38
20	Bio Staff Room	First floor	33.1	3.5	Tubelight	NON-LED	8	40	0	8	180	460800	460.8	640	19.3353	0.32
21	Bio Lab 5	First floor	56.53	3.5	Tubelight	NON-LED	8	40	14	8	180	622080	622.08	480	8.49107	0.432
	Bio Lab 5	First floor			LED light	LED	2	24	18	8	180	120960	120.96			0.084
22	LCR	First floor	89.22	3.5	Tubelight	NON-LED	18	40	14	8	180	1399680	1399.68	972	10.8944	0.972
23	Room 12	First floor	122.52	3.5	Tubelight	NON-LED	12	40	14	8	180	933120	933.12	648	5.28893	0.648
24	Room 11	First floor	110.88	3.5	Tubelight	NON-LED	11	40	14	8	180	855360	855.36	594	5.35714	0.594
25	Passage	First floor	180	3.5	LED light	LED	8	24	0	8	180	276480	276.48	192	1.06667	0.192
26	Room 21A	Second floor	47.03625	3.5	Tubelight	NON-LED	6	40	14	8	300	777600	777.6	324	6.8883	0.324
27	Room 21B	Second floor	47.03625	3.5	Tubelight	NON-LED	6	40	14	8	180	466560	466.56	324	6.8883	0.324
28	Room 22	Second floor	47.421	3.5	Tubelight	NON-LED	8	40	14	8	180	622080	622.08	432	9.10989	0.432
29	Room 23	Second floor	79.94	3.5	Tubelight	NON-LED	8	40	14	8	180	622080	622.08	432	5.40405	0.432
30	Room 24	Second floor	51.39	3.5	Tubelight	NON-LED	8	40	14	8	180	622080	622.08	432	8.4065	0.432
31	Room 26	Second floor	85.324	3.5	Tubelight	NON-LED	7	40	14	8	180	544320	544.32	402	4.71145	0.378
	Room 26	Second floor			LED light	LED	1	24	0	8	180	34560	34.56			0.024
32	Phy Lab 1	Second floor	151.64	3.5	Tubelight	NON-LED	17	40	14	8	180	1321920	1321.92	918	6.05381	0.918
33	Phy Dark Room	Second floor	28.19	3.5	Tubelight	NON-LED	6	40	14	8	180	466560	466.56	324	11.4934	0.324
34	Phy Lab 2	Second floor	69.94	3.5	Tubelight	NON-LED	11	40	14	8	180	855360	855.36	594	8.49299	0.594
35	Phy staff room	Second floor	28.19	3.5	Tubelight	NON-LED	7	40	14	8	180	544320	544.32	378	13.409	0.378
36	Phy Lab 3	Second floor	160	3.5	Tubelight	NON-LED	19	40	14	8	180	1477440	1477.44	1026	6.4125	1.026
37	Passage	Second floor	180	3.5	Tubelight	NON-LED	6	40	14	8	180	466560	466.56	324	1.8	0.324
38	Biotechnology Dept	Third floor	200.44	3.5	Tubelight	NON-LED	39	40	14	8	180	3032640	3032.64	2106	10.5069	2.106
39	Room 38	Third floor	78.3412	3.5	Tubelight	NON-LED	8	40	14	8	180	622080	622.08	432	5.51434	0.432
40	Room 39	Third floor	79.94	3.5	Tubelight	NON-LED	9	40	14	8	180	699840	699.84	486	6.07956	0.486
41	Study Room	Third floor	45.505	3.5	Tubelight	NON-LED	9	40	14	8	180	699840	699.84	486	10.6801	0.486
42	Library 01	Third floor	94.0725	3.5	Tubelight	NON-LED	15	40	14	8	180	1166400	1166.4	954	10.1411	0.81
	Library 01	Third floor			LED light	LED	6	24	0	8	180	207360	207.36			0.144

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S. No	Name of the Space	Floor	Type of Fan (Ceiling/ Exhaust/ Wall Mounted Fan/ Pedestal Fan)	Total no. of Fans	Approximate Wattage	Usage Hours per day	Total no. of days used	Total usage Wh/year	Total usage Kwh/year
1	Chemistry Lab 2	Ground floor	Ceiling fan	3	72	4	180	155520	155.52
	Chemistry Lab 2	Ground floor	Exhaust fan	14	50	4	180	504000	504
2	Chemistry Lab 1	Ground floor	Ceiling fan	1	72	4	180	51840	51.84
	Chemistry Lab 1	Ground floor	Exhaust fan	13	50	4	180	468000	468
3	Chem library	Ground floor	Ceiling fan	1	72	4	180	51840	51.84
4	Staff room	Ground floor	Ceiling fan	2	72	8	180	207360	207.36
6	Store room	Ground floor	Ceiling fan	2	72	4	180	103680	103.68
	Store room	Ground floor	Exhaust fan	1	50	4	180	36000	36
7	Chem Lab 3	Ground floor	Ceiling fan	3	72	4	180	155520	155.52
	Chem Lab 3	Ground floor	Exhaust fan	1	50	4	180	36000	36
8	Chem Lab 4	Ground floor	Ceiling fan	5	72	4	180	259200	259.2
9	Research Lab	Ground floor	Ceiling fan	1	72	4	180	51840	51.84
	Research Lab	Ground floor	Exhaust fan	1	50	4	180	36000	36
10	Canteen	Ground floor	Ceiling fan	8	72	4	180	414720	414.72
11	Seminar Hall	Ground floor	Ceiling fan	7	72	4	180	362880	362.88
12	Gymkhana	Ground floor	Ceiling fan	8	72	4	180	414720	414.72
13	Gymnasium	Ground floor	Exhaust fan	3	50	4	180	108000	108
14	Hindi centre, counselling	Ground floor	Ceiling fan	1	72	2	180	25920	25.92
15	Passage	Ground floor	Ceiling fan	2	72	2	180	51840	51.84
16	Office	First floor	Ceiling fan	39	72	8	180	4043520	4043.52
	Office	First floor	Exhaust fan	2	50	8	180	144000	144
17	Bio Lab 1	First floor	Ceiling fan	11	72	4	180	570240	570.24
18	Bio Lab 2	First floor	Ceiling fan	6	72	4	180	311040	311.04
19	Bio Lab 3	First floor	Ceiling fan	4	72	4	180	207360	207.36
20	Bio Lab 4	First floor	Wall mounted fan	2	50	4	180	72000	72
21	Bio Staff Room	First floor	Ceiling fan	3	72	4	180	155520	155.52
22	Bio Lab F	First floor	Ceiling fan	8	72	4	180	414720	414.72
23	LCR	First floor	Ceiling fan	8	72	4	180	414720	414.72
	LCR	First floor	Exhaust fan	1	50	4	180	36000	36
24	Room 12	First floor	Ceiling fan	7	72	8	180	725760	725.76
25	Room 11	First floor	Ceiling fan	7	72	8	180	725760	725.76
26	Room 21A	Second floor	Ceiling fan	7	72	8	180	725760	725.76
	Room 21A	Second floor	Exhaust fan	2	50	8	180	144000	144
27	Room 21B	Second floor	Ceiling fan	7	72	8	180	725760	725.76
	Room 21B	Second floor	Exhaust fan	2	50	8	180	144000	144
28	Room 22	Second floor	Ceiling fan	7	72	8	180	725760	725.76
	Room 22	Second floor	Exhaust fan	1	50	8	180	72000	72
29	Room 23	Second floor	Ceiling fan	7	72	8	180	725760	725.76
30	Room 24	Second floor	Ceiling fan	7	72	8	180	725760	725.76
31	Room 26	Second floor	Ceiling fan	7	72	8	180	725760	725.76
32	Phy Lab 1	Second floor	Ceiling fan	7	72	4	180	362880	362.88
	Phy Lab 1	Second floor	Exhaust fan	1	50	4	180	36000	36
	Phy Lab 1	Second floor	Wall mounted fan	1	50	4	180	36000	36
33	Phy Dark Room	Second floor	Ceiling fan	2	72	4	180	103680	103.68
	Phy Dark Room	Second floor	Exhaust fan	1	50	4	180	36000	36
34	Phy Lab 2	Second floor	Ceiling fan	4	72	4	180	207360	207.36
	Phy Lab 2	Second floor	Exhaust fan	1	50	4	180	36000	36
35	Phy staff room	Second floor	Ceiling fan	3	72	8	180	311040	311.04

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S. No	Name of the Space	Floor	Name of the Equipment	Total no. of Equipment	Approximate Wattage	Usage hours/ day	Total no. of days used	Total usage Wh/year	Total usage Kwh/year	Connected Load
1	Passage	Ground floor	Water coolor	1	100	12	180	216000	216	0.1
2	Passage	First floor	Water coolor	1	100	12	180	216000	216	0.1
3	biology lab	First floor	Autoclave	1	6000	2	180	2160000	2160	6
4	biology lab	First floor	Hot air oven	2	1500	2	180	1080000	1080	3
5	biology lab	First floor	Incubator	1	300	2	180	108000	108	0.3
6	biology lab	First floor	Muffle furnace	1	2000	2	180	720000	720	2
7	Central facilty lab	First floor	Ultracentrifuge	1	1000	2	180	360000	360	1
8	Central facilty lab	First floor	HPLC	1	500	2	180	180000	180	0.5
9	Central facilty lab	First floor	Digital motic Microscope	1	300	2	180	108000	108	0.3
10	Central facilty lab	First floor	FTIR	1	300	2	180	108000	108	0.3
11	Central facilty lab	First floor	Centifuge	2	700	2	180	504000	504	1.4
12	Central facilty lab	First floor	Sensitive balance	2	100	2	180	72000	72	0.2
13	Central facilty lab	First floor	Laminar air flow	1	450	2	180	162000	162	0.45
14	Central facilty lab	First floor	pH Meter	2	100	2	180	72000	72	0.2
15	Central facilty lab	First floor	Conductivity meter	1	100	2	180	36000	36	0.1
16	Passage	Second floor	Water coolor	2	100	12	180	432000	432	0.2
17	Passage	Third floor	Water coolor	2	100	12	180	432000	432	0.2
18	biotechnology lab	Third floor	Hot air oven	1	1500	2	180	540000	540	1.5
19	biotechnology lab	Third floor	Incubator	1	350	2	180	126000	126	0.35
20	biotechnology lab	Third floor	Autoclave	1	6000	2	180	2160000	2160	6
21	biotechnology lab	Third floor	Shaker	1	300	2	180	108000	108	0.3
22	biotechnology lab	Third floor	Laminar air flow	3	450	2	180	486000	486	1.35
23	research lab	Fourth floor	Autoclave	1	3000	2	180	1080000	1080	3
24	research lab	Fourth floor	Hot air oven	1	1500	2	180	540000	540	1.5
25	research lab	Fourth floor	Vaccum oven	1	500	2	180	180000	180	0.5
26	research lab	Fourth floor	Laminar air flow	2	450	2	180	324000	324	0.9
27	research lab	Fourth floor	Zeiss Microscope	1	300	2	180	108000	108	0.3
28	research lab	Fourth floor	UV-VIS spectrophotomete	2	100	2	180	72000	72	0.2
29	research lab	Fourth floor	Centifuge	1	700	2	180	252000	252	0.7
30	research lab	Fourth floor	Sensitive balance	2	100	2	180	72000	72	0.2
31	research lab	Fourth floor	Laminar air flow	2	450	2	180	324000	324	0.9
32	research lab	Fourth floor	pH Meter	1	100	2	180	36000	36	0.1
33	research lab	Fourth floor	Balance	1	100	2	180	36000	36	0.1
34	Passage	Fourth floor	Water coolor	2	100	12	180	432000	432	0.2
35	Passage	Fifth floor	Water coolor	1	100	12	180	216000	216	0.1
36	entire college	all five floor	Computers	562	100	6	180	60696000	60696	56.2
	Pumps	ground floor	pumps	3	7500	1	300	2250000	2250	7.5
	Lift	all five floor	Lifts	2	4000	6	300	14400000	14400	8
								91404000	**91404**	**106.25**

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B. Floor Layouts

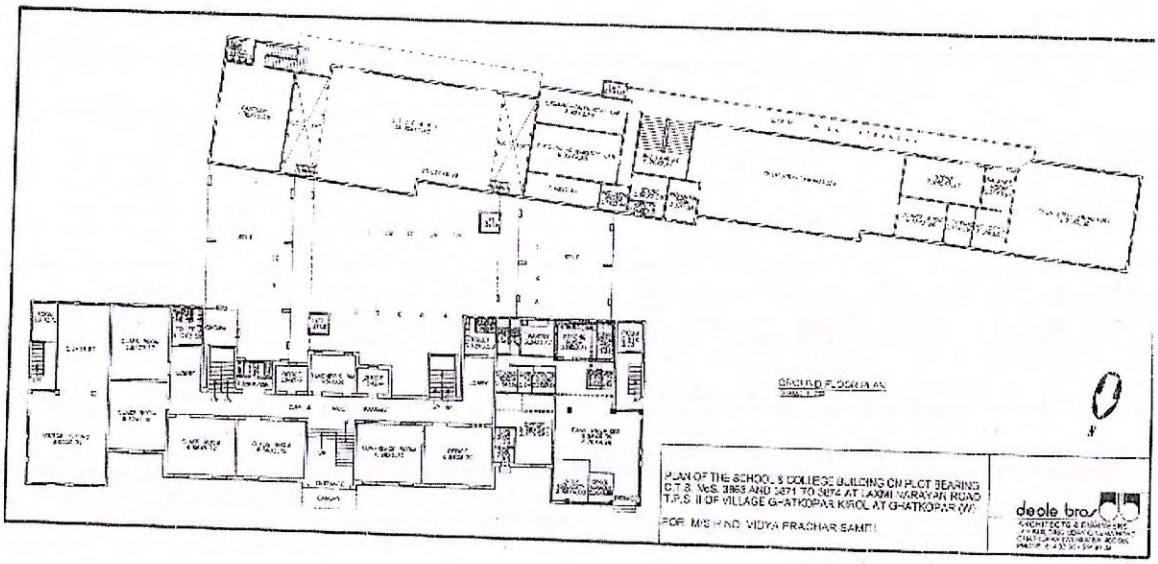

Figure 20: Campus Layout

Ramniranjan Jhunjhunwala College of Arts, Science & Commerce
Est. 1963
AUTONOMOUS
NAAC
Re-accredited
'A' Grade
Ghatkopar (W), Mumbai-400 086, INDIA

Certified as
TRUE COPY

Principal
Ramniranjan Jhunjhunwala College,
Ghatkopar (W), Mumbai-400086.

C.Sample Electricity bill of Jhunjhunwala College

The power of service

स्वच्छाग्रह
Join us at www.swachhagraha.org to be part of our cleanliness drive

SCAN CODE TO PAY YOUR BILL VIA UPI
Use any bank / UPI App

adani Electricity

T-605

BILL OF SUPPLY | PUBLIC SERVICE-OTHER

PRINCIPAL RAMNIRANJA ZUNZUNWALA COLLEGE
OPP GHATKOPAR RAILWAY STATION
GHATKOPAR (W) near railway station
MUMBAI 400086
Mobile No. 99******41
Email ID
Connected Load 0.88kW

To update your email id and mobile no.,call us on 19122

24X7 Powerline
19122 We're listening.

CUSTOMER CARE CENTRE / CORRESPONDENCE ADDRESS / INTERNAL GRIEVANCE REDRESSAL CELL (IGRC)
i) Tilak Nagar, Road No. 3, Chembur, Mumbai - 400 089 • Fax: 30092022 ii) Sakinaka Junction, Andheri-Kurla Road, Mumbai, - 400 072

For power interruption complaint or restoration status
SMS POWER <9 digit account no.> to 7065313030 from any mobile no.
Give us a missed call on 1800 532 9998 from your registered mobile no.
Whatsapp POWER <9 digit account no.> to 9594519122 from any mobile number.

www.adanielectricity.com
helpdesk.mumbaielectricity@adani.com
Join us on,

Bill No. 101264230564 Bill Date 15-01-2020 Type of Supply LT
Bill Distribution No. EAST/EZ1-POWAI /23/123/26/026/001 Cycle No. 23

ACCOUNT NO. 150513306
BILL MONTH DEC-19
DUE DATE* 05-02-2020*
Electric Smiles SMILES EARNED 980

DUE AMOUNT
2890.00

NEW Earn Points on E-payments/ Cashless Payments. Please login to Adani Electricity Mobile App to view/redeem points (Electric Smiles) earned.

DISCOUNTED BILL AMOUNT
Round sum bill payable (after discount of ₹ 23.21) on or before discount date 22-01-2020 ₹ 2860.00 #

LATE PAYMENT BILL AMOUNT
Round sum bill payable (including DPC of ₹ 36.04) after due date 05-02-2020 ₹ 2920.00 #

*Refers only to current bill amount. Previous balance is payable immediately.
#Payable until one month after due date, thereafter interest applicable as per MERC tariff order

YOUR CURRENT CONSUMPTION

Tariff	Meter number	Multiplying Factor (MF)	Energy consumption: Present reading	Energy consumption: Previous reading	Energy consumption: Consumption (Unit kWh)	Energy charge (₹)	Fixed charge (₹)
LT IX (B)	8716305	1	20167.00	19946.00	221.00	1414.40	365.00
Total					221	1414.40	365.00

TRACK YOUR CONSUMPTION (UNITS)

Nov-19	400
Oct-19	96
Sep-19	398
Aug-19	305
Jul-19	296
Jun-19	113
May-19	300
Apr-19	310
Mar-19	434
Feb-19	141
Jan-19	345

221 Dec-19 | 323 Dec-18

NS-7
108789
18/01/2020

IMPORTANT MESSAGE
- Install earth leakage protection device for sanctioned load 1kw and above to prevent harmful electric shock.
- Additional security deposit demanded along with April 2019 bill still unpaid Rs 550.00
- Tentative meter reading date for your Jan-20 bill is 31/02/2020.
- Please Check / Update your PAN and GSTIN number by visiting nearest Customer Care Center or email to helpdesk.mumbaielectricity@adani.com with copies of PAN and GSTIN for verification. If already submitted & correctly printed on the bill please ignore this message.

J COLLEGE, GHATKOPAR
MUMBAI-400 086. ****
WARD No. 1903
DATE 16/01/2020
SIGNATURE



Electricity bill payments, now more convenient.
Introducing the GeniusPay outlet in your locality.
geniusPay
PAYMENTS MADE SIMPLE
Payment modes available • Cash • Cheque • Card • Online Open all days from 7 AM to 11 PM

NITIN KATE
Commercial Management Head

Abbr. in receipt: 'Q' for cheque 'C' for cash, E80 E. Consolidated stamp duty paid by order no. CSD/183/2019/4980 dated 22.10.2019

For Advertisement, please contact on info@seshaasai.com

This electricity bill neither reflects a title nor is to be used as a proof of ownership of any property or premises.

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I/c Principal
Ramniranjan Jhunjhunwala College, Ghatkopar (W), Mumbai-400086.

D.Sample Water bill

Cheque Reissued :-

बृहन्मुंबई महानगरपालिका

-: जल आकार देयक :-

SAC : 999111

GSTIN : 27AAALM0042L3Z4

जलजोडणी धारकाचे नाव आणि पत्ता :-
PRINCIPAL, RAMNIRANJAN JHUJUNWALLA COLLEGE GHATKOPAR WEST BOMBAY 400086

जलजोडणी क्र (CCN)
NXA6170008

देयक कालावधी (Bill Period)
26-11-2018 to 22-02-2019

विभाग (Ward)
N-WARD

देयं दिनांक (Due Date)
12-04-2019

देयक क्रमांक (Bill No.)
1819HEW1336710

विद्यमान देयक रक्कम (Current Bill Amount) (₹)
18552

देयक दिनांक (Bill Date)
26-02-2019

पुस्तक / पृष्ठ क्र.	मलप्पा अधिनियम क्र	जलजोडणी आकार
N 046 / 185	169	40 (मि.मी.)

दैनिक गरज (लिटर)	संख्या - सदनिका/गाळे/झोपडी
1	0

जलमापक मालकी	जलमापक क्रमांक	जलमापक आकार
P	222	40 (मि.मी.)

मागील दिनांक/वाचन (कि.ली.)	विद्यमान दिनांक/वाचन (कि.ली.)	दिवस
26-11-2018	22-02-2019	88
0	3732	

विद्यमान वापर (कि.ली.)	दुय्यम/संमिश्र वापर सूट (कि.ली.)	प्रत्यक्ष वापर (कि.ली.)
(C1) 2144	(C2) 0	(C1-C2) 2144

जलमापक स्थिती	जलजोडणी प्रकार	दर प्रति (कि.ली.) ₹
RNR	MB01	5.09

मागील देयक कालावधी	वापर (कि.ली.)
21-08-2018 to 26-11-2018	2363
22-05-2018 to 21-08-2018	2217
21-02-2018 to 22-05-2018	2193
22-11-2017 to 21-02-2018	2217
21-08-2017 to 22-11-2017	2266
20-05-2017 to 21-08-2017	2266
20-02-2017 to 20-05-2017	2169
21-11-2016 to 20-02-2017	2193
22-08-2016 to 22-11-2016	2242
23-05-2016 to 22-08-2016	2218
24-02-2016 to 23-05-2016	2169
21-11-2015 to 24-02-2016	2315

महत्वाच्या सूचना

१) देयक प्राप्त झाले नाही म्हणून देयकाचा भरणा केला नाही ही सबब ग्राह्य धरली जाणार नाही.

२) www.portal.mcgm.gov.in या बृहन्मुंबई महानगरपालिकेच्या संकेतस्थळावर तसेच मोबाईलवर MCGM 24 x 7 या app द्वारे देखील जलजोडणी क्रमांकाची नोंद करुन देयकाची दुय्यम प्रत उपलब्ध होते, तसेच थकबाकीसह जलदेयकाचा भरणा करता येतो.

३) देयक आणि त्याचा भरणा केल्याची माहिती विहित वेळेत मिळण्याकरिता ग्राहकाने मोबाईल नंबर व ई-मेल, संबंधित विभागीय सहाय्यक अभियंता (जलकामे) यांच्याकडे अथवा महानगरपालिकेच्या संकेतस्थळावरील KYC मध्ये नोंदवावा.

४) "Brihanmumbai Mahanagarpalika" या नावाने धनादेश काढावा व धनादेशाच्या पाठीमागे जलजोडणी क्रमांक व मोबाईल नंबर लिहावा.

५) मालमत्तेचा SAC/UID क्रमांक विभाग कार्यालयातील सहाय्यक अभियंता (जलकामे) यांच्याकडे अर्जाद्वारे अथवा महानगरपालिकेच्या संकेतस्थळावरील KYC मध्ये नोंदवावा

6) To make Payment through NEFT

IFSC Code - SBIN0COLLEC
A/C. No. - BMCW000000NXA6170008
Name - MCGM Water Charges

जलआकार (Water Charges)	10913
मलनिःसारण आकार - जल आकाराच्या ७०% (Sewerage Charges) - (70% of waterchrges)	7639
जलमापक भाडे (Meter Rent)	0
अतिरिक्त आकार (Additional Charges)	0
विद्यमान देयक रक्कम (Current Bill Amount)	18552
मागील बाकी (Previous Outstanding)	0
जमा रक्कम (Credit Amount)	0
एकूण देय रक्कम (Total Payable Amount)	18552

देयक निर्मिती दिनांकास जादा जमा रक्कम (Excess Credit Amount as on Bill Process Date) 26-02-2019 ₹ 0

NXA6170008

जल अभियंता

दुरुस्ती

(१) देय दिनांकापर्यंत देयकाचा भरणा न केल्यास सदर देयक नोटीस समजण्यात येऊन मुंबई महानगरपालिका अधिनियम कलम २७२ अन्वये जलजोडणी खंडित करण्यात येईल त्या नोटीशीमुळे दुर्योची नोटीस रद्द होत नाही.

(२) झोपडपट्ट्यामधील निवासी जलजोडण्यांवरील खाजगी जलमापक १२ महिन्यांपेक्षा व इतर सर्व जलजोडण्यांवरील खाजगी जलमापक ६ महिन्यांपेक्षा जास्त कालावधीसाठी नादुरुस्त (EXM, RVS, MMR, TPR) असल्यास पाण्याची दैनंदिन सरासरी किंवा मागील जलावधीतील प्रत्यक्ष वापर यापैकी जो जास्त असेल तो ७ पट जादावार २.५% अधिक कायम वापर आकारण्यात येतो.

(३) आपले जलमापक कायम चालू स्थितीत राहील तसेच जलमापक चेंबर, पाईप फिटिंग सुस्थितीत राहतील याची खबरदारी घेण्यात यावी.

◆ Available Security Deposit: (उपलब्ध अनामत रक्कम.) ₹	null null

पत्रव्यवहारासाठी पत्ता :-
Asst. Engineer (Water Works) N Ward Municipal Office Bldg.,(Annex), Jawahar Road, Ghatkoper (E),Mumbai-400 077.

दूरध्वनी क्र 25010161/65

नाव व टपालाचा पत्ता :- Ch Cancelled 003379. NXA6170008 N 046 / 185

PRINCIPAL
RAMNIRANJAN JHUJUNWALLA COLLEGE GHATKOPAR
WEST BOMBAY 400086

V.NO:- DUN373

हे जलदेयक मालमत्ता अथवा मालमत्तेचा मालकी हक्क सिद्ध करण्यासाठी तसेच पुरावा म्हणून ग्राह्य धरु नये.

Certified as TRUE COPY

I/c Principal
Ramniranjan Jhunjhunwala College, Ghatkopar (W), Mumbai-400086.

E. A Branch of Safai Bank of India - Multi Layer Plastic collection

Kulkarni Foundation
Make World a Better Place

To,

Dr. (Mrs.) Usha Mukundan,

Principal,

Ramniranjan Jhunjhunwala College

Ghatkopar West, Mumbai

Dear Madam,

Thank you very much for your pro- active acceptance of opening a branch of our Project "Safai Bank Of India".

Hereby we appoint your College (*HVPS's* **Ramniranjan Jhunjhunwala College**) as a branch of Safai Bank of India.

We would start the process of integrating on our website. And shortly we will start the process of Training your students on concept and why Plastic bank is necessary.

We would urge you to create a core team with key professors of NSS, NCC and other departments in the college. We would train students on collection and how the whole system of branch operations work.

Thanking you

Satish Kulkarni

Kulkarni Foundation

M3/804 Riddhi Gardens, Film City Road, Malad East Mumbai 400097 email kulkarnifoundation@gmail.com mobile +917045351897 /9322891897

Ramniranjan Jhunjhunwala College of Arts, Science & Commerce Est. 1963 AUTONOMOUS NAAC Re-accredited 'A' Grade Ghatkopar (W), Mumbai-400086

Certified as TRUE COPY

T/c Principal
Ramniranjan Jhunjhunwala College,
Ghatkopar (W), Mumbai-400086.

F. Certificate for E-waste Recycling

CERTIFICATE
OF
RESPONSIBLE RECYCLING

ISSUED TO

Rj College of Arts, Science and Commerce

This document certifies that E-Incarnation Recycling Private Limited, processes, recycles, destroys and displaces the received material in an environmentally sustainable manner that is in accordance with all local, state and central Government regulations. Further E-Incarnation Recycling Private Limited certifies that all intellectual client data will be destroyed or erased properly from the hard drives and other media.

E-Incarnation Recycling Private Limited assumes ownership, possession, title, responsibility and control of the materials received on 10-08-2019;listed in Section A of this Certification.

Contact: Opposite Ghatkopar Railway Station, Ghatkopar (west), Mumbai - 400086

Section A: Materials Received for processing

ERPL Customer Id: 987 Transaction Id: 970

Materials Received	Quantity
E- waste	519 kg

E-INCARNATION RECYCLING PVT. LTD. Mumbai

Reg. No.: MPCB/RO(HQ)/Reg./15/E-waste/HWMD-258

E-Incarnation Recycling Pvt. Ltd. Mardia House, 96, C. P. Tank Road, Mumbai - 400 004.
Tel - 022 66251300-33. Fax - 022 23877102. E-Mail - recycle@E-Incarnation.com. Web - www.E-Incarnation.com.

Ramniranjan Jhunjhunwala College of Arts, Science & Commerce * Ghatkopar (W), Mumbai-400 086 * Est. 1963 AUTONOMOUS NAAC Re-accredited 'A' Grade

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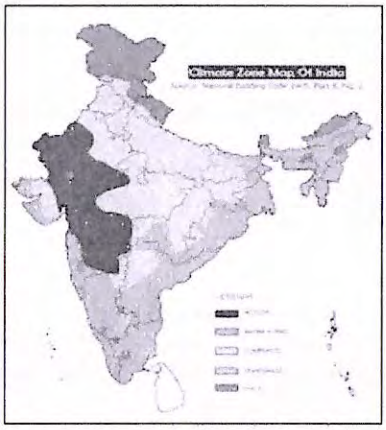
Principal
Ramniranjan Jhunjhunwala College,
Ghatkopar (W), Mumbai-400086.

G. Energy benchmarks for Commercial Buildings



Based on the data collected from different categories of commercial buildings, the following tables show the indicative EPI benchmarks.

EPI benchmarks for Office Buildings

Climate Zone	Less than 50% AC	More than 50% AC
	EPI (kWh/m²/yr)	
Warm & Humid	101	182
Composite	86	179
Hot & Dry	90	173
Moderate	94	179

EPI benchmarks for Shopping Malls

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	428
Composite	327
Hot & Dry	273
Moderate	257

EPI benchmarks for Hospitals

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	275
Composite	264
Hot & Dry	261
Moderate	247

EPI benchmarks for Hotels

Climate Zone	Upto 3 star	Above 3 star
	EPI (kWh/m²/yr)	
Warm & Humid	215	333
Composite	201	290
Hot & Dry	167	250
Moderate	107	313

EPI benchmarks for Institutes

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	150
Composite	117
Hot & Dry	106
Moderate	129

EPI benchmarks for BPOs

Climate Zone	EPI (kWh/m²/yr)
Warm & Humid	452
Composite	437
Hot & Dry	-
Moderate	433

Disclaimer : The EPI benchmarks should be considered as an indicative figure as it largely depends upon the operating hours, energy efficiency measures, sample size, climatic zone and lack of detailed information by building owners.

UNDP gef

Energy benchmarks for Commercial Buildings



ENERGY IS LIFE CONSERVE IT

Bureau of Energy Efficiency
4th Floor, Sewa Bhawan, R.K. Puram, New Delhi – 110066
Website : www.beenet.in

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Ghatkopar (W), Mumbai-400086.

H.List of Vendors

Solid Waste Management

Ms. Jyoti Mhapsekar,
President,
Stree Mukti Sanghatana (SMS)
Mobile: +91 9867724529

Chembur Center
Room No. 14 Santiniketan Chawl,
Postal colony, Next to BD Shukla school
Chembur, Mumbai - 400071
Phone: 022 65745837/022 25274588
Email: smspv123@gmail.com

Govandi Office
Ahilyabai Holkar Marg, Near Jafri High School bus stop,
Govandi- Mumbai - 400043
Phone: 022 65745840
Email: smspbvs@gmail.com

Solar PV panels

Avesta Solar
Dossabhoy Manison A,
Ground floor plot no. 796, Jame Jamshed Road,
Dadar East, Mumbai - 400014
Phone: 09819867196

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Ghatkopar (W), Mumbai-400086.

I. Solar Photo Voltaic System: Inspection and Maintenance Process Document

1. General Checks and Inspections

a. Roof drainage to be adequately designed and maintained to allow the Rainwater to Flow out from the Solar PV System area.
b. Check for ground erosion near the footings of the System
c. Electrical enclosures to be accessible to authorised personnel only
d. Inspect for corrosion on the Array Structures & outside of enclosures.
e. Check for cleanliness throughout the site to ensure that there is no Grime and dust in and around the inverter pad area or elsewhere
f. Ensure No loose hanging wires in the array
g. Check for signs of Bird's dropping infestation over the array and attend to it immediately by cleaning.

2. Modules

Condition Based Monitoring is the Best Management Practice for Maintenance of Solar Array. Modules need the maximum amount of preventive maintenance, and cleaning activities are majorly concentrated around them.

a. Frequency of cleaning: Ideally Once a Week an inspection of Array to be carried out. Cleaning frequency To be decided upon the location and seasonal variation.
b. Water Quality: The cleaning of the modules is done keeping in mind the TDS (total dissolved solids) levels, water specifications and certain wiping details. In India, the TDS level of the water needs to be at least below 250 parts per million (ppm). The chlorine (less than 250 ppm) and calcium (less than 250 ppm) level of the water, as well as the electrical conductivity, is kept in mind while carrying out the cleaning. Water quality is tested after every six months to ensure that set standards are maintained.

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Ramniranjan Jhunjhunwala College, Ghatkopar (W), Mumbai-400086.

c. Quality of cleaning equipment: Fibre cloth / Soft Brushes to be used to avoid abrasion on the Glass surface. For Bird Droppings / Stubborn Stains consult OEM for approval of cleaning chemicals.

d. Drying of Washed Surface : is of prime importance to avoid leaving Wash marks and dust getting stuck to the wet surface.

e. Automated Cleaning System saves 50% of Water used and improves system's Efficacy @ 5-7%. Cleaning is programmed on daily basis.
As the system is costly it is slowly gaining acceptance in the industry. Cost justification is challenging for Smaller Capacity systems

3. Inverter

a. Inverter is hi-Tech device in the entire PV System. Follow the instruction of the OEM and leave Checking and Servicing to the OEM or their approved Service Vendor.

b. Annual Health Check-up of Inverter is strongly recommended.

c. Continuous (daily) Online Monitoring of the Data @ Inverter will convey the health of the Inverter. In case of any change in Generation pattern to be immediately communicated to OEM for check-up.

d. Installation of the Inverter to be done as per the OEM's guidelines and ensure it's protection from Rain Water, Lightning. Proper Protection to be ensured.

e. ACDB (Alternate Current Distribution Board) is a unit which is installed & integrated with Inverter for Solar Power Output to the Premise. It's protection protocol should be similar to that of Inverter.

f. Annual Health Check up should include but not limited to following

i. Checking connection of Wires at Terminals

ii. Testing Voltage / Current through the Array strings

iii. Inspection of moisture ingress in the Terminal boxes etc.

iv. Functional Testing of online communication devices like routers, metrological devices.

v. Setting at the Inverter

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Ghatkopar (W), Mumbai-400086.

4. **Cabling & Connector**

   a. Ensure that there is no gap between the male and female connector pipes. Any gap, irrespective of the size, could cause a fire and damage the modules.

5. **Lightning Protection**

   a. There shall be the required number of suitable Lightning Arrestors installed in the Array field. Lightning protection shall be provided by use of 'Surge Protection Device' (SPD) and suitable Earthing such that induced transients are routed through the Earthing path and not impact the Solar Inverter system.

6. **Earthing Protection**

   b. Each array structure of the PV system should be properly grounded in addition to Lightning arrestor grounding. Provision to be kept for shorting and grounding of PV array at the time of Maintenance work.

7. **Rain Protection**

   a. Inverter and ACDB are installed besides the Solar Array on the open Terrace.
   b. Rain cover Shade or better to provide Enclosure over the Inverter and ACDB to avoid direct exposure to Rain Water and also help avoid Dust Ingress.
   c. All the Enclosures should be IP 65
   d. Sealing (Water proofing) of Inverters, ACDB, Terminal Boxes to be thoroughly check prior to onset of Monsoon.

8. **Remote Metering: Monitoring the solar PV panels consistently is the cornerstone of the O&M of a solar power plant**

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Ghatkopar (W), Mumbai-400086.

a. A "check meter" of equal or higher accuracy with reference to the main meter to cross-check the production level on a regular basis is highly desirable. All readings must be, more or less equal, with a 2-3% correction allowance.

b. A solar power plant constantly needs to be monitored to detect breakdowns and optimise its operation. Online Monitoring System will go a long way in ensuring the 'Operational Efficiency' of the system.

c. System should be capable of executing following function

   i. Individual Array Monitoring
   ii. Measurement and Recording of Energy and other Allied parameters
   iii. Operating state monitoring and failure indication

9. Safety

a. Operations, Inspection & Maintenance work to be carried out by Authorized Trained Personnel ONLY
b. High Voltages are prevalent at the Arrary and Inverter.
c. Before Initiating any work on Electrical Device (Inverter, ACDB, Terminals at Solar Array) Switch OFF the System.
d. Do not open the inverter when Powered ON. To be done by authorized person only.
e. All the wiring and connectors to be properly harnessed and routed through Cable Trays.

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Ghatkopar (W), Mumbai-400086.

J. Energy Auditor's Certificate

Regn. No. EA-4593

No. 1765

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr. / Ms. Shripad Vishnu Kale

son / daughter of Mr./Ms. Vishnu Krishna Kale

has passed the National Certification Examination for Energy Auditors held in 2006, conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Govern

He / She is qualified as Certified Energy Manag[illegible] as Certified Energy Auditor.

He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for the Accredited Energy Auditor and issue of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the issuance of an official certificate by the Bureau of Energy Efficiency.

Place : Chennai, India

Date : 2nd November, 2006

Controller of Examination

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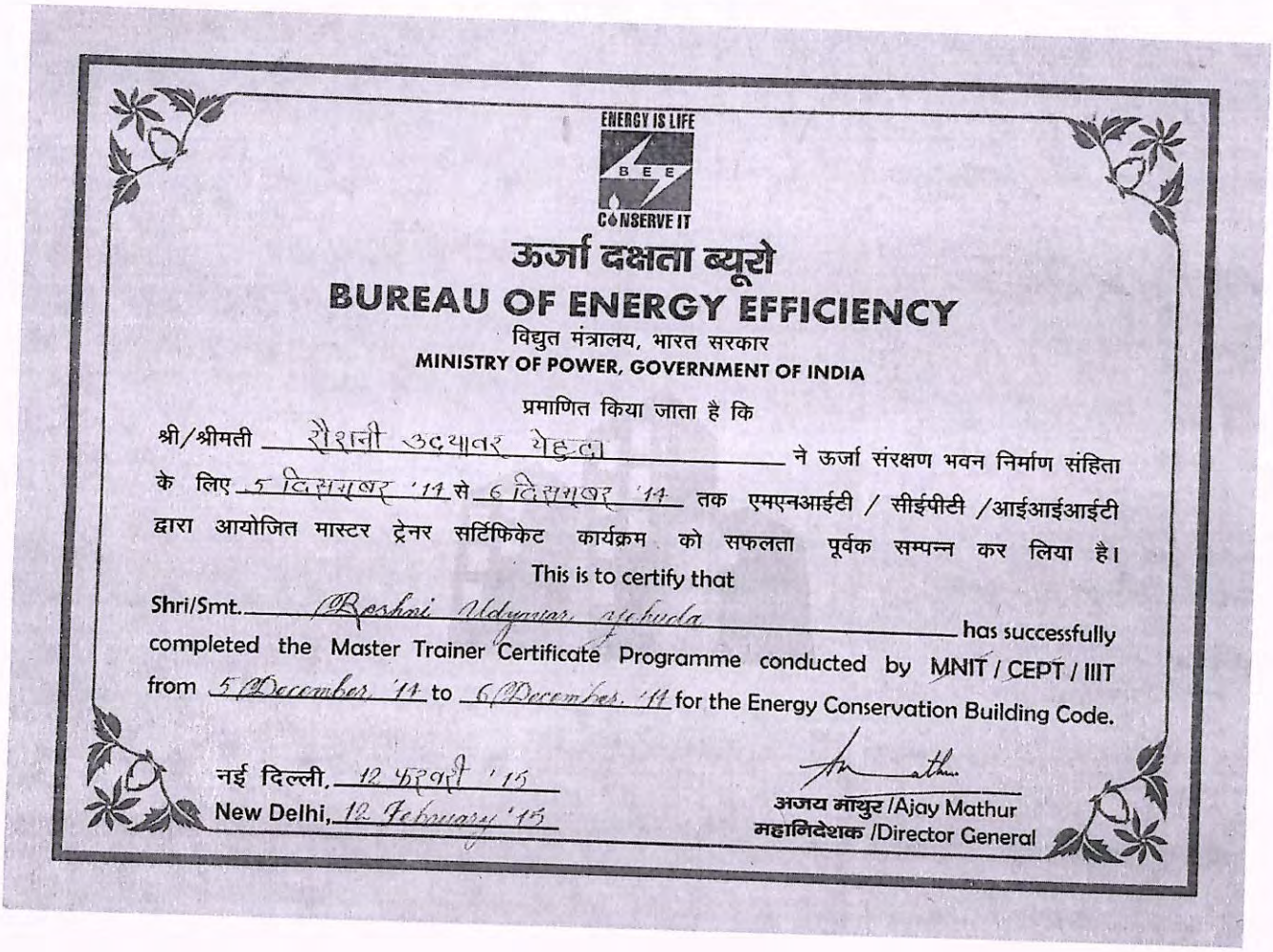
K. BEE Master Trainer Certificate



ENERGY IS LIFE
CONSERVE IT

ऊर्जा दक्षता ब्यूरो
BUREAU OF ENERGY EFFICIENCY
विद्युत मंत्रालय, भारत सरकार
MINISTRY OF POWER, GOVERNMENT OF INDIA

प्रमाणित किया जाता है कि

श्री/श्रीमती रौशनी उदयावर येहुदा ने ऊर्जा संरक्षण भवन निर्माण संहिता के लिए 5 दिसम्बर '14 से 6 दिसम्बर '14 तक एमएनआईटी / सीईपीटी /आईआईआईटी द्वारा आयोजित मास्टर ट्रेनर सर्टिफिकेट कार्यक्रम को सफलता पूर्वक सम्पन्न कर लिया है।

This is to certify that

Shri/Smt. Roshni Udyavar, Yehuda has successfully completed the Master Trainer Certificate Programme conducted by MNIT / CEPT / IIIT from 5 December '14 to 6 December '14 for the Energy Conservation Building Code.

नई दिल्ली, 12 फरवरी '15
New Delhi, 12 February '15

अजय माथुर /Ajay Mathur
महानिदेशक /Director General

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L. BEE Empaneled Expert professional

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(भारत सरकार, विद्युत मंत्रालय)

BUREAU OF ENERGY EFFICIENCY
(Government of India, Ministry of Power)

SPEED POST

F.No.09/06/07/IMPL/ECBC/11745

28th March, 2016

Ms. Roshni Udyavar Yehuda
Rachana Sansad's Institute of Environmental Architecture
278, Shankar Ghanekar Marg, Prabhadevi
Mumbai – 400 025

Sub: Energy Conservation Building Code – Shortlisting of Architects/ Consultant reg.

Dear Madam,

This has reference to your application for shortlisting of Architects/Consultants for implementing the Energy Conservation Building Code (ECBC). We are pleased to inform you that you have been shortlisted to act as the resource person of the Bureau of Energy Efficiency (BEE) for helping in building technical capacity and develop compliance procedures and tools for the effective implementation of the ECBC. In addition, you would also be expected to advise design professionals in modifying the standard specifications so as to correspond with the Code requirements.

We would like you to send in your acceptance to being associated with the BEE in providing technical assistance to all those seeking to adopt Energy Conservation Building Code.

Yours faithfully,

(Sanjay Seth)
Energy Economist

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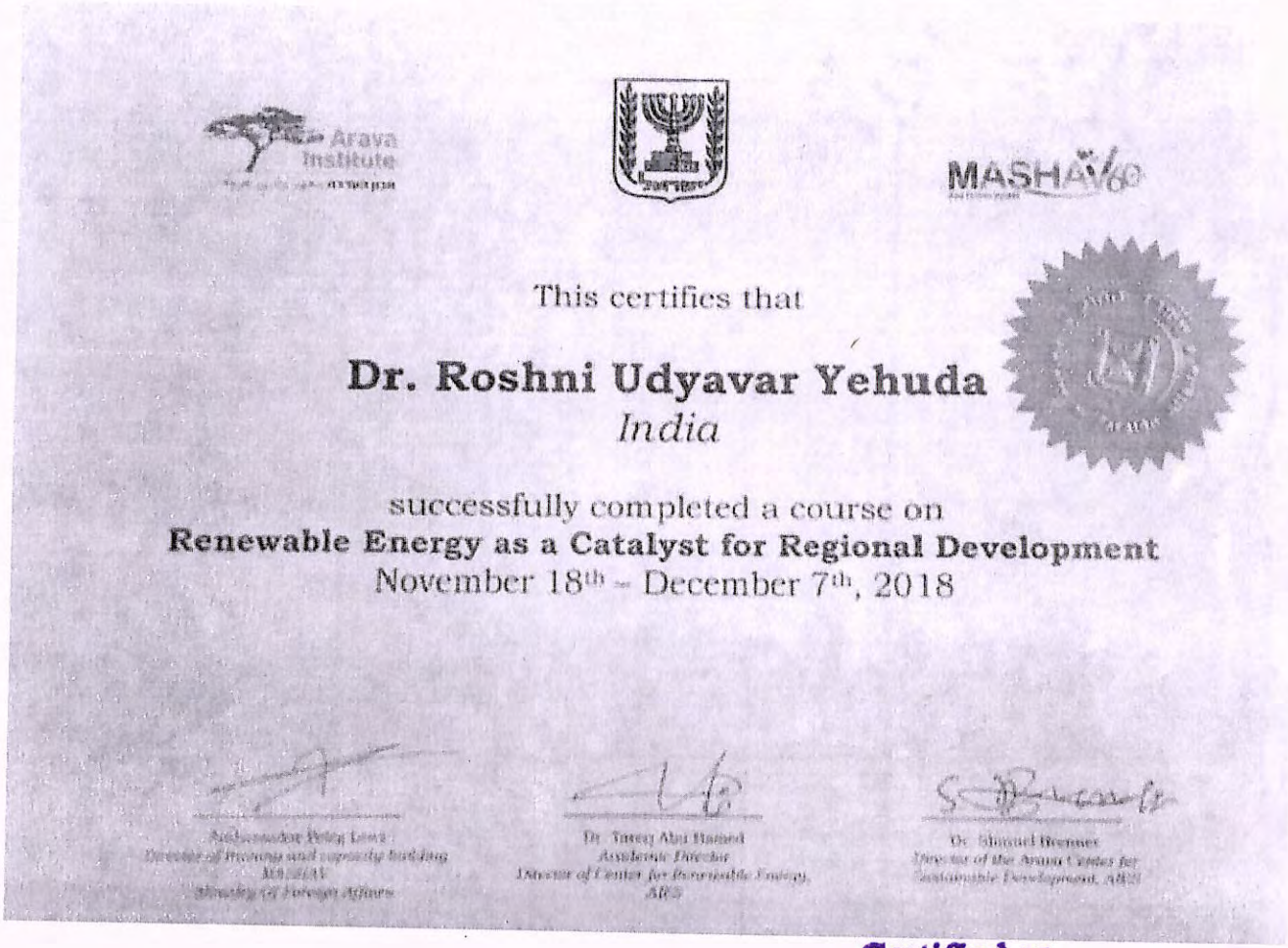
M. Renewable Energy Mashav Course Certificate



Arava Institute

MASHAV

This certifies that

Dr. Roshni Udyavar Yehuda

India

successfully completed a course on

Renewable Energy as a Catalyst for Regional Development

November 18th – December 7th, 2018

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