THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

GREEN AUDIT REPORT

THE ASSAM ROYAL GLOBAL UNIVERSITY
GUWAHATI

Prepared By
Livolt Pvt. Ltd

LIVOLT
ENERGY ENGINEERING
ACCELERATING THE TRANSITION

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EXECUTIVE SUMMARY:

The rapid urbanization and economic development at local, regional and global level has led to several environmental and ecological crises. On this background it becomes essential to adopt the system of the Green Campus for the institutes which will lead for sustainable development and at the same time reduce a sizable amount of atmospheric CO2 from the environment. The National Assessment and Accreditation Council, New Delhi (NAAC) has made it mandatory that all Higher Educational Institutions should submit an annual Green Audit Report. Moreover, it is part of Corporate Social Responsibility of the Higher Educational Institutions to ensure that they contribute towards the reduction of global warming through carbon footprint reduction measures.

Royal Global University (R.G.U.), one of the premium universities in India, which is in the state of Assam and was established in 2017. RGU features state-of-the-art infrastructure, including modern classrooms, well-equipped laboratories, a comprehensive library, and advanced research facilities. The campus is designed to provide an ideal environment for academic pursuits and personal development. RGU provides a comprehensive range of courses in fields such as Engineering, Management, Applied and Pure Sciences, Fine Arts, Architecture, Commerce, Behavioral and Allied Sciences, Information Technology, Law, and Media and Mass Communication.

Green audit is a practice to reduce the overall carbon foot print of an organization by adopting environment friendly or resource efficient planning and operation & maintenance protocol. Overall objectives of a Green Audit (GA) of a campus are an assessment of the environmental sustainability of its current policies and practices, identification of opportunities to improve and make the campus environment-friendly as possible, as well as raising awareness on environmental issues and sustainable practices among the campus community. Green audit is all about corporate responsibility. It uncovers the truth about statements made by governments with regard to the effects of environmental pollution. The aim of green audit is to review the measures taken by the organization to combat pollution. Green audit is defined as an official examination of the effects of an organization has on the environment

EXTERNAL AUDIT COMMITTEE (S. B. H):

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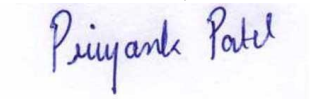

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ELECTRICITY CONSUMPTION DATA:

Month	Start Date	End Date	Unit Consumed (kWh)	Rate (Rs/kWh)	Contract Demand (KVA)	Maximum Demand (KVA)	Demand/Fixed Charges (KVA)	Rate (Rs/kWh)	Average Power Factor	Billing Amount (Rs)
Jul-21	1-Jul-21	31-Jul-21	52,408.00	7.10	2,000.00	436.50	2,000.00	180.00	98.70	775,951.00
Aug-21	1-Aug-21	31-Aug-21	48,003.07	7.10	500.00	90.00	1,000.00	180.00	99.00	454,175.00
Sep-21	1-Sep-21	30-Sep-21	31,801.50	7.10	500.00	135.00	500.00	180.00	98.30	330,286.00
Oct-21	1-Oct-21	31-Oct-21	47,100.60	7.10	2,400.00	162.00	500.00	180.00	98.00	56,068.00
Nov-21	1-Nov-21	30-Nov-21	54,169.99	7.10	2,400.00	222.30	500.00	180.00	99.00	496,788.00
Dec-21	1-Dec-21	31-Dec-21	58,897.24	7.10	500.00	200.70	500.00	180.00	99.00	535,391.00
Feb-22	1-Feb-22	28-Feb-22	47,422.92	7.10	500.00	144.90	500.00	180.00	99.00	440,445.00
Mar-22	1-Mar-22	31-Mar-22	87,053.97	7.10	2,294.12	450.00	2,794.12	180.00	96.60	990,542.00
Apr-22	1-Apr-22	30-Apr-22	105,957.00	7.60	2,294.12	630.00	2,294.12	200.00	96.00	1,320,135.00
May-22	1-May-22	31-May-22	186,468.75	7.60	2,294.12	855.00	2,294.12	200.00	94.50	1,989,678.00
Jun-22	1-Jun-22	30-Jun-22	223,762.50	7.60	2,294.12	855.00	2,294.12	200.00	93.40	1,897,844.00
Jul-22	1-Jul-22	31-Jul-22	243,506.25	7.60	2,294.12	810.00	2,294.12	200.00	93.20	2,421,983.00
Aug-22	1-Aug-22	31-Aug-22	196,998.75	7.60	2,294.12	855.00	2,294.12	200.00	93.20	2,122,128.00
Sep-22	1-Sep-22	30-Sep-22	259,740.00	7.60	2,294.12	900.00	2,294.12	200.00	93.50	2,625,788.00

Oct-22	1-Oct-22	31-Oct-22	160,672.50	7.60	2,294.12	765.00	2,294.12	200.00	95.30	1,797,246.00
Nov-22	1-Nov-22	30-Nov-22	133,749.00	7.60	2,294.12	630.00	2,294.12	200.00	96.90	1,582,582.00
Dec-22	1-Dec-22	31-Dec-22	99,702.00	7.60	2,294.12	360.00	2,294.12	200.00	96.80	1,316,511.00
Jan-23	1-Jan-23	31-Jan-23	79,503.75	7.60	2,294.12	180.00	2,294.12	200.00	99.10	1,165,171.00
Feb-23	1-Feb-23	28-Feb-23	73,917.00	7.60	2,294.12	225.00	2,294.12	200.00	99.30	1,070,281.00
Mar-23	1-Mar-23	31-Mar-23	115,173.00	7.60	2,294.12	540.00	2,294.12	200.00	97.30	1,467,646.00
Apr-23	1-Apr-23	30-Apr-23	181,082.25	8.00	2,294.12	945.00	2,294.12	210.00	95.40	2,019,989.00
May-23	1-May-23	31-May-23	244,048.50	8.00	2,294.12	990.00	2,294.12	210.00	95.30	2,736,369.00
Jun-23	1-Jun-23	30-Jun-23	222,007.50	8.00	2,294.12	1,080.00	2,294.12	210.00	94.90	2,519,166.00
Jul-23	1-Jul-23	31-Jul-23	154,593.00	8.00	2,294.12	810.00	2,294.12	210.00	95.50	1,922,324.00

Feb-2022 to Dec-2022 have been taken as the baseline years for doing calculations. The average unit charge for the baseline year has been calculated at Rs. 7.51/kWh. The annual electrical consumption from the grid in the year 2022–22 was 17,45,034 kWh, with a monthly average of 1,58,639 kWh (as the electricity bill for January–22 was not available, the average has been calculated based on 11 months of billing data, and annual consumption was also calculated subsequently).

Comparative Charts:

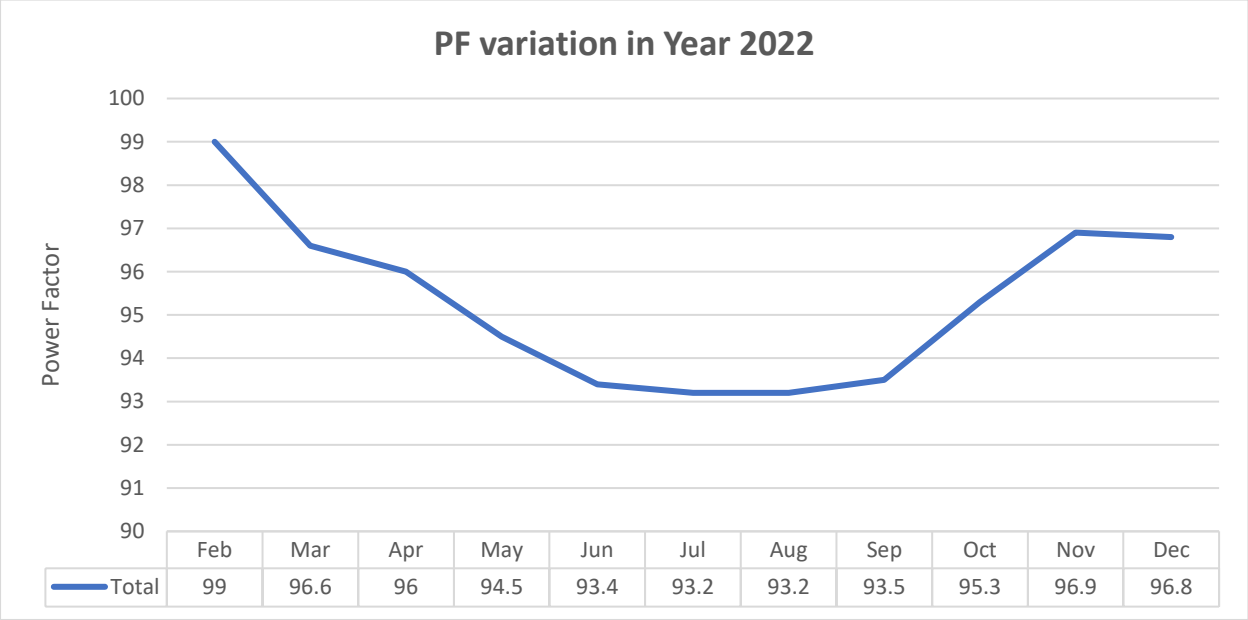
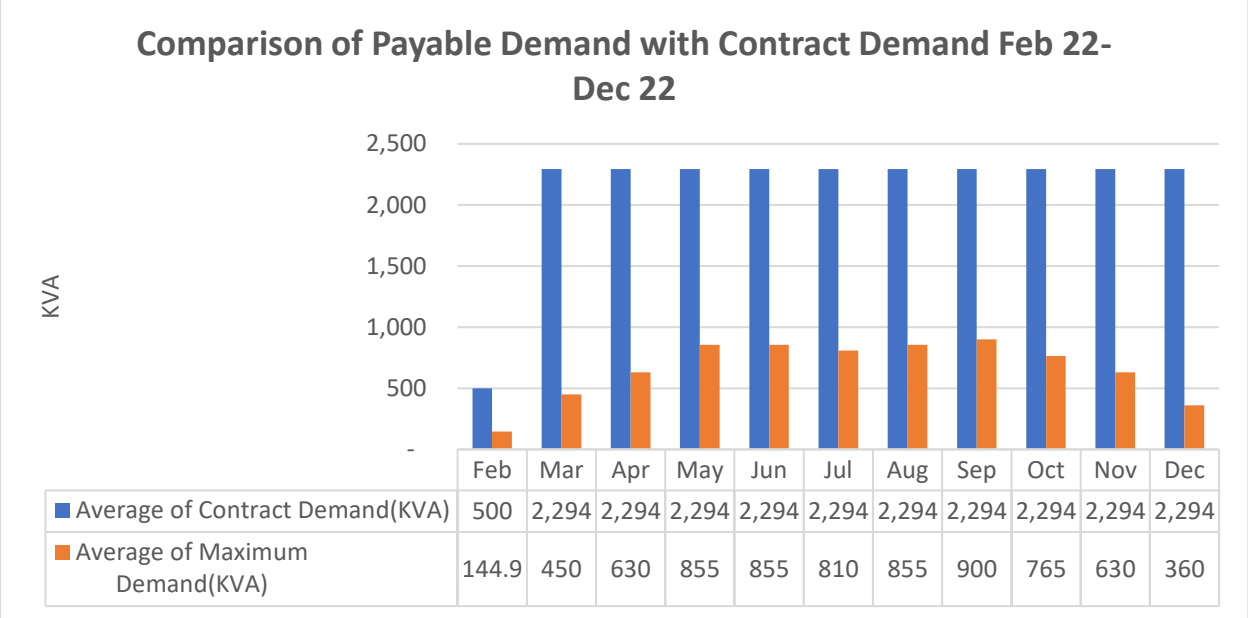
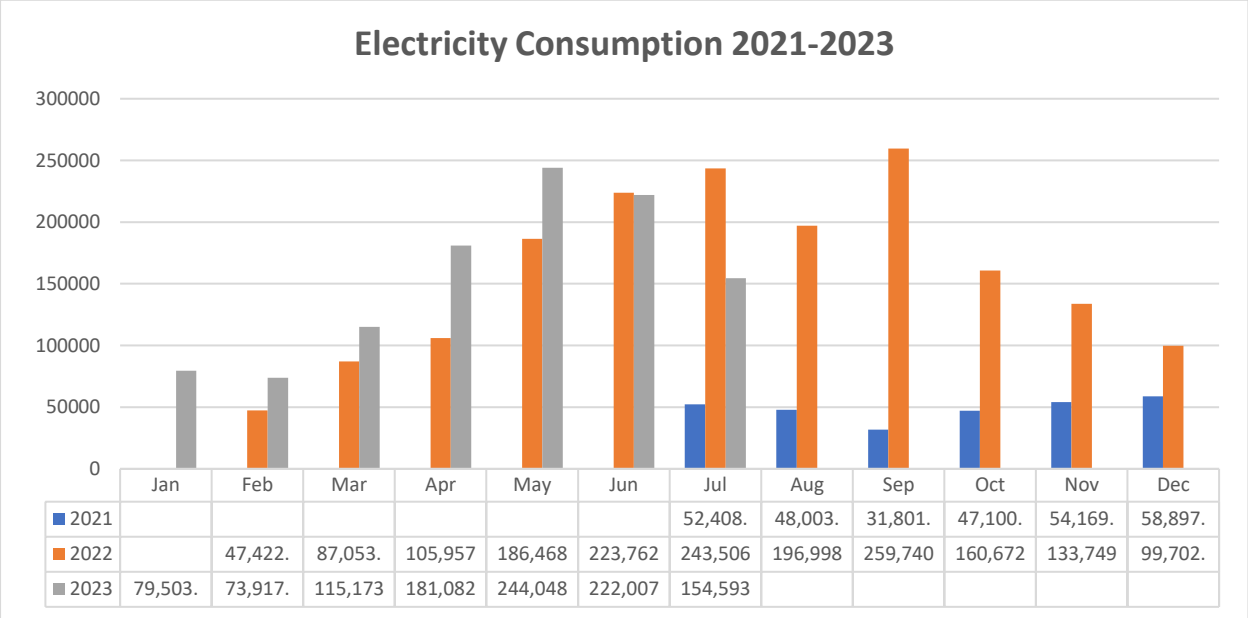


Figure 1:Graphical representation of Power Factor variation during Feb 2022-Dec 2022



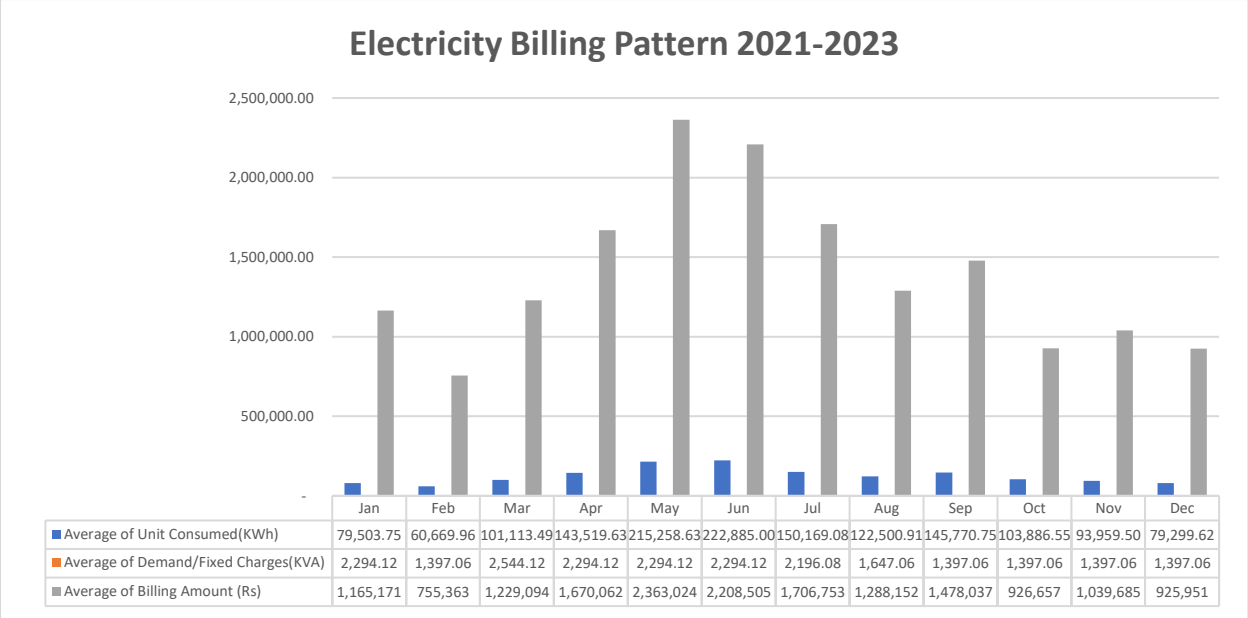
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average of Contract Demand(KVA)	500	2,294	2,294	2,294	2,294	2,294	2,294	2,294	2,294	2,294	2,294
Average of Maximum Demand(KVA)	144.9	450	630	855	855	810	855	900	765	630	360

Figure 2:Comparison of Payable Demand with Contract Demand Feb 22-Dec 22



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2021							52,408.	48,003.	31,801.	47,100.	54,169.	58,897.
2022		47,422.	87,053.	105,957	186,468	223,762	243,506	196,998	259,740	160,672	133,749	99,702.
2023	79,503.	73,917.	115,173	181,082	244,048	222,007	154,593					

Figure 3:Electricity Consumption 2021-2023



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average of Unit Consumed(KWh)	79,503.75	60,669.96	101,113.49	143,519.63	215,258.63	222,885.00	150,169.08	122,500.91	145,770.75	103,886.55	93,959.50	79,299.62
Average of Demand/Fixed Charges(KVA)	2,294.12	1,397.06	2,544.12	2,294.12	2,294.12	2,294.12	2,196.08	1,647.06	1,397.06	1,397.06	1,397.06	1,397.06
Average of Billing Amount (Rs)	1,165,171	755,363	1,229,094	1,670,062	2,363,024	2,208,505	1,706,753	1,288,152	1,478,037	926,657	1,039,685	925,951

Figure 4:Electricity Billing Pattern 2021-2023

Observations:

a) The billing pattern is comprised of a two-part tariff: one is demand charges paid based on the maximum demand, and the other is energy charges paid on the basis of unit (kWh) consumption.

b) PF from the electricity billing is found satisfactory; the monthly average PF varies from 0.93 to 0.99 for the period from February 2022 to December 2022, with an average value of 95.31, which needs further improvement to 0.99.

c) From the analysis of the electricity bill, it was found that more than 50% of the margin is between contract demand and billing demand. Even historical records also reveal that in the years 2021-23, the maximum demand never surpassed the contract demand; later, the varying contract demand was made stable from March 22 at 2294.12 KVA. The contract demand can be lowered by energy forecasting, and savings in demand charges can be achieved. As per the load of the building, it is suggested to revise the contract demand at 1400 kVA and save money in demand charges category.

VARIOUS ELECTRIC LOAD:

Equipment type	Equipment name	Location	Quantity	Capacity	Unit	Running Hours	Yearly Consumption (kWh)
Water Cooled Chiller	Kehems (180TR)	Plant Room	1	180	TR	1,200	180,822.86
Water Cooled Chiller	Kehems (135TR)	Plant Room	2	135	TR	1,200	135,617.14
Water Cooled Chiller	120TR	B Top	1	120	TR	1,200	120,548.57
Cooling Tower	300TR	Plant Room	1	300	TR	1,200	21,600
Cooling Tower	180TR	Plant Room	1	180	TR	1,200	12,960
Cooling Tower	120TR	B Top	1	120	TR	1,200	8,640
Pump	Chilled Water Pump	Plant Room	3	40	HP	1,200	71,616.00
Pump	Chilled Water Pump	Plant Room	4	20	HP	1,200	35,808.00
Pump	Chilled Water Pump	Plant Room	6	7.5	HP	1,200	26,856.00
Pump	Chilled Water Pump	B Top	2	15	HP	1,200	13,428.00
Pump	Chilled Water Pump	B Top	4	7.5	HP	1,200	20,142.00
Pump	Water Lifting Pump	Water Plant Gate	2	15	HP	365	4,084.35
Pump	Water Lifting Pump	Water Plant Gate	2	10	HP	365	2,722.90
Pump	Water Lifting Pump	Water Plant Gate	2	5	HP	365	1,361.45
Pump	Water Lifting Pump	Samaya	2	3	HP	365	816.87
Pump	Water Lifting Pump	D block	1	15	HP	365	4,084.35
Pump	Water Lifting Pump	D block	2	5	HP	365	1,361.45
Domestic Water Heater	Geyser	Aditya	8	100	LITRE	488	5,856.00
Domestic Water Heater	Geyser	Aditya	5	80	LITRE	488	3,660
Domestic Water Heater	Geyser	Harsha	7	100	LITRE	488	5,124
Domestic Water Heater	Geyser	Harsha	5	80	LITRE	488	3,660

VRF	Voltas	A 4th Floor	1	40	HP	1,200	7,635.00
VRF	Voltas	B 2nd Floor	1	22	HP	1,200	4,199.25
VRF	Voltas	B 4th Floor	1	32	HP	1,200	6,108.00
VRF	Voltas	C 5th & 6th Floor	1	30	HP	1,200	5,726.25
VRF	Voltas	Aditya	1	28	HP	1,200	5,344.50
VRF	Mitsubishi	D E F	1	550	HP	1,200	104,981.25
VRF	Mitsubishi	Samaya House	1	280	HP	1,200	53,445.00
VRF	Daikin	C Block	1	206	HP	1,200	39,320.25
Air Handling Unit	EDGETECH	A 5th Floor	2	20	TR	1,200	9,600
Air Handling Unit	EDGETECH	A 5th Floor	2	10	TR	1,200	4,800
Air Handling Unit	EDGETECH	A 4th Floor	3	5.5	TR	1,200	3,960
Air Handling Unit	EDGETECH	A 3rd Floor	10	5.5	TR	1,200	13,200
Air Handling Unit	EDGETECH	A 2nd Floor	10	5.5	TR	1,200	13,200
Air Handling Unit	EDGETECH	A 2nd Floor	2	3	TR	1,200	1,440
Air Handling Unit	EDGETECH	A 1st Floor	7	5.5	TR	1,200	9,240
Air Handling Unit	EDGETECH	A 1st Floor	3	3	TR	1,200	2,160
Air Handling Unit	EDGETECH	A Ground Floor	4	10	TR	1,200	9,600
Air Handling Unit	EDGETECH	B 5th Floor	3	5.5	TR	1,200	3,960
Air Handling Unit	EDGETECH	B 4th Floor	5	5.5	TR	1,200	6,600
Air Handling Unit	EDGETECH	B 3rd Floor	3	5.5	TR	1,200	3,960
Air Handling Unit	EDGETECH	B 2nd Floor	6	5.5	TR	1,200	7,920
Air Handling Unit	EDGETECH	B 1st Floor	5	5.5	TR	1,200	6,600
Air Handling Unit	EDGETECH	Aditya House	38	5.5	TR	1,200	50,160
Air Handling Unit	EDGETECH	Aditya House	38	5.5	TR	1,200	50,160
Heat Pump	-	Samaya House	2	6	HP	900	2,160.00

ELECTRICAL LOAD DISTRIBUTION BY END USE TYPE:

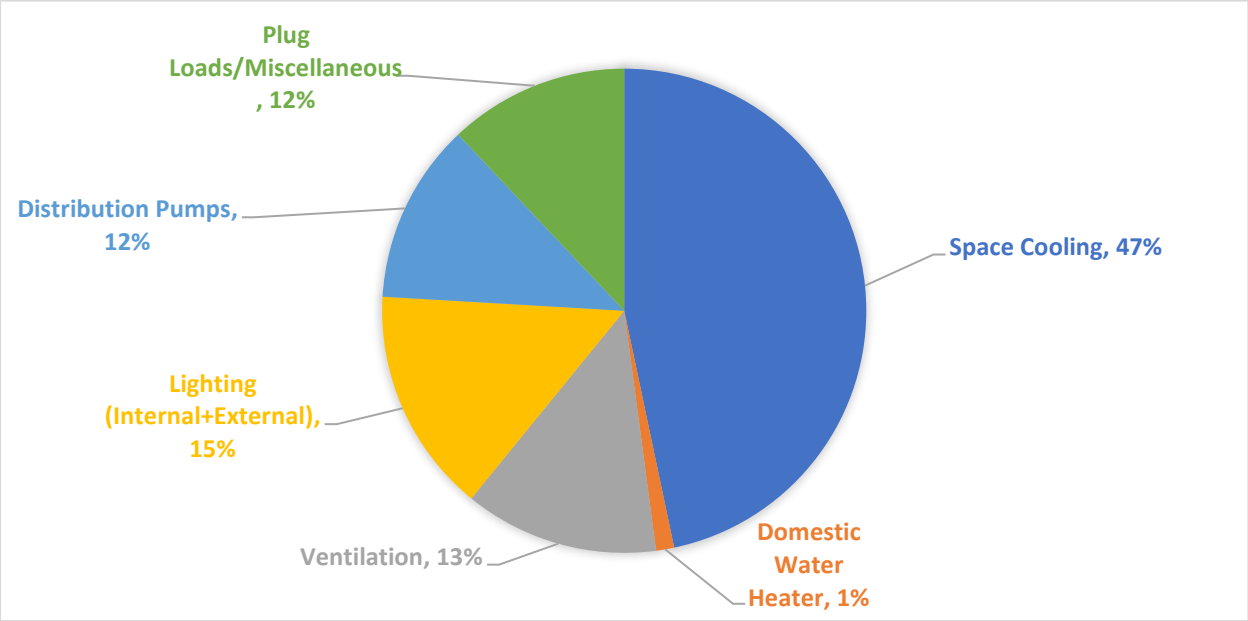


Figure 5:Electrical Load Distribution by End Use Type

Existing End Uses Type	Annual Average Electric Energy Consumption[kWh]	kBtu
Domestic Hot Water	18,300.00	62,439.60
Space Cooling	706,948.07	2,412,106.82
Ventilation	196,560.00	670,662.72
Lighting	227,780.53	777,187.16
Distribution Pumps	182,281.37	621,944.03
Plug Loads/Miscellaneous	182,224.42	621,749.73

GENERAL RECOMMENDATIONS:

1. **Electricity**

- Installation of IGBT based power factor controller to improve power factor up to 0.99 (lag) to get monetary benefit in terms of power factor rebate in electricity billing
- Installation of capacitors near the load centre to avoid line loss
- Shut off computers, printers, and lights when not in use.

2. **Motors**

- Select the proper size of motor for optimum efficiency.
- Use energy-efficient motors. (Energy-efficient motors are 4-5% more efficient than normal motors.)
- Provide proper ventilation. (For every 100C rise in motor operating temperature over the recommended peak, motor life is estimated to be halved.)
- Check for undervoltage or overvoltage conditions.
- Balance the three-phase power supply (an imbalanced power supply at the motor end increases power consumption by 3–5% to deliver the same output).
- Demand efficiency restoration after motor rewinding (if rewinding is not done properly, the efficiency can be reduced by 5-8%).

3. **Drives**

- Use variable-speed drives for large, variable loads.
- Use high-efficiency gear sets.
- Eliminate variable-pitch pulleys.
- Use flat belts as an alternative to V-belts.
- Use synthetic lubricants for large gearboxes.

4. Pumps

- Operate pumps near the best efficiency point.
- Abolish throttling as far as possible. The use of throttle increases the input power consumption to avoid the extra resistance incurred through line throttling.
- Repair seals and packing to minimise water loss.

5. Central AC plant and AHU

- Increase the chilled water temperature set point if possible. Operate the chiller within the human comfort zone temperature range of 22^0C to 27^0C with a relative humidity of 40–60%.
- Use the lowest temperature condensate water available that the chiller can handle. (Reducing the condenser temperature by 5.5°C, result in a 20-25% decrease in compressor power consumption.)
- Increase the evaporator temperature (5.5°C increase in evaporator temperature reduces compressor power consumption 20-25%)
- Clean the heat exchangers when they are fouled. (1mm scale build up on the condenser tubes can increase energy consumption by 40%).
- Replace old chillers with new, high-efficiency models.
- Use of screw chillers as an alternative to reciprocating chillers, as screw chillers are more energy efficient than reciprocating chillers.
- Maintain good water quality to avoid scaling inside the heat exchangers.
- Clean the AHU air inlet filter periodically to reduce air resistance through the filter and thus save AHU motor power.

6. Cooling Tower

- Try to keep the CT approach as low as possible.
- Turn off unnecessary cooling towers when loads are reduced.
- Optimise cooling tower fan blade angle on a seasonal and load basis.
- Use an FRP blade instead of a metal blade for CT fans.
- Optimise the blowdown flow rate to maintain a healthy COC.

- Use of blow-down water in toilets, gardening, etc. to minimise the pumping losses.

7. Lighting

- Reduce excessive illumination levels to standard levels using switching, de-lamping, etc.
- Use automatic control for lighting, like occupancy sensors, etc.
- Consider day lighting, sky lighting, etc. to use day light as much as possible.
- Consider lighter colours in walls to avoid light absorbance through walls.

8. DG Sets

- Optimise loading
- Clean the air filter regularly.

9. Buildings

- Seal exterior cracks, openings, and gaps with chaulk, gasketing, weather stripping, etc.
- Consider new thermal doors, windows, etc.
- Consider automatic doors and air curtains at high-traffic passages between conditioned and non-conditioned spaces.