ENERGY AUDIT

conducted at

Indian Institute of Space Science and Technology

Valiamala, Thiruvananthapuram

FOR THE PERIOD OF

2021-23

JUNE 2023

Study conducted by

ISRO CMD-Electrical Team

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ACKNOWLEDGEMENT

The audit team is thankful to the management of IIST and management of LPSC & VSSC for awarding for the task to conduct the Energy Audit in IIST, Valiamala campus.

We thank the following officials of IIST, Valiamala for the excellent cooperation, valuable help and arrangements made during the conduct of the study.

Sl No.	Name`	Designation
1	Shri S N Chandrasekaran	Head CMD/IIST
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3	Shri Sunil S	Sr Tech.Asst 'A' CMD/IIST
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5	Shri Prasanth S	Technical Assistant on Contract

We also thank all other technicians and staff of IIST for the cooperation extended during the conduct of this study.

1. INTRODUCTION:

Indian Institute of Space Science and Technology (IIST), situated at Thiruvananthapuram, Kerala, is a Deemed to be University under Section 3 of the UGC Act, 1956. IIST, established in 2007, functions as an autonomous institution under the Department of Space (DoS), Government of India. IIST was conceived with a vision to nurture exceptional human resource for the Indian Space Research Organization (ISRO), one of the world's leading scientific organizations engaged in space research and space applications. The institute is the first of its kind in the country to offer high quality education at the undergraduate, graduate, doctoral and post-doctoral levels on areas with special focus on space sciences, space technology and space applications.

Equipped with excellent infrastructure and highly qualified faculty members, IIST has risen to great heights within a decade of its inception. It is ranked 48th in NIRF in 2023 and initiatives are planned to further improve the ranking. The Institute has initiated actions for INI status and is getting ready for the second cycle of NAAC and NBA accreditation. Total campus includes 23 Nos. ofbuildings with total built up area 70,266 Sq.Mtr.

1.1 OBJECTIVE:

The objective of this report is to observe the energy consumption of electrical appliances within Indian Institute of Space Science and Technology, Valiamala It also aimed to review and analyse energy usage history to create a baseline for which savings can be measured. This will entail analyzing the energy usage of the Indian Institute of Space Science and Technology by identifying the various loads that are in use, their ratings, their consumption, and their patterns. It will also involve offering alternatives to lower energy consumption, which will lower the cost of electricity bills and lessen the negative environmental effects of conventional power generation. It could have a technique or procedure to lower the energy input into the system without impairing the output. Electrical energy is frequently reported to be the largest operating expense in organizations such as Science and Technology Institutes. Preparation of energy audit report for furnishing to various authorities like NAAC, UGC etc. as and when required.

2. METHODOLOGY:

2.1 DATA ANALYSIS:

In this process, the data is gathered, analyzed and trend is formed for easy visual comprehension. The following details are collected for the period and analysed.

- Monthly electricity bills from KSEB during Jan 2020 to May 2023.
- Monthly **EB log details** from Substation-1 & 2 during the period of Jan 2022 to May 2023.
- Monthly **DG log details** from Substation-1 & 2 during the period of Jan 2022 to May 2023.
- Monthly Solar Power generation details from Substation-1 & 2 during the period of March 2022 to May 2023.
- Weekly Energy consumption details of Substation-1 & 2 during the period of 01.05.2023 to 07.05.2023.
- Hourly Energy consumption details of buildings on 05.05.2023.
- Fuel consumption details from DG log during the period of Jan 2022 to May 2023.

The analysed data's, graphical representations such as Pie chart, Column chart, Bar chart and Line curves are formed.

2.2 DATA COLLECTION:

The detailed energy audit was conducted during the month of May 2023. The audit consisted of measurement of input and output variables of various individual equipment comprising of the utilities and end use equipments. Tests were conducted to evaluate the performance of the individual systems. The details of portable instruments used for the measurement are given in Table-1, Annexure-1.

The data is processed to evaluate the performance of the individual systems and end use equipments for identification of losses and for suggestions on remedial measures to reduce the energy and fuel bill to improve the performance of the overall systems.

2.3 RECOMMENDATIONS:

Based on the analysis, systems with high energy consumption are taken into consideration and actions are performed to lower the energy consumption without compromising the system's capacity to carry out its necessary functions.

3 ENERGY REPORT:

3.1 ENERGY SOURCES & FUEL SOURCES, DISTRIBUTION NETWORK:

SOURCE 1

KERALA STATE ELECTRICITY BOARD (KSEB)

IIST is an 11 kV HT consumer and is fed from 110 kV / 11 kV Substation at Nedumangad by means of DEDICATED UG Cable feeder and one more feeder connected with 66/11kV substation at Chullimanoor as standby.
The present Contract Demand is 1000 kVA and connected load of 1917 kW. The incoming feeder is received at Substation No.1 and further distributed to Substation No.2.
Substation No.1 – Feeds power supply to all Hostels, Mess buildings & Muti Purpose Hall (Total 15 buildings).

Source	Capacity	Voltage Rating	Quantity
Transformer	1500 kVA	11kV/433 V	2 Nos.

Substation No.2 - Feeds power supply to all Academic buildings Administration and Library (total 6 buildings).

Source	Capacity	Voltage Rating	Quantity
Transformer	2000 kVA	11kV/433 V	2 Nos.

SOURCE 2

Diesel Generator (DG) sets are installed in Substations as secondary sources having capacities of 1010 kVA (3Nos) & 125 kVA (2Nos.) for providing backup power supply to the entire campus. The DG sets are run occasionally since supply from KSEB is available almost all the time.

Location	Source	Capacity	Voltage Rating	Quantity
Substation-1	DG set	1010 kVA	415 V	1 No
	DG set	125 kVA	415 V	1 No
Substation-2	DG set	1010 kVA	415 V	2 Nos
	DG set	125 kVA	415 V	1 No

SOURCE 3

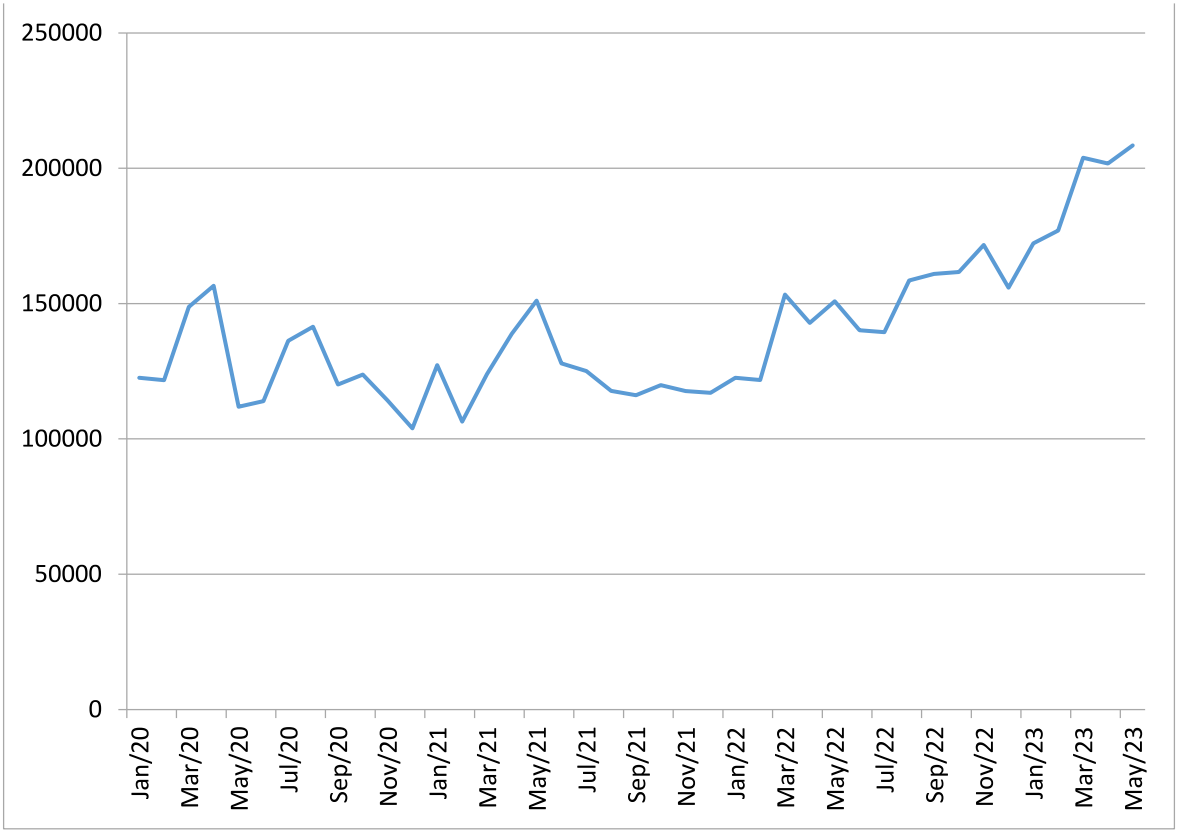
SOLAR POWER PLANTS (500kWp)

There areON Grid Solar Power Plantsinstal led on roof top of all Academic Buildings, Administration Building, Library and Mess Building of IIST, totalling to **500kWp** capacity as furnished below.

Sl.No	Location	Capacity in kWp	Total Capacity in kWp
1.0	Avionics Building	2x50	100
2.0	Aerospace Building	1x30, 1x50	80
3.0	Interdisciplinary Building	1x30, 1x50	80
4.0	Science Building	1x30, 1x50	80
5.0	Administration Building	1x50	50
6.0	Library Building	1x40	40
7.0	Mess-02 Lower roof	1x40	40
8.0	Mess-02 Upper roof	1x30	30
			500 kWp

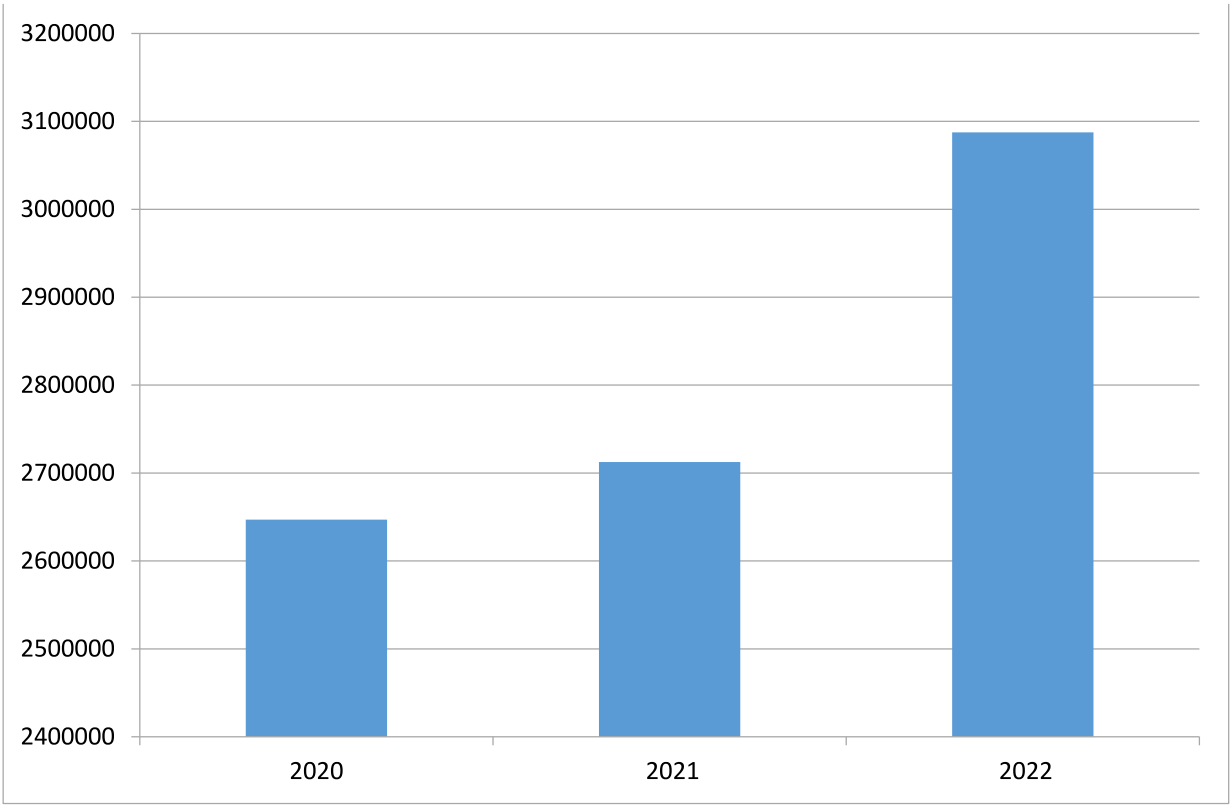
3.2 EB CONSUMPTION AND BILL ANALYSIS:

Month	Unit consumption			
	2020	2021	2022	2023
JAN	258640	211480	240600	272320
FEB	321120	205880	219840	272000
MAR	332400	252960	275840	341000
APR	276960	264520	268240	323080
MAY	168960	211480	294120	332600
JUN	204520	204680	246520	
JUL	171800	234520	234920	
AUG	170760	243680	256800	
SEP	175600	222880	253920	
OCT	178760	222800	268960	
NOV	183120	214040	268880	
DEC	204400	223520	258920	

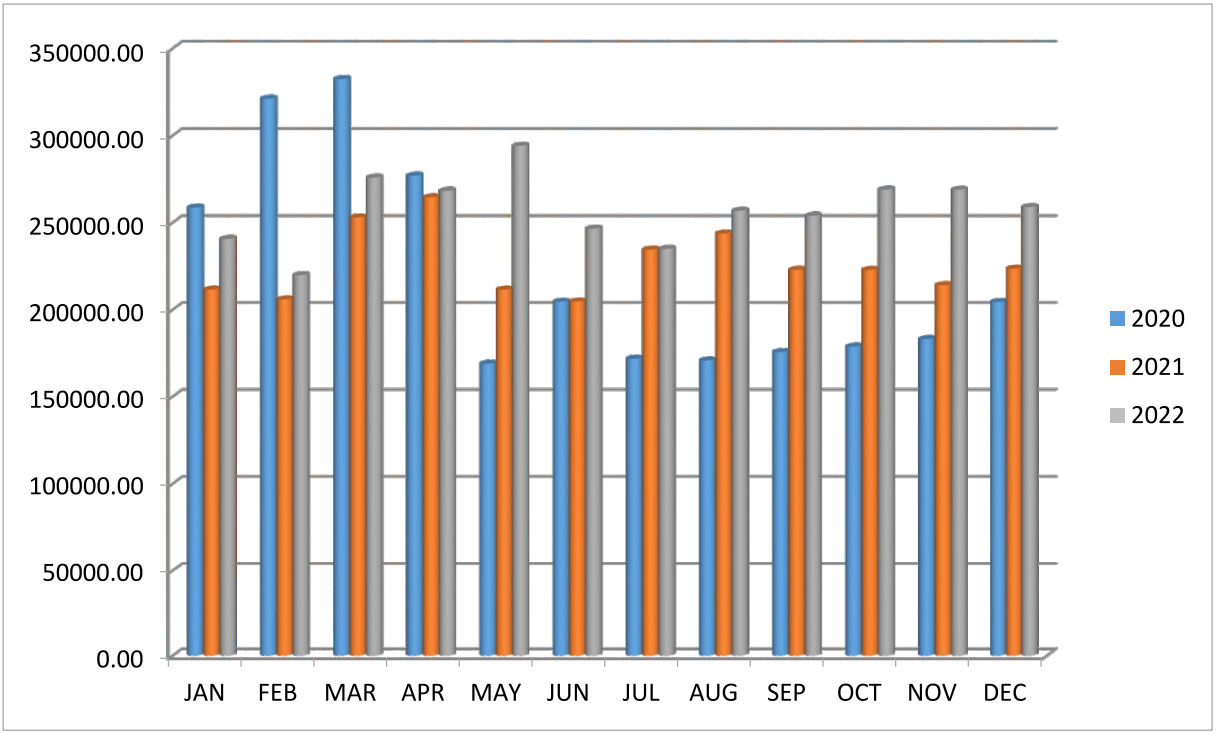


- **Inclusion of 500kWp Solar Power Plant in grid is visible as fall of trend after June 2022**
- **The increasing trend after Feb 2023 is due to establishment of various labs in Academic buildings.**

YEAR ON YEAR COMPARISON



MONTH ON MONTH ENERGY COMPARISON

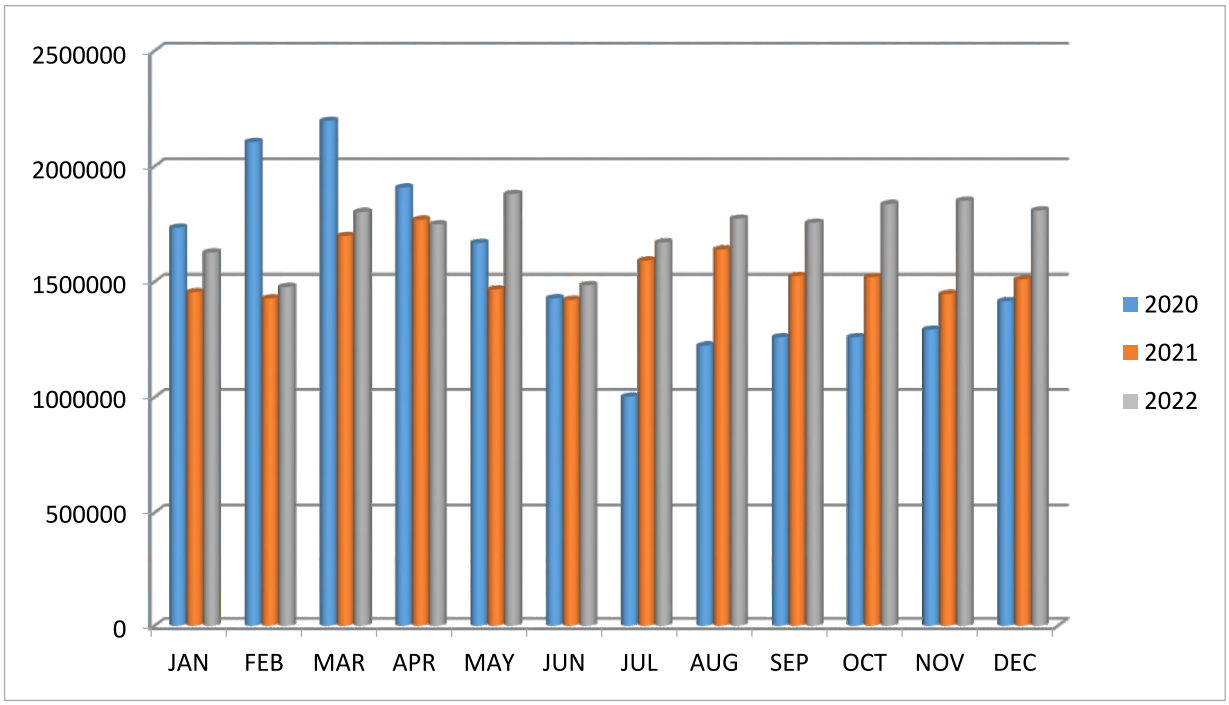


- **Reduction in energy consumption during 2021 due to COVID-19 Lockdown restrictions.**

EB BILL AMOUNT

Month	Bill Value in Rupees			
	2020	**2021**	**2022**	**2023**
JAN	1733188	1453597	1625622	1866840
FEB	2104498	1426622	1476548	1899047
MAR	2196158	1697520	1801133	2345402
APR	1906942	1767662	1747966	2256210
MAY	1667009	1465362	1879267	2337313
JUN	1427075	1420389	1483982	
JUL	1001557	1590877	1669311	
AUG	1222083	1638360	1772159	
SEP	1258332	1523634	1755058	
OCT	1258599	1519244	1835007	
NOV	1291541	1445981	1849796	
DEC	1414510	1509413	1807962	

MONTH ON MONTH EB BILL COMPARISON

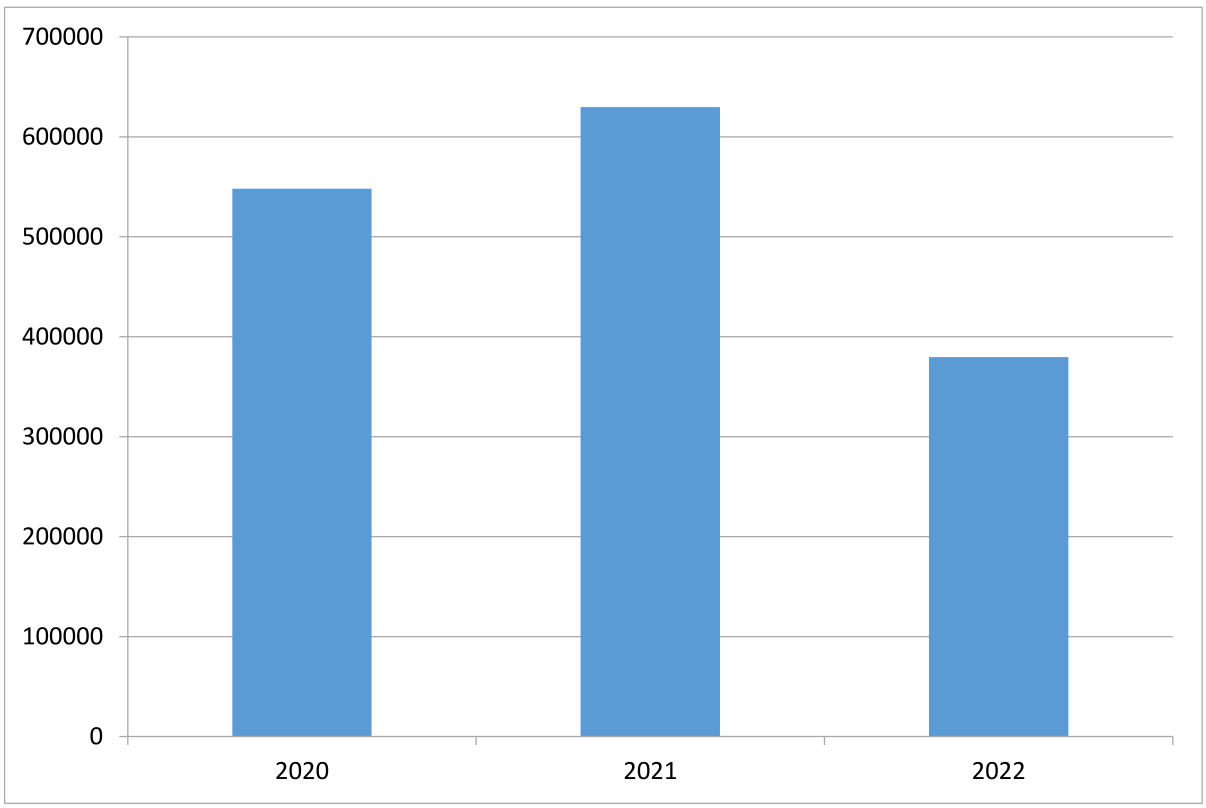


- **Tariff at 2021 Maximum Demand (MD) @ ₹ 370/- per kVA, ₹ 5.6/- Per kWh**
- **Tariff revised during June 2022 at the rate of MD @ ₹ 420/- per kVA, ₹ 5.85/- Per kWh**

INCENTIVES DUE TO MAINTAINANCE OF BETTER POWER FACTOR

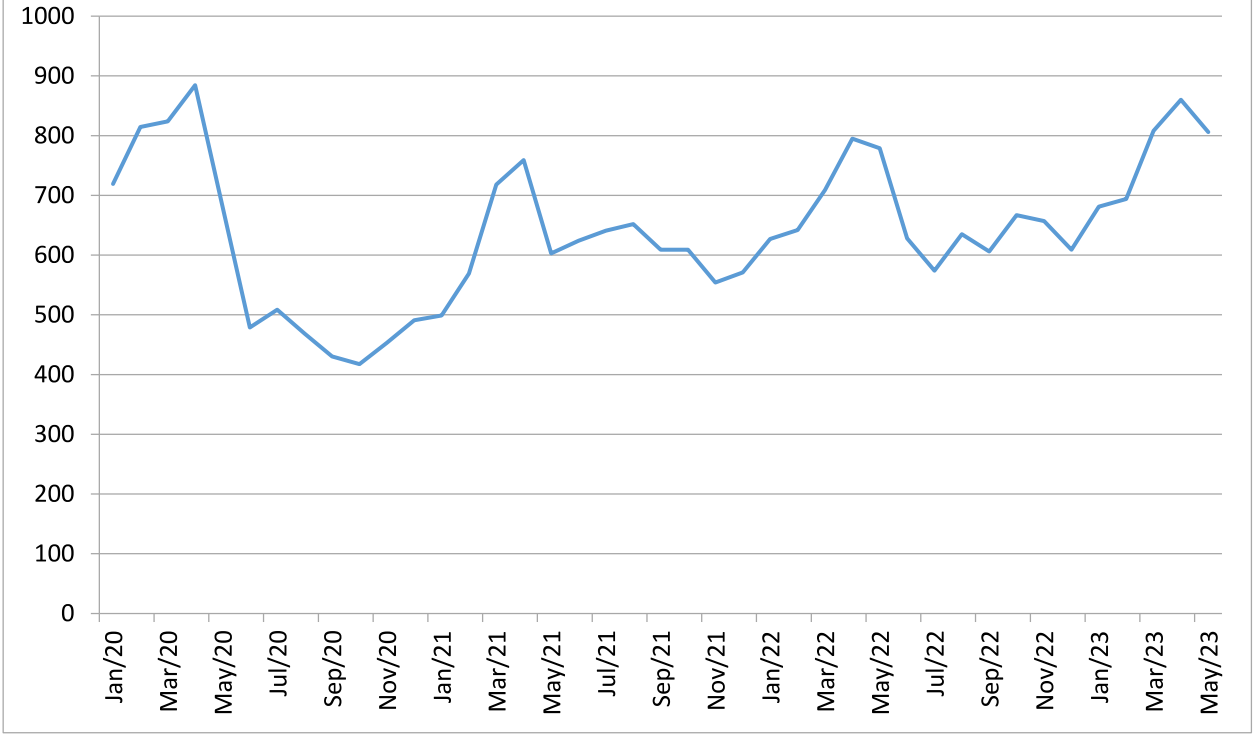
Month	Incentive Amount in ₹			
	2020	**2021**	**2022**	**2023**
JAN	29575	23894	20438	39616
FEB	46023	23346	18175	31676
MAR	38065	21528	23097	40139
APR	31528	22541	29534	37906
MAY	19040	18008	32320	39470
JUN	23014	23219	26182	
JUL	19320	19911	20534	
AUG	19191	27648	29606	
SEP	14869	25317	29259	
OCT	25041	25228	30883	
NOV	20601	23737	31185	
DEC	23100	18674	22637	
TOTAL	**311387**	**275072**	**315872**	**190830**

YEARLY COMPARISON

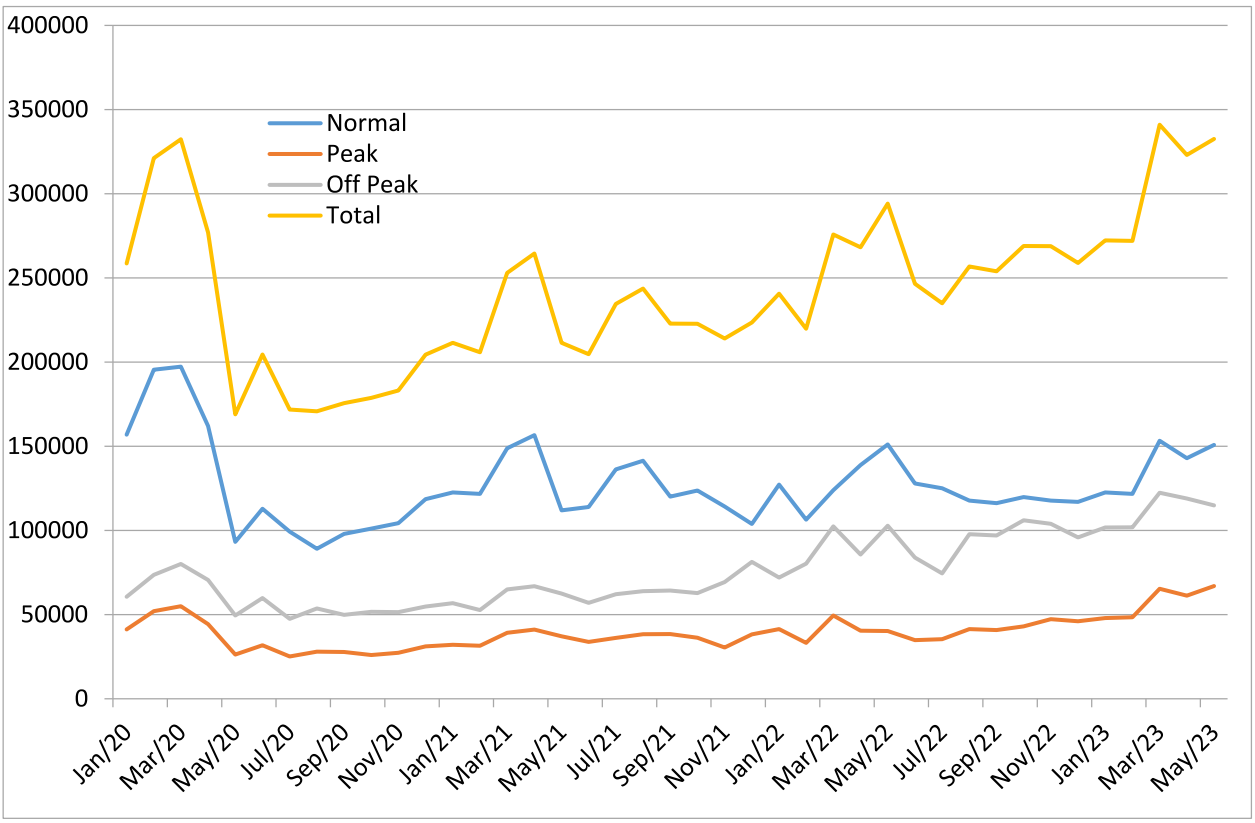


- **Power factor between 0.95 to 1.0 incentives at 0.5% of Energy charges every increase of 0.01 from 0.95.**
- **IIST is maintaining a better power factor of 0.99**

MAXIMUM DEMAND MONTHWISE COMPARISON

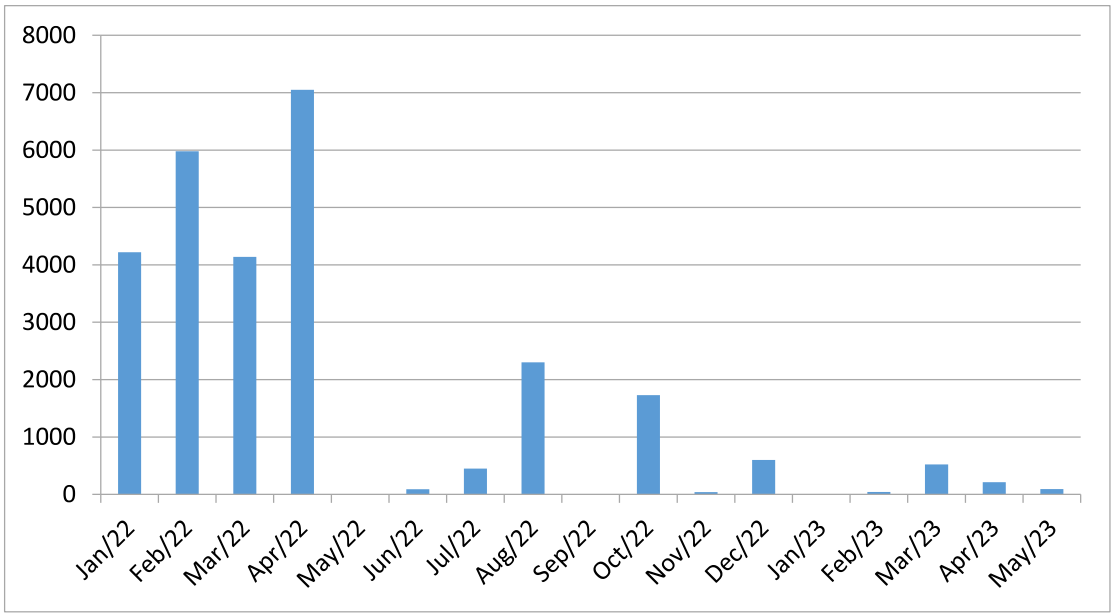


TIME OF THE DAY ENERGY CONSUMPTION COMPARISON



3.3 ENERGY GENERATION BY DIESEL GENERATOR SETS

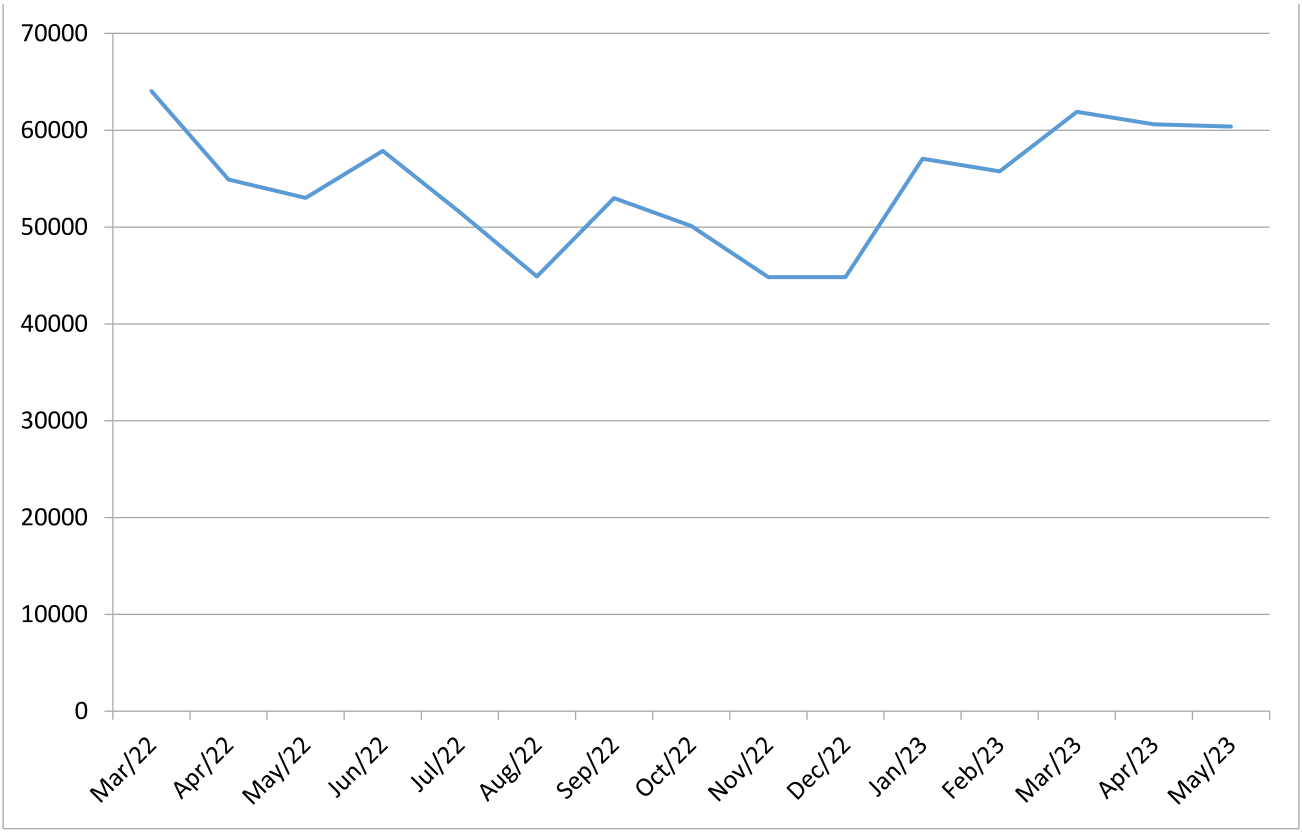
MONTH	SS1	SS2	TOTAL
Jan-22	841	3380	4221
Feb-22	2300	3680	5980
Mar-22	2300	1840	4140
Apr-22	1730	5320	7050
May-22	0	0	0
Jun-22	70	20	90
Jul-22	80	370	450
Aug-22	510	1790	2300
Sep-22	0	0	0
Oct-22	190	1540	1730
Nov-22	10	30	40
Dec-22	110	490	600
Jan-23	0	0	0
Feb-23	30	12	42
Mar-23	520	3	523
Apr-23	110	103	213
May-23	70	23	93



- **DG sets are used during EB power failure (Both Feeders)**
- **Specific Fuel consumption of DG sets - 2.18 kWh/Litre**
- **Specific Energy consumption of DG sets – 0.45 Litre/kWh**

3.4 ENERGY GENERATION BY 500kWp Roof Top Solar Power Plant

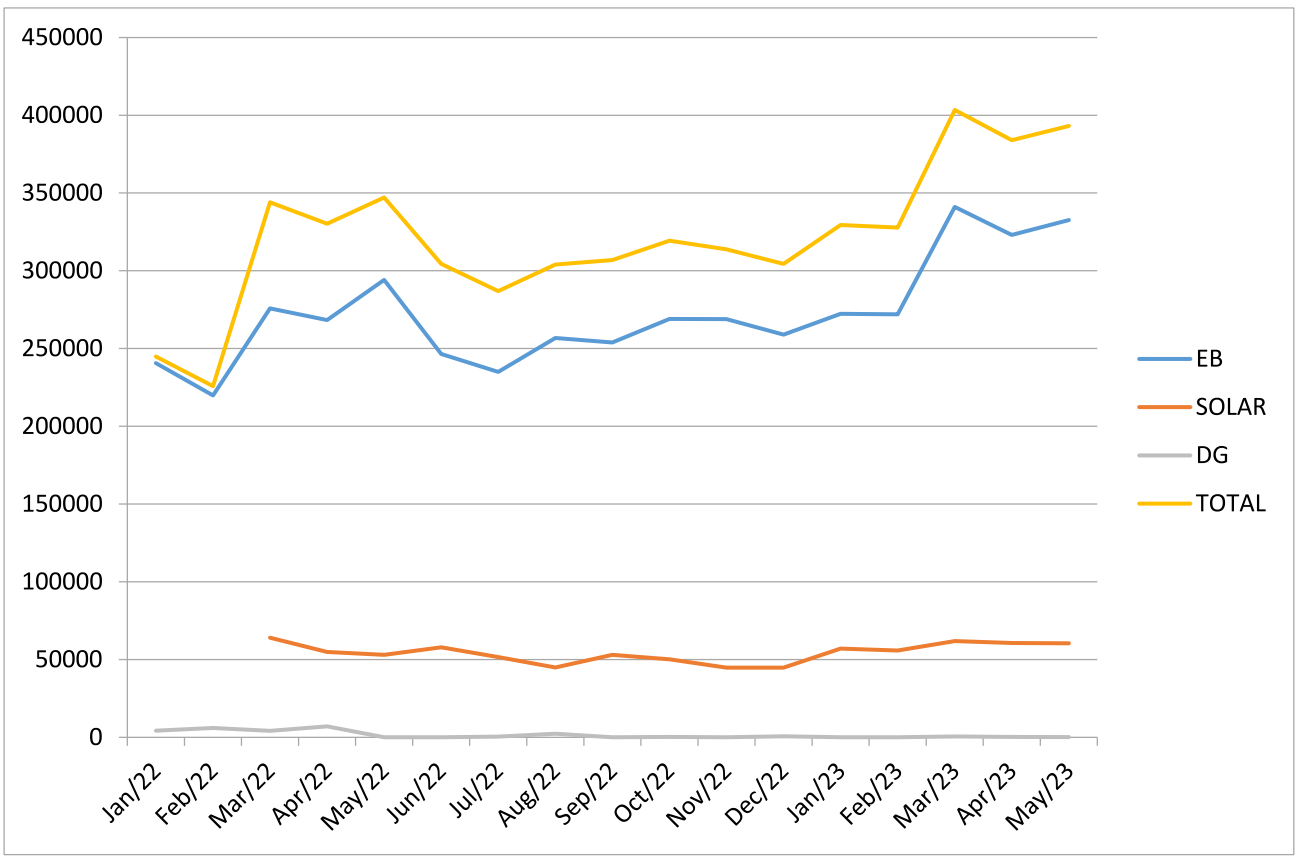
Month	Solar Energy Generation	
	2022	**2023**
JAN		57067
FEB		55756
MAR	64053	61907
APR	54916	60608
MAY	53004	60388
JUN	57870	
JUL	51530	
AUG	44899	
SEP	52988	
OCT	50118	
NOV	44826	
DEC	44838	



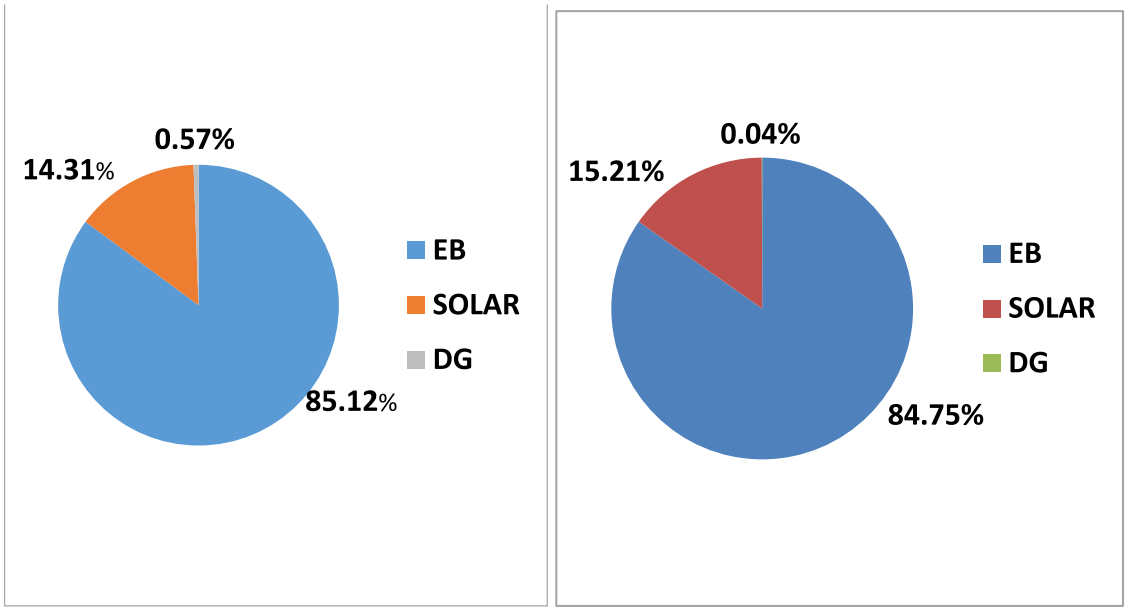
- **Maximum generation observed from SPP is 4.13 Units/kWp during March 2022.**
- **Minimum generation observed from SPP is 2.99 Units/kWp during Nov 2022.**
- **Average energy generation from SPP is *4.11* Units/kWp**
- **Total Unit generated from SPP is *814768 Units*.**
- **Total savings obtained due to SPP is *₹ 58.66 Lakh***
- **Revenue recovered from capital is 19.4% in 15 Months.**

3.5 TOTAL CONSUMPTION OF IIST INCLUDING ALL THE SOURCES

MONTH	TOTAL ENERGY CONSUMPTION FROM ALL SOURCES							
	2022				2023			
	EB	SOLAR	DG	TOTAL	EB	SOLAR	DG	TOTAL
JAN	240600	NA	4221	244821	272320	57067	0	329387
FEB	219840	NA	5980	225820	272000	55756	42	327798
MAR	275840	64053	4140	344033	341000	61907	523	403430
APR	268240	54916	7050	330206	323080	60608	213	383901
MAY	294120	53004	0	347124	332600	60388	93	393081
JUN	246520	57870	20	304410				
JUL	234920	51530	450	286900				
AUG	256800	44899	2300	303999				
SEP	253920	52988	0	306908				
OCT	268960	50118	220	319298				
NOV	268880	44826	40	313746				
DEC	258920	44838	600	304358				

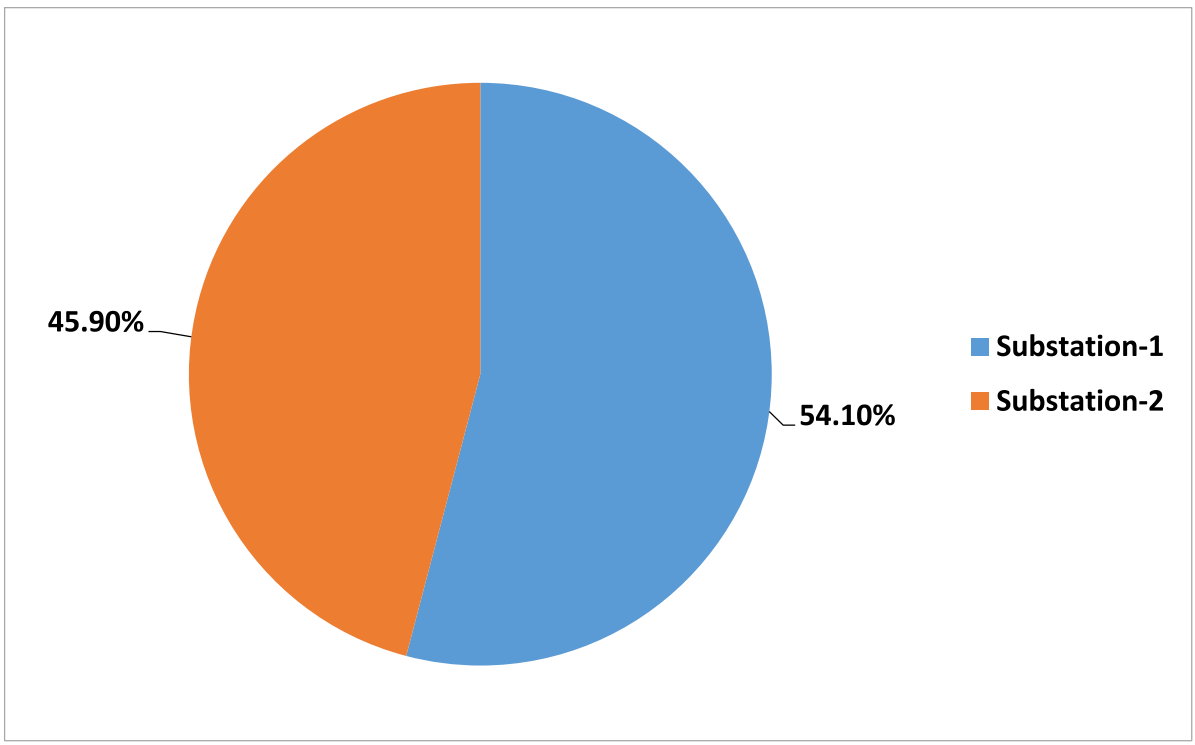


3.6 ENERGY CONSUMPTION FROM ALL THE SOURCES



2022 2023

SUBSTATION WISE COMPARISON (Jan 2022 to May 2023)

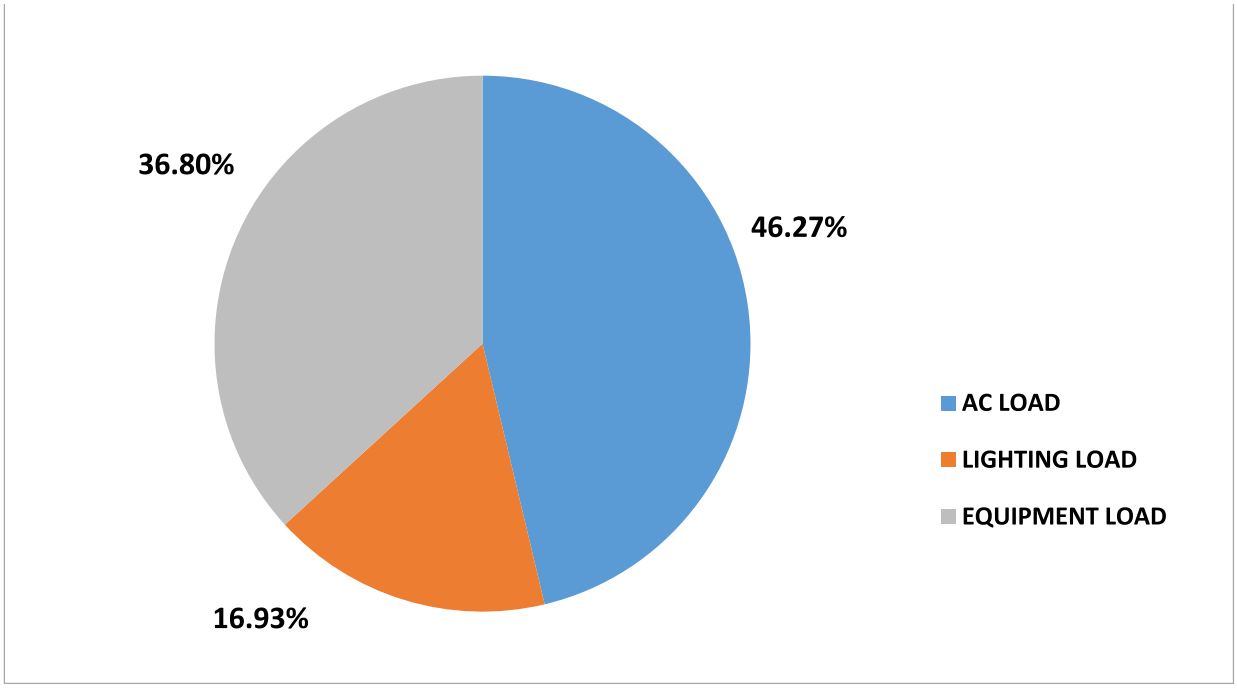


4. LOAD DETAILS

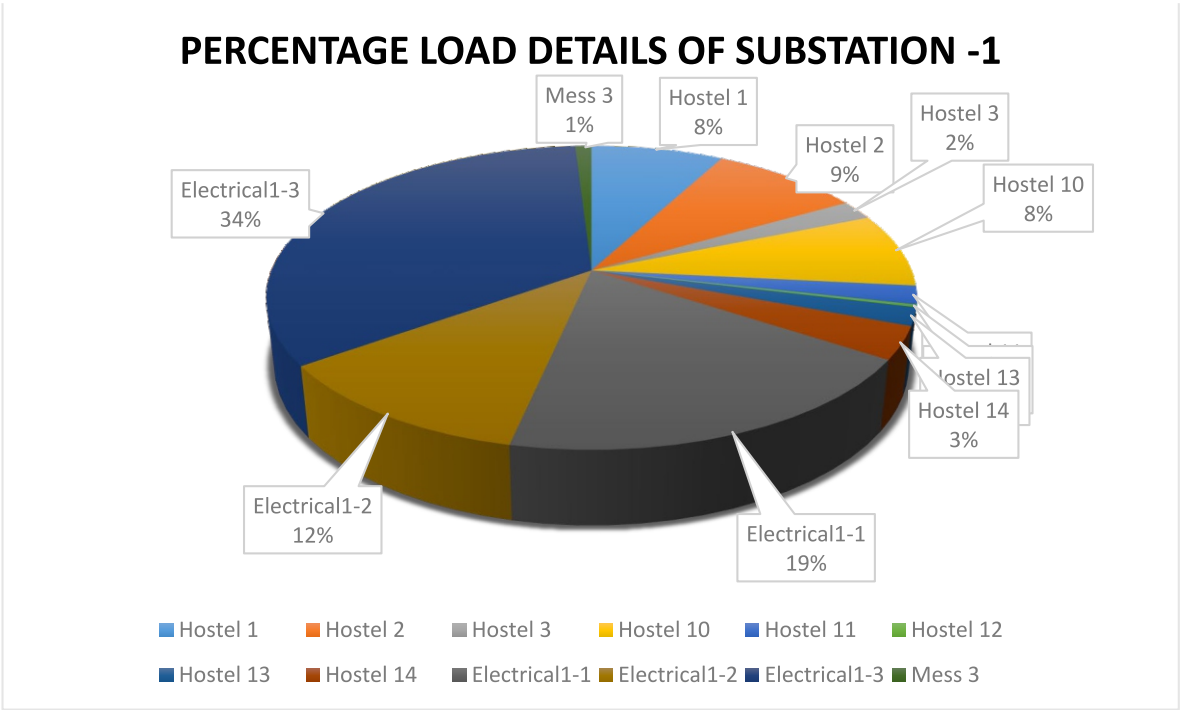
4.1 BUILDINGS WISE LOAD DETAILS

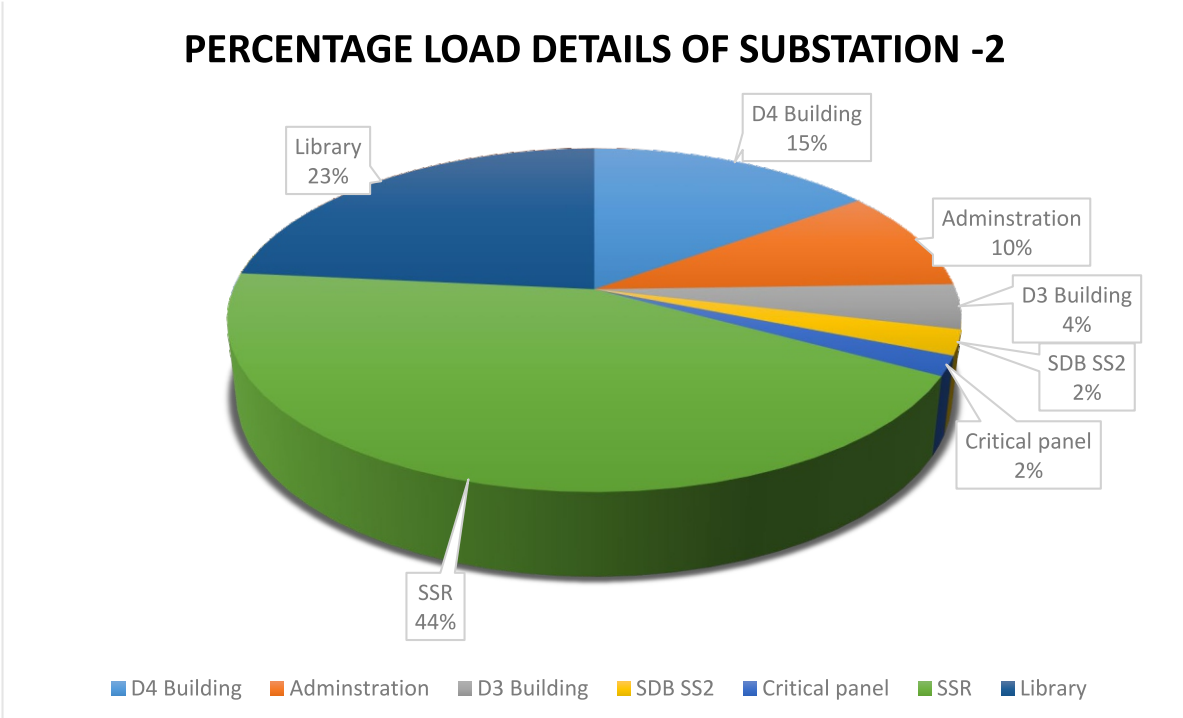
NAME OF THE BUILDING	BUILT UP AREA IN SQ.M	AIR CONDITIONED AREA IN SQ.M	AC LOAD	LIGHTING LOAD	EQUIPMENT LOAD
D1	8209.99	2390	241.5	60.26	45
D2	6608.94	1620	145.5	45.79	40
D3	7664.15	1950	211.75	60.85	50
D4	10068.12	2655	369.5	50.84	60
LIBRARY	4371.51	4215	168	31.49	61.7
ADMIN	5298.67	1055	116	21.37	30
HOSTEL & MESS	7465715	530	47.5	148.27	550
OTHER AMENITIES	4208.76	1535	44	11.5	8
WATER TREATMENT & PUMP HOUSE					60
SEWAGE TREATMENT & PUMP HOUSE					57.15
STREET LIGHTS				12	
TOTAL			**1209**	**442**	**962**

4.2 COMPARISON OF CONNECTED LOADS OF IIST



- **Major consumption is AC load out of total connected load**


PERCENTAGE LOAD DETAILS OF SUBSTATION -1
Mess 3 1%
Hostel 1 8%
Hostel 3 2%
Hostel 2 9%
Hostel 10 8%
Electrical1-3 34%
Hostel 14 3%
Electrical1-2 12%
Electrical1-1 19%
Hostel 1
Hostel 2
Hostel 3
Hostel 10
Hostel 11
Hostel 12
Hostel 13
Hostel 14
Electrical1-1
Electrical1-2
Electrical1-3
Mess 3


PERCENTAGE LOAD DETAILS OF SUBSTATION -2
D4 Building 15%
Library 23%
Adminstration 10%
D3 Building 4%
SDB SS2 2%
Critical panel 2%
SSR 44%
D4 Building
Adminstration
D3 Building
SDB SS2
Critical panel
SSR
Library

5. ENERGY PERFORMANCE INDEX (EPI)

5.1 BUILDING WISE EPI DETAILS

Buildings	Built up area in Sq.M	AC area in Sq.M	Connected Load in kW	Yearly Total Energy (kWh)	EPI (kWh/ Sq.m/ Year)	AAhEPI (Wh/hr/ Sq.m)	Star Rating
D1	8210.0	2390.0	323	564696	68.8	33	★★★
D2	6608.9	1620.0	217	312524	47.3	22.7	★★★★★
D3	7664.2	1950.0	301	258631	33.7	16	★★★★★
D4	10068.1	2655.0	443	494756	49.1	23	★★★★
Admin	5298.7	1055.0	156	230682	43.5	20.9	★★★★★
Library	4371.5	4215.0	244	384471	87.9	23.4	★★★★★
Other Amenities	3529.0	1535.0	59	314432	89.1		**NA**
Hostels & Mess	21739.6	530.0	156	317571	14.6		**NA**
Total	**67490.0**	**15950.0**	**1899**	**2877767**	**42.6**		

STAR RATING TABLE: The Star Rating Band is formed by straight line equations is in the form y=(**a*****b**) +c, where 'b' denotes the percentage of AC area out of total built-up area.

Table for Star Rating of the BPO Building

Climatic Zone	1 Star	2 Star	3 Star	4 Star	5 Star
Composite	y = 0.21x + 28	y = 0.18x + 24	y = 0.15x + 20	y = 0.12x + 16	y = 0.09x + 12
Hot & Dry	y = 0.1x + 24	y = 0.08x + 20	y = 0.06x + 16	y = 0.04x + 12	y = 0.02x + 8
Warm & Humid	y = 0.17x + 36	y = 0.14x + 32	y = 0.11x + 28	y = 0.08x + 24	y = 0.05x + 20
Temperate	y = 0.13x + 31	y = 0.11x + 27	y = 0.09x + 23	y = 0.07x + 19	y = 0.05x + 15

6. ENERGY CONSERVATION ACTIONS TAKEN DURING LAST THREE YEARS

- **500kWp Roof top Solar Power Plant**
- **75 Nos. 90W LED Street lights against 150W MH Street lights**
- **750 Nos. 18W 'U' shaped LED tube lights against 36W CFL tube lights**
- **135 Nos. BLDC Ceiling fans**
- **750 Nos. 20W LED tube lights against conventional tube lights**
- **1000 Nos. 18W LED tube lights against conventional tube lights**
- **50 Nos. 100W LED Flood lights**
- **50 Nos. 50W LED Flood lights**
- **100 Nos. 30W LED Flood lights**
- **750 Nos. 9W LED Mirror lights**
- **800 Nos. 10W LED Bulbs**

Note:- The above numbers based on site visit, SRV and purchase order.

7. WALK THROUGH ELECTRICAL SAFETY AUDIT:

During the electrical measurement, the general conditions of cables and bus bars were inspected and generally found to be in good condition. The gap between the electrical panel boards and the wall is as per standards. Rubber earth mats is present in front of all HT and major LT panel boards. Danger Sign board is present on major bus bar areas. Electrical safety chart is displayed in substations. Electrical safety gadgets like Hand gloves, Insulated tools, etc and First aid kit are available in the substation. Contact details of electrical safety officers / staffs are displayed at substation. The electrical staffs have general safe working practices.

8. LIGHTNING PROTECTION SYSTEM:

On each building, lightning arrester is provided and earthed. It is understood from the discussion that the measurement of earth resistance and maintenance of each earth pit is carried out once in six months and it's adequate. The lightning protection system is found to be in good condition.

9. RECOMMENDATIONS:

- **Replacement of 1250 Nos. existing conventional 2x36W Fluorescent tube lights with suitable LED tube lights.**
- **Replacement of 750 Nos. existing conventional 1x36W Fluorescent tube lights with suitable LED tube lights.**
- **Replacement of 400 Nos. existing conventional 2x36W CFL lights with suitable LED light fittings.**
- **Replacement of150 Nos. existing conventional 1x18W CFL lights with suitable LED light fittings.**
- **Replacement of 250 Nos. existing conventional 1x11W CFL lights with suitable LED light fittings.**
- **Replacement of 1250 Nos. existing 50Watts Capacitor type ceiling fans with Five star rated 28W BLDC ceiling fans & BLDC wall mounted fans.**
- **Replacement of 250 Nos. existing non star rated Geysers with Five star rated Geysers. (Option-1)**
- **Replacement of Geysers with Solar Water Heaters. (Option-2)**
- **Replacement of motors with Energy Efficient motors.**
- **Fixing of Occupancy / Movement sensors at Toilets and Lobbies.**
- **Setting of temperature of AC units at 24-25 Deg C.**
- **Setting of temperature of Water Coolers / Hot & Cold water purifiers at 40-45 / 20-22 Deg C to avoid mixing of water.**
- **Spare space available at roof of existing buildings can be fixed with Roof top Solar Power Plant (Approx. 200kWp)**
- **Additional Power Factor Improvement capacitors can be added to maintain Unity Power Factor.**
- **Inverter ACs can be introduced in place of conventional Air-conditioning units.**
- **Energy Monitoring System (EMS) can be introduced in substation HT & LT panels and building panels for effective monitoring.**
- **Automatic water pumping systems can be introduced.**

10. CONCLUSION:

The main conclusion for the study is as follows.

- **The measures taken in last three years towards Energy conservation are commendable and appreciable.**
- **Further replacement of existing conventional fluorescent lamps with suitable LED lamps will improve the energy conservation.**
- **Installation of Solar Water Heaters in place of Geysers will save the electrical energy.**
- **Introduction of EMS / SCADA will help to efficient monitoring and improves the overall performance of electrical systems.**
- **Electrical safety and Lightning protection system are in order.**

N.NEETHI RAJAN

BEE CERTIFIED ENERGY AUDITOR

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