VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

ENERGY AUDIT REPORT

YEAR – 2022

VELLORE INSTITUTE OF TECHNOLOGY

VELLORE - 632014

1. INTRODUCTION:

VIT is focussed on providing quality education and is engaged in transformative research. It offers bachelors, masters and doctoral level programs in diverse areas including Science, Engineering, Humanises, Life Science, Agriculture, Law, Fashion, Architecture, Hospitality, Design and Management. VIT has established 19 research centres, 11 in Vellore and 8 in Chennai, in almost all frontier areas including Biotechnology, Nano technology, Climate change and Data Science.

VIT has grown as a leading Educational Institution in India. National Assessment and Accreditation Council (NAAC) has accredited VIT Vellore with CGPA of 3.66 on four-point scale at A^{++} grade. VIT Vellore has been ranked among the Top 20 Universities in the country consecutively since 2016 by National Institutional Ranking Framework (NIRF), Government of India. In NIRF 2023 VIT is ranked at 8 under University category, at 11 under Research, 11 under Engineering and at 17 in the Over All category.

VIT is also ranked high globally. The engineering programs of the Institute are ranked at 240 globally by QS subject ranking 2023. In QS World University Rankings 2024 the University is Ranked within 851-900. In Shanghai Ranking of World Universities 2023 of VIT Vellore is within 701-800.

58 Professors of VIT are among the Top 2% Scientists in the world according to the study conducted by the Stanford University, USA in 2023.

1.1 OBJECTIVE:

- To provide solution for lack of power and excess consumption of power during the Summer months
- To provide a better method for air conditioning in Hostel blocks and academic buildings.
- To find a reliable water source for the chiller plant
- To find an external power source provider in order to reduce the dependence on power from TNEB and Diesel generators.
- To use more efficient lighting system and to start phasing out the old Fluorescent halogen bulbs with newer efficient LED lights.

2. ENERGY AUDIT METHODOLOGY:

2.1 DATA COLLECTION:

The first step involves the collection of data of all sorts such as, the number of hostel, departmental and administrative buildings and the number of floors, their occupancies, the number and the different type of loads connected, the usage hours which involves surveys, observations and measurements.

2.2 DATA ANALYSIS:

This step is where the collected data is analysed for the rate of energy usage, the energy usage pattern and for other information and the analysed data is represented in graphs for visual understanding.

2.3 RECOMMENDATIONS:

Based on the analysis the system of high energy consumption are taken into account and steps are taken to reduce the energy consumption without affecting the ability of the particular system to perform it's required operation.

3. ENERGY REPORT:

VIT's sanctioned maximum demand is 10.5 MVA with the incoming voltage of 33 kV. The incoming supply is connected to 2 X 5 MVA transformers of 33 kV / 11 kV. 11 kV is drawn to the incoming internal substations of 22 no's of 11 kV / 433 V transformers of different capacity. Four transformer stations are supplying 16 men's hostels, six transformers station supply academic buildings and 9 ladies hostels. The following table shows the transformer and DG capacity of different power houses.

3.1 TRANSFORMER CAPACITY IN VIT

S. No	Capacity	Voltage rating	Quantity
1	5 MVA Transformer	33 kV/11 kV	2 Nos
2	2000 kVA Transformer	11 kV/433 V	7 No.
3	1000 kVA Transformer	11 kV/433 V	10 Nos.
4	950 kVA Transformar	11 kV/433 V	1 No
5	800 kVA Transformer	11 kV/433 V	3 Nos.
6	630 kVA Transformer	11 kV/433 V	1 No.

3.2 GENERATOR CAPACITY IN VIT

S. No	Capacity	Voltage rating	Quantity
1	810 kVA DG set	433 V	5 No
2	650 kVA DG set	433 V	2 No
3	500 kVA Generator	433 V	15 Nos
4	250 kVA Generator	433 V	3 Nos (Excluded mobile DG)
5	140 kVA Generator	433 V	1 No
6	40 kVA Generator	433 V	3 Nos

After analyzing the electricity consumption from 2021, the major problems were found to be the extended usage of air conditioning during the month of March to May, lack of power due to large demands from the grid leading to accept load shedding inside VIT. The construction for the new blocks with 10 plus floors was also getting completed. Major problems faced during the summer months were water scarcity, electricity shortage and also AC repair works and maintenance.

Timing	Hostels	Duration
	Men's Hostel	
9.00AM to 10.00AM	G, J,K, (M&N odd floors), Q Block	1 Hour
10.00AM to 11.00AM	A, F, H, L, (M&N even floors), R Block	1 Hour
11.00AM to 12.00PM	B,D,E, (M&N odd floors), Q Block	1 Hour
12.00PM to 01.00PM	B Annex, D Annex, (M&N even floors), R Block	1 Hour
2.00PM to 3.00PM	G, J,K, (M&N odd floors), Q Block	1 Hour
3.00PM to 4.00PM	A, F, H, L, (M&N even floors), R Block	1 Hour
4.00PM to 5.00PM	B,D,E, (M&N odd floors), Q Block	1 Hour

Timing	Hostels	Duration
	Men's Hostel	
5.00PM to 6.00PM	B Annex, D Annex, (M&N even floors), R Block	1 Hour
6.00PM to 07.00PM	G,J,K (M&N odd floors), Q Block	1 Hour
07.00PM to 08.00PM	A, F, H, L, (M&N even floors), R Block	1 Hour
08.00 to 09.00PM	B,D,E, (M&N odd floors), Q Block	1 Hour
09.00PM to 10.00PM	B Annex, D Annex, (M&N even floors), R Block	1 Hour

However, the minimum requirements such as power for lights and fans was supplied uninterruptedly, with the use of diesel generator power supply.

Despite these steps and the last exam day being Sep 22, 39,71,280 units of electricity were consumed.

Although not as high as April consumption (40 Lakh units, the highest during 2019), April did not have complete load shedding(Load shedding was done for only 15 days in April) nor the student free vacation time(last 6 days- summer vacation).

The vacation time for students were during December and June till 2017, Analysing the energy consumption trends in VIT, it was seen that January and December had the least energy consumed as the climate during those months is very cold and air conditioners were rarely being used.

A decision was made to change the vacation period to the months of May and June. The start of the winter semester was shifted to December. A chiller plant was initially only planned for the new hostel block (Q block). In order to reduce air conditioning loads from hostel blocks, the chiller plant connection was extended to M,N,K and L blocks. This provided more number of air conditioned rooms all the while maintaining electrical loads close to the previous one.

EB Bill Analysis in terms of Amount

Electricity Bill Amount of VIT

Month	HT Units (C24)	Max. demand in kVA	Amount as per HT bill
	2019		
Jan-19	20,39,280	5533.2	1,61,95,685.00
Feb-19	33,42,120	7598.4	2,46,64,385.00
Mar-19	40,59,120	8570.4	2,99,58,182.00
Apr-19	46,88,760	8756.4	3,44,13,114.00
May-19	17,59,680	6421.2	1,22,94,040.00
Jun-19	14,79,960	4200	80,56,050.00
Jul-19	28,85,280	7992	1,74,31,988.00

Aug-19	39,70,320	8223.6	2,47,17,193.00
Sep-19	38,28,600	8197.2	2,57,74,858.00
Oct-19	34,68,480	7976.4	2,52,84,250.00
Nov-19	34,14,360	6699.6	2,40,23,453.00
Dec-19	22,26,120	5793.6	1,56,97,790.00
Total	**3,71,62,080**		**25,85,10,988.00**
		2020	
Jan-20	27,77,640	5952	1,99,68,584.00
Feb-20	30,48,600	6879.6	2,13,78,590.00
Mar-20	21,85,080	7490.4	1,66,25,803.00
Apr-20	3,67,680	836.4	31,88,132.00
May-20	4,45,920	1054.8	41,29,207.00
Jun-20	4,92,360	1237.2	42,33,427.00
Jul-20	4,48,920	1106.4	39,36,185.00
Aug-20	4,44,240	996	39,89,962.00
Sep-20	4,67,760	1392	39,79,444.00
Oct-20	4,84,080	1357.2	40,16,038.00
Nov-20	4,55,160	1342.8	55,59,143.00
Dec-20	4,56,960	1544.4	57,25,171.00
Total	**1,20,74,400**		**9,67,29,686.00**
		2021	
Jan-21	4,64,040	1501.2	55,53,813.00
Feb-21	4,09,320	1623.6	54,83,212.00
Mar-21	5,69,880	1694.4	66,50,163.00
Apr-21	5,17,920	1752	58,35,308.00
May-21	4,07,280	927.6	42,06,681.00
Jun-21	3,74,520	1443.6	41,28,614.00
Jul-21	5,82,720	2205.6	45,44,936.00
Aug-21	7,02,240	2973.6	49,31,850.00
Sep-21	5,94,600	2052	45,66,958.00
Oct-21	5,93,640	2023.2	50,14,461.00
Nov-21	6,91,680	2,114.40	67,37,027.00
Dec-21	7,71,000	2,304.00	73,82,576.00
Total	**66,78,840**		**6,50,35,599.00**
		2022	
Jan-22	5,34,360	2798.4	59,03,716.00
Feb-22	5,05,200	1888.8	56,96,727.00
Mar-22	23,27,520	6588	1,79,76,870.49
Apr-22	33,37,080	8412	2,53,02,743
May-22	37,07,520	8,530.8	2,40,80,924
Jun-22	24,10,320	6588	1,62,22,687
Jul-22	28,95,720	7452	1,79,40,951
Aug-22	38,09,160	8220	2,08,53,207

Sep-22	39,71,280	8544	2,88,97,851
OCT-22	33,93,480	7990	1,90,32,157
NOV-22	34,65,000	8100	1,97,41,756
DEC-22	27,12,960	7310	1,65,16,435

Renewable power usage percentage:

Year	Sanctioned Demand in kVA	energy consumed	Solar Generation	Solar PV capacity in kWp	Wind Power Purchased	RES %
2014	7000	27729159	0		0	
2015	7500	31075507	186725	500	0	0.600875
2016	8000	32633454	748983	500	0	2.295139
2017	8000	35006610	682272	500	0	1.94898
2018	9000	34166270	816194	1113	97039	2.672908
2019	9000	37162080	1297346	1113	5431477	18.10669
2020	9000	12074400	1398979	2113	3749393	42.63874
2021	9000	66,78,840	16,82,742.65	2113	37,59,122	81.48
2022	10500	3,30,69,600	23,25,237.40	2113	71,15,061	28.5

Hot water system

- Our aim is to provide hot water to the students using sustainable technologies
- Objective is to generate hot water using highly efficient heating system

Hot water system

- Three kinds of system have been used to generate hot water such as solar water heater, heat pump water heater and electric heater
- **Electric heater with storage tank** - conventional method for hot water generation using electrical resistance technique
- **Solar water heaters** - cost-effective way to generate hot water. They can be used in any climate, and the fuel they use -- sunshine -- is free.
- **Heat pump water heater** - Heat pump water heaters use electricity to move heat from one place to another instead of generating heat directly. To move the heat, heat pumps work like a refrigerator in reverse.

The heating system installed at VIT saves Energy, emission and social cost of carbon as mentioned in the below table.

Energy, emission and social cost of carbon savings

Savings (One-year)	
Energy (kWh)	1529775
Emission (kg of CO2)	1392095.25
Operating cost (Rs.)	12314688.75
Tonne of CO_2 emission	1392.09525
Social cost of carbon (USD)	119720.1915
Social cost of carbon (INR)	8895210.228
No ozone depletion refrigerant used	

Summary

Summary - One year operation	Conventional system	Installed system
Total energy consumption (kWh)	3122874	1593099

Total CO_2 emission (kg)	2841815.34	1449720
Operating cost (Rs)	25139135.7	12824447

Technical Specification of SES 12T Heat Pump Water Heating System

Rated heat input power	12 kw
Rated heating output power	48 KW
Voltage	440V~50HZ
Rated Output Water Temperature	55° C
Max Output Water Temperature	60° C
Rated Output Water Quantity	1800 Ltrs/hr
Compressor type	Effective Scroll type
No. of compressor and brand name	2, COPELAND
Heat Exchanger pipe diameter	DN 40
No. of heat exchanger	2
No. of fan	4
No. of condenser	2
Heat exchanger type	Effective Shell and tube heat exchanger
Draught	External rotor motor ,Steel leaves
Weight	700 KG
Control Mode	Dixell Digital controller
No. of Controls	2 controls for Individual controlling system.
Protection Function	High Pressure, Low Pressure Protection, overload, water switch, Freeze protection
Dimensions L X B X H	**2200 X 1370 X 1450 mm**

TECHNICAL SPECIFICATIONS OF 10000 LPD FLAT PLATE SOLAR WATER HEATING SYSTEMS

SOLAR COLLECTOR	
1. Absorber material	Electro Grade-Copper-Copper
2. Absorber Coating	Selectively coated continuous electroplating of black Chrome on copper sheet with Heat treatment to withstand temperature up to 300 deg C. **Optical property:** Absorptivity = 0.96 +/- 0.02, Emissivity = 0.12 +/- 0.02
3. Riser	Copper tube of diameter: 12.5mm +/-0.5mm,Thickness 0.56mm
4. Header	Copper tube of diameter :25mm +/- 0.5mm,Thickness 0.71mm
5. Bonding b/w Riser & Header	Brazing
6. Bonding between Fin & Tube	Ultrasonic
7. Back Insulation	Resin bonded Rock wool of 48 Kg/m3, Thickness 50mm
8. Side Insulation	Polyurethane, Thickness 25mm
9. Collector Box	100mm X 25mm Aluminum channel, Thickness 1.63mm
10. Collector Bottom Sheet	Aluminum, *Thickness* 0.71mm
11. Collector Stand	Corrosion resistant Coated MS
12. Glazing 13. Retainer Angle for Glass	Toughened glass, Thickness 4mm with low Iron Transitivity :>85% @ near normal incidence Aluminum Angle, size 25mm X 25mm X 1.6mm
14. Beading for Glass	EPDM Rubber
15. Absorber Area	2 sq. meter +/- 0.1 sq. meter / Collector
16. Wt. of the Collector (dry)	45 Kgs
17. Collector ilt between	24.5 deg to HORIZON (non-variable) for places located 12 deg North and 15 deg South
18. Heat Transfer Medium	Water
19. Collector Area	2.132 .sq meter /collector.
20. No. of Collectors	80 Nos (10000 lpd) 60 Deg Temperature
21. Number of Fins	9
22. Dimensions / collector	Length – 2050 mm, Breadth – 1040 mm, Height – 750 mm

PAY BACK CALCULATION FOR 20000 LTRS

<table>
<tr><td colspan="2" align="center">ELECTRIC HEATER</td></tr>
<tr><td colspan="2" align="center">= <u>Volume of water in Liters x Specific Gravity of media x Temperature Difference to raise Temperature of media</u>
860</td></tr>
<tr><td>To heat 20000 liters of media from 30 degree C to 60 degree C</td><td><u>20000 x 1.01 x (60-30 degrees) Per Day</u>
860</td></tr>
<tr><td>Electricity Required per day</td><td>704 UNITS</td></tr>
<tr><td>Cost of Electricity</td><td>704 x Rs 9 Per Unit = Rs. 6,336 / day</td></tr>
<tr><td colspan="2" align="center">BOILER</td></tr>
<tr><td colspan="2">Diesel = Volume of water in Lts x specific Gravity of water x Temperature Difference to raise temperature of water</td></tr>
<tr><td>To heat 20000 liters of Water from 30 degree C to 60 degree C</td><td>20000x 1.01 x (60 - 30 degrees) Per Day K cal.</td></tr>
<tr><td>Total Calorific Valve required to Heat 20000 Liters water</td><td>606000 cal.</td></tr>
<tr><td>Calorific Valve of Diesel / Kg

Diesel required to Heat the 20000 Lts per day</td><td>10,200 K cal.

606000 / 10,200 = 59 Liters Diesel / day</td></tr>
<tr><td>Cost Diesel per 20000 lits

40 % of Indirect heating Loss</td><td>59 Lts x Rs 55= Rs 3245
23.6 Lts x Rs 55 = Rs
1298 Total = Rs.4543
per day.</td></tr>
<tr><td colspan="2" align="center">HEAT PUMP</td></tr>
<tr><td>12 T Heat Pump Input power</td><td>48 kw</td></tr>
<tr><td>12 T Heat Pump Heating Output in kw</td><td>COP(Co –efficient of performance of Heat Pump is 4 X Input Power of the Heat Pump)
4 X 20KW = 48 KW so 704/48 kw = 14.6 hrs</td></tr>
<tr><td>Electricity Required Per 20000 LITS FOR HEAT PUMP</td><td>14.6 hrs x 12 Kw = 175 units</td></tr>
<tr><td>Cost of Electricity</td><td>175 units x Rs 9 per unit = Rs. 1575 / day.</td></tr>
</table>

Cooling system

- Our aim is to reduce electricity use by both encouraging the deployment of efficient ACs and ensuring that older, less-efficient ACs are removed from the stock.
- Our institution follows Montreal protocol and Kigali agreement for the use of refrigerant.
- Our campus has zero ozone depletion potential refrigerant

About the cooling system

- We have removed all the window, split and ducted type air conditioners
- District Cooling System (DCS) distributes cooling energy in the form of chilled water from a central source to multiple buildings through a network of pipes.
- DCS has been installed with a total capacity 5500 TR, (500 TR, 11 Nos.)
- District cooling system running capacity is 4500 TR (500 TR x 9, 2 Nos.- standby unit)
- DCS uses R134a refrigerant

The cooling system installed at VIT saves Energy, emission and social cost of carbon as mentioned in the below table.

Energy, Emission and social cost of carbon savings:

Savings (20 years)	
Energy (kWh)	10988372
Emission (kg of CO2)	30619570
Operating cost (Rs.)	88456395
Tonne of CO2 emission	30619.56977
Social cost of carbon (USD)	2633283
Social cost of carbon (INR)	195657403
No ozone depletion refrigerant used	

Summary

Summary - 20 years operation	Traditional system	District cooling system
Total energy consumption (kWh)	26250000	15261628
Total CO2 emission (kg)	59504250	28884680
Operating cost (Rs)	211312500	122856105

Innovative cooling system – Gandhi block, VIT

The main aim is to develop innovative cooling system, energy efficient solution for the educational building and to promote advancement in building thermal comfort, district energy system, low-GWP cooling solutions in accordance with India cooling action plan (ICAP).

Innovative cooling system

- Three kinds of system have been used to cool the building such as radiant cooling through structures, evaporative cooling and district cooling
- **Radiant cooling** - A radiant cooling system works by absorbing the heat accumulated in the building envelope. This system consists of a network of pipes and distribution manifolds embedded within the structure.
- **Indirect Evaporative Cooling** (IEC) - IEC works on the same principle as direct EC lowering air temperature by water Evaporation. IEC provides cool air to interior spaces with less relative humidity.
- Adopting combined passive cooling solutions, such as radiant slab cooling and evaporative cooling to provide cooling to the open classrooms and the corridors
- One passive system integrated with district cooling to provide cooling to seminar halls, laboratory, and closed classrooms

Energy, Emission and social cost of carbon savings

Savings (One-year)	
Energy (kWh)	3,14,160
Emission (kg of CO2)	12570
Operating cost (Rs.)	21,99,120
Tonne of CO_2 emission	12.57
Social cost of carbon (USD)	1081.02
Social cost of carbon (INR)	80319.786
No ozone depletion refrigerant used	

Summary

Summary - One year operation	Conventional system	Innovative cooling system
Total energy consumption (kWh)	650160	336000
Total CO_2 emission (kg)	26010	13440
Operating cost (Rs)	4551120	2352000

Conclusion

It is clearly observed that by changing the vacation period time around 20 lakh unit of power were saved due to this change in spite of the additional six floors in Q block, the energy consumption was on par with the previous year trends. A chiller plant which uses recycled water from the sewage treatment plant was constructed during this year. The chiller plant was able to provide air conditioning for more rooms while consuming half the power of its predecessor. Two separate chiller plants were established one for Men's hostel and one for ladies hostel. About 70% of the light fixtures were converted to LED. Seeing the performance of the LED, it was decided to convert all the Lighting systems in Library to LED during the next year and the same was replaced during 2019

In November 2018, an agreement was signed between VIT and Bharat enterprises, a wind energy company. According to the agreement, Bharat enterprises agreed to provide 95 lakh units power and BBK shoes to provide 27 Lakhs to VIT during 2022 via TANGEDCO Grid

Scope for the further improvement:

1. Conventional lighting systems in some of the old buildings need to be replaced by phased manner or as and when the lights are defective replace with LED lights.
2. Ceiling fans can be replaced with BLDC based 5 star energy efficient fans and also for the new buildings BLDC fan is recommended.
3. New RUB walk ways of 4 * 80 Meters can be installed with roof top solar PV of 100 kW rating and PRP block, 2 MLD, 3 MLD STP roofs, R block also considered for the solar PV installation.
4. Through energy Open exchange market the remaining power also procured from wind / solar -green power.

5. Occupancy sensor based electrical appliances control is recommended
6. Recommend to conduct regular awareness program on energy efficiency and saving. Suggest behavioural change against energy wastages – like forget to switch off the fans, lights, chargers, CPU and Monitors, printers, UPS also forget to close the doors of AC rooms and to switch off.
7. Recommend to keep the ACs at the adoptive temperature like above 25 ℃.
8. Apply load signature analysis to identify the optimal load pattern and the energy wastages.
9. Some of the pumps at STP are found throttling – water by passed in the pumping source itself, need to be fixed with lesser rated pumps.
10. Recommend the people to take stair cases at least for two floors.