VIT®

Vellore Institute of Technology

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

ENERGY AUDIT REPORT

YEAR - 2020

VELLORE INSTITUTE OF TECHNOLOGY

VELLORE - 632014

Dr. K. Palanisamy, EA3024
Certified Energy Auditor
Associate Professor
Department of Energy and Power Electronics
School of Electrical Engineering
VIT University
Vellore – 632 014, TN, India.

1. INTRODUCTION:

VIT was established under Section 3 of the University Grants Commission (UGC) Act, 1956, and was founded in 1984 as a self-financing institution called the Vellore Engineering College. VIT was established with the aim of providing quality higher education on par with international standards. It persistently seeks and adopts innovative methods to improve the quality of higher education on a consistent basis. VIT is the first institute of India to receive QS 4-Star rating in overall category and QS 5-Star rating in teaching, employability, facilities, innovation and inclusiveness. VIT is accredited by NAAC, Govt. of India with A Grade. FICCI, Industry Consortium of India, awarded VIT as “the University of the Year 2016” and "Excellence in faculty for the year 2017" in India.

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 inorder 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 9 MW 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 / 415 V transformers of different capacity. Four transformer stations are supplying 15 men's hostels, Six transformers 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	1 No
2	650 kVA DG set	433 V	2 No
3	500 kVA Generator	433 V	15 Nos
4	250 kVA Generator	433 V	4 Nos
5	180 kVA Generator	433 V	1 No
6	140 kVA Generator	433 V	1 No
7	40 kVA Generator	433 V	3 Nos

After analyzing the electricity consumption from 2019, 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 were also getting completed. Major problems faced during the summer months were water scarcity, electricity shortage and also AC repair works and maintenance.

In 2018 in order to compensate for the power shortage a rolling load shedding was introduced.

This was the routine being followed in Men's Hostel, and was carried out even throughout the night incase of very high shortages.

Timing	Hostels	Duration
	Men's Hostel	
9.00AM to 10.00AM	G, J,K, (M&N odd floors)	1 Hour
10.00AM to 11.00AM	A, F, H, L, (M&N even floors)	1 Hour
11.00AM to 12.00PM	B,D,E, (M&N odd floors)	1 Hour
12.00PM to 01.00PM	B Annex, D Annex, (M&N even floors)	1 Hour
2.00PM to 3.00PM	G, J,K, (M&N odd floors)	1 Hour
3.00PM to 4.00PM	A, F, H, L, (M&N even floors)	1 Hour
4.00PM to 5.00PM	B,D,E, (M&N odd floors)	1 Hour
5.00PM to 6.00PM	B Annex, D Annex, (M&N even floors)	1 Hour
6.00PM to 07.00PM	G,J,K (M&N odd floors)	1 Hour
07.00PM to 08.00PM	A, F, H, L, (M&N even floors)	1 Hour
08.00 to 09.00PM	B,D,E, (M&N odd floors)	1 Hour
09.00PM to 10.00PM	B Annex, D Annex, (M&N even floors)	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 25th May, 37 lakh 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.

EB Bill Analysis in terms of Amount

Electricity Bill Amount of VIT

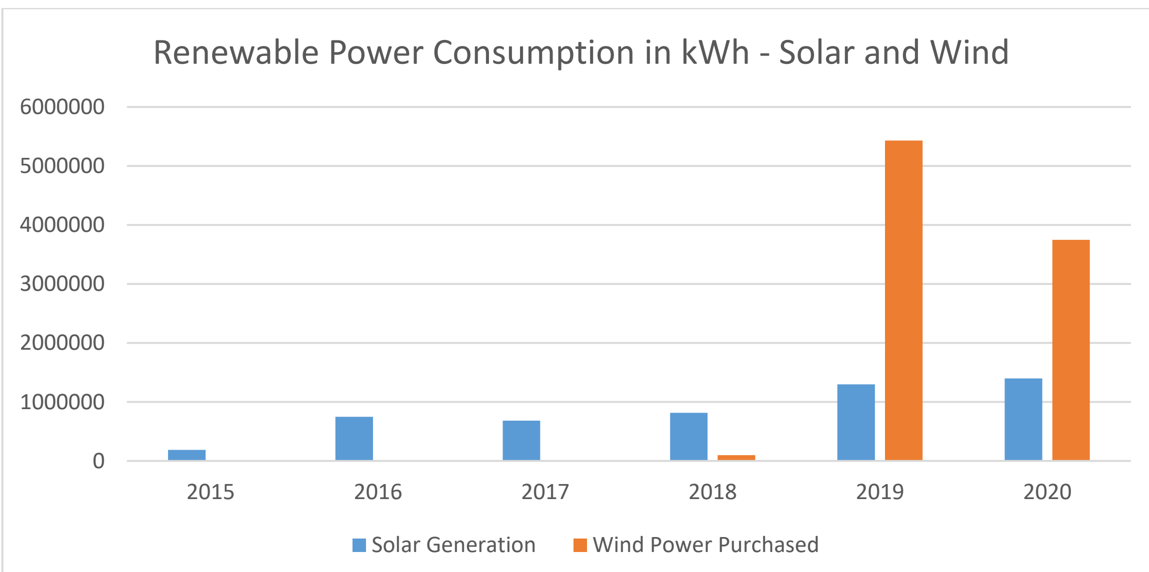
Month	HT Units (C24)	Max. demand in kVA	Amount as per HT bill
		2019	
Jan-19	20,39,280	5533.2	1,61,95,685.00
Feb-19	33,42,120	7598.4	2,46,64,385.00
Mar-19	40,59,120	8570.4	2,99,58,182.00
Apr-19	46,88,760	8756.4	3,44,13,114.00
May-19	17,59,680	6421.2	1,22,94,040.00
Jun-19	14,79,960	4200	80,56,050.00
Jul-19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

			40,76,467.30

<u>Renewable power usage percentage:</u>

year	Sanctioned Demand in kW	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	2742960	1110534	2113	1732792	103.659



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

HEAT PUMP CALCULATION:

A chiller plant was initially only planned for the new hostel block(Q block). Inorder 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.

To also compensate for the lack of power during peak consumption time, a tender for outsourcing power from private company was decided to be made. To promote better and greener policy in VIT, the use of diesel generators were decided to be reduced and the external power outsourcing was obtained from a Renewable energy company.

<u>Technical Specification of SES 12T Heat Pump Water Heating System</u>

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**

Note:

The heat pump designed for modulation controlling units which mean we can run and control the system individually.

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 dia. 12.5mm +/-0.5mm,Thickness 0.56mm
4. Header	Copper tube of dia 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 Transmitivity :>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 Tilt 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

ELECTRIC HEATER.	
= Volume of water in Lts x specific Gravity of media x Temperature Difference to raise temperature of media / 860	
To heat 20000 lts of media from 30 degree C to 60 degree C	20000 x 1.01 x (60-30 degrees) Per Day / 860
Electricity Required per day	704 UNITS
Cost of Electricity	704 x Rs 9 Per Unit = Rs. 6,336 / day
BOILER	
Diesel = Volume of water in Lts x specific Gravity of water x Temperature Difference to raise temperature of water	
To heat 20000 ltrs of Water from 30 degree C to 60 degree C	20000x 1.01 x (60 - 30 degrees) Per Day K cal.
Total Calorific Valve required to Heat 20000 Lts water	606000 cal.
Calorific Valve of Diesel / Kg Diesel required to Heat the 20000 Lts per day	10,200 K cal. 606000 / 10,200 = 59 Lts Diesel / day
Cost Diesel per 20000 lits 40 % of Indirect heating Loss	59 Lts x Rs 55= Rs 3245 23.6 Lts x Rs 55 = Rs 1298 Total = Rs.4543 per day.
HEAT PUMP	
12 T Heat Pump Input power	48 kw
12 T Heat Pump Heating Output in kw	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
Electricity Required Per 20000 LITS FOR HEAT PUMP	14.6 hrs x 12 Kw = 175 units
Cost of Electricity	175 units x Rs 9 per unit = Rs. 1575 / day.

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 50% 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 90 lakh units power to VIT during 2019 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.
3. New RUB walk ways of 4 * 80 Meters can be installed with roof top solar PV of 100 kW rating.
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 24 °C.
8. Apply load signature analysis to identify the optimal load pattern and the energy wastages.
9. Recommend the people to take stair cases at least for two floors.