Report on

Energy Audit and Green Audit

For

Zeal College of Engineering and Research, Narhe

by:

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Team Enertek

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BEE Certified Energy Auditor

Preamble:

Zeal Education Society is established in year 1996, education. Society runs eight institutes from Pre-primary to PhD courses. It caters to educational needs of more than 7000 students, and it's continuously expanding to cope up with growing demands in the field of technical education.

ZCOER is established in 2007 which symbolized the beginning of new era in technical education. The college offers UG engineering degree courses in Civil Engineering, Computer Engineering, and Electrical Engineering, Information Technology, Electronics & Telecommunication and Mechanical Engineering. The college also offers PG courses in Computer Engineering, Electrical Engineering (Power System), Electronics & Telecommunication (VLSI and Embedded System), Mechanical Engineering (ME Design / CADEM) and Master of Business Administration. The institute is also granted as PhD research center in Computer Engineering, Electronics & Telecommunication and Mechanical Engineering.

Executive Summary:

Electricity Bill:

Tariff Structure:

Sanctioned load for energy meters is 150 kW but connected load is around 188.73 kW. Current tariff structures, **LTVII-B** are recommended for above 20kW respectively. According to #322 of 2019 MERC amendment (Maharashtra Electricity Regulatory Commission); the recommended category for public services (such as schools, hospitals) is **LTVII–B tariff**. In this category there will be fixed demand charges per month.

By implementing the energy efficiency measures for Lighting, Ceiling fans and pumps, the connected load would come down from 190.33 kW to 184.08kW.

MEP System:

Lighting System:

In order to provide appropriate illumination to levels with high Uniformity and Diversity, we have proposed to replace these existing T5 and T8 lighting system with LED tube light for improving energy efficiency and energy saving.

The Replacement of the T5 & T8 Lighting fixtures with LED Fixture can reduce the lighting load from 37.75kW to 31.46kW.

Ceiling fans:

Existing ceiling fans in the classrooms are consuming 40W, 60 W and 85W power, which are conventional induction motor type fans. Considering the vintage of these fans, it would be prudent to replace these fans by new energy-efficient BLDC fans, which would consume around 28W to 30W power each.

Currently, there are 311 nos. ceiling fans in the college and that number would increase to 880 nos. Electrical load of fans would be reduced by 41.5 kW.

Total proposed investment for 880 nos. BLDC fans would be Rs.16.3 Lakh and the expected saving potential would be Rs. 5.04 Lakh per annum. The sample payback period would be 3.3 years.

Air conditioning system:

Air conditioning system installed at college premises are of BEE 2-Star and 3-Star rating under BEE's star labelling program. While installing of new air conditioning system evaluation of star rating is considered in details. Performance of AC was near to rated EER as per star rating.

Water pumping system:

College receives water from Municipal Corporation. There are a U/G tank of various capacities, which stores water received from Municipal Corporation and then as needed, water is pumped to OH Tanks. Usually, the water is topped up once a day for one and half hour each.

For lifting water from U/G Tanks, 8 nos. submersible pumps (4W + 4S/B) have been installed. As confirmed by team, these pumps were installed more than 10 years and the pump motors have undergone rewinding several times.

The operating efficiency of the Pump + Motor was found to between 27% to 31 %, and it would be prudent to replace these pumps by new energy - efficient pumps.

An investment of Rs. 1.8 Lakh would be needed for replacing both these pumps along with interconnecting piping. Pump is operated for lesser hour/day and the payback period would be very high, but considering vintage of these pumps, management need to replace both the pumps without actually considering payback period.

The summary of expenses to be incurred for upgrading the electrical system, including future addition of equipment's in next 5/6 years, is as under:

Sr. No.	Description	Cost Savings, Rs. Lakh	Expected Expenses, Rs. Lakh	Simple Payback period
1	Installation of APFC panels for both energy meters to maintain power factor to unity		0.9	< 3 Years
2	Replace existing ceiling fans with 30W BLDC fans, including addition of new fans	5.4	16.3	<3.2 Years

3	Replace existing Water pumps with new energy efficient pumps, including piping	0.16	1.8	< 3 Years
	Total:	5.56	**19**	

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Chapter 1

Audit Methodology:

ESIPL team carried out the entire energy and MEP audit study with a well-defined methodology and all the energy consuming areas were covered including billing analysis. The detailed methodology followed was as under:

1.1. Electrical Distribution System:

Scope of Work:

- Study the Load distribution pattern of major energy meters
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

- Find out the electrical normal & emergency loading.
- Type of tariff
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

Performance audit:

Electric load recording with:

- Voltage, current, kVA, kW, kWh, P.F. and Hz
- Harmonic analysis for V_{THD} and I_{THD} levels
- Thermography of electrical panels for identifying 'hot-spots', if any

1.2. Indoor Lighting:

Scope of Work:

- To study existing lighting scenario of facility and verify the building data
- To find out the performance of lighting fixtures
- To calculate (Watt/m^2) and compare lux with the bench mark/prevailing standard in the facility
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

All the lighting fixtures were inspected for following:

- No. of lights installed and no. of lights working
- Type of lights

- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

Performance audit:

Total connected lighting load from the Census was studied in detail as per following:

- Measurement of Lux level
- Measurement of room dimensions
- Power drawn by the lighting system

1.3. Pumps:

Scope of Work:

- To study existing pumping system of facility and verify the building data
- To carry out analysis
- To find out the performance of pumping system
- To compare the operating efficiency with the bench mark/prevailing standard in the facility
- To identify the causes of deviation in the performance and suggest recommendations for corrective actions
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

Census:

All pumps (Chilled water, cooling water and domestic water) were audited for following:

- Total no. of pumps installed
- Total no. of pumps working
- Pressure gauge working
- Ammeter working
- General hygiene conditions
- Data on operating hours data was collected from the operating staff

Performance audit:

All working pumps from the Census were studied in detail as per following:

- Water flow rate, m^3/hr
- Head generated, mWC
- Power drawn by pump, kW

1.4. Power Quality Analysis:

Scope of Work:

- Check of incoming power quality using power analyser device (Data collected will indicate the status of deviations in power, harmonics, voltage sags, frequency
- Specific corrective actions will lead to decrease in losses and increased life of equipment)

Methodology:

- Inspection of power quality with three phase power quality analyser at main incomer for understanding of various parameters.

1.5. HVAC System:

Scope of Work:

- To study existing split air conditioners of facility and verify the building data
- To find out the performance of air conditioners
- To compare the specific energy consumption with the bench mark/prevailing standard in the facility
- To identify the causes of deviation in the performance and suggest recommendations for corrective actions
- To suggest various energy efficient measures with first order cost benefit analysis

Methodology:

- No. of ODUs and IDUs installed and no. of regularly operated machines
- General hygiene as per standard maintenance practices
- Data on operating hours data was collected from the operating staff

1.6. Green Audit:

Scope of Work:

- To evaluate water layout and water consumption pattern in college premises
- To evaluate carbon footprints for energy consumption at college
- To identify opportunities for sewage treatment plant and waste management at college premises.

Methodology:

- To identify water usage consumption pattern in campus
- Identification of water sources and distribution analysis across points.
- Usage of renewable energy and consumption pattern for energy perspective
- Review of existing facilities available for waste disposal methodologies in campus.

Chapter 2

Billing Analysis:

Zeal College of Engineering and Research receives electricity supply from MSEDCL. One LT energy meters were installed for the college premises at electrical room.

The electrical load mainly comprises of the classroom lighting, office lighting, fans, Split AC units, domestic water pumping on an average, the building functions for about 10-11 hours a day for five and half days a week.

Sr. No.	Energy Meter Number	Tariff category	Phase	Contract Demand (kVA)	Connected Load (kW)	Operation status
1	170019032730	LTVII –B	3	188	150	Operational

2.1. Connected Load List:

A Building:

Sr. No.	Load	Power (W)	Quantity (Nos.)	Total Load (kW)
1	LED Tube Light	8	37	0.296
2	LED Tube Light	12	3	0.036
3	LED Tube Light	18	11	0.198
4	LED Tube Light	20	31	0.62
5	Tube Light	36	46	1.65
6	Tube Light	40	121	4.84
7	Ceiling Fan	85	128	10.88
8	Split AC Unit	1800	7	12.6
9	Water Pump	5500	1	5.5
10	Computer	100	100	10
			Total:	**46.62**

B Building:

Sr. No.	Load	Power (W)	Quantity (Nos.)	Total Load (kW)
1	LED Tube Light	18	5	0.09
2	LED Tube Light	20	10	0.2

Sr. No.	Load	Power (W)	Quantity (Nos.)	Total Load (kW)
3	Tube Light	28	78	2.18
4	Tube Light	36	66	2.38
5	Tube Light	40	63	2.52
6	Ceiling Fan	85	151	12.835
7	Water Pump	7500	1	7.5
8	Computer	100	100	10
			Total:	**37.61**

C Building:

Sr. No.	Load	Power (W)	Quantity (Nos.)	Total Load (kW)
1	LED Tube Light	8	1	0.008
2	LED Tube Light	12	9	0.108
3	LED Tube Light	18	0	0
4	LED Tube Light	20	10	0.2
5	Tube Light	28	284	7.952
6	Tube Light	36	0	0
7	Tube Light	40	17	0.68
8	Ceiling Fan	85	201	17.085
9	Water Pump	3700	1	3.7
10	Computer	100	100	10
			Total:	**39.73**

D Building:

Sr. No.	Load	Power (W)	Quantity (Nos.)	Total Load (kW)
1	LED Tube Light	8	16	0.128
2	LED Tube Light	12	92	1.104
3	LED Tube Light	18	15	0.27
4	LED Tube Light	20	28	0.56
5	Tube Light	28	347	9.716

Sr. No.	Load	Power (W)	Quantity (Nos.)	Total Load (kW)
6	Tube Light	36	56	2.02
7	Ceiling Fan	85	319	27.115
8	Split AC Unit	1800	6	10.8
9	Water Pump	5500	1	5.5
10	Computer	100	100	10
			Total:	**67.22**

2.2. Other Cost Saving measures:

As per MERC guidelines, a prompt payment discount of one percent of the monthly bill (excluding Taxes and Duties) shall be provided to consumers for payment of electricity bills within 7 days from the date of their issue.

In case the electricity bill is not paid within the due date mentioned on the bill, delayed payment charges on the billed amount, including the taxes, cess, duties, etc..., shall be levied on simple interest basis at the rate of 1.25% on the billed amount for the first month of delay.

A discount of 0.25% of the monthly bill (excluding taxes and duties), subject to a cap of Rs. 500/-, shall be provided to LT category consumers for payment of electricity bills through various modes of digital payment such as credit cards, debit cards, UPI, BHIM, internet banking, mobile banking, mobile wallets, etc....

College management can avail this benefit and make necessary provisions for making digital payments to MSEDCL.

Chapter 3

MEP Systems

3.1. Lighting System:

Zeal College of Engineering and Research has total 4 buildings. 1346 number of lighting fixtures and out of that 20% of lighting fixtures are T5 and T8 Type. This lighting is inefficient in terms of lumens/watt and that can be better replaced with LED lighting fixtures.

The total lighting load for all building is 37.75 kW and with overall BUA of 161425 ft^2, the actual LPD is 0.23 W/ft^2.

Energy Saving Calculations:

Parameters	Value
Existing Connected load, kW	37.75
Proposed connected load, kW	31.46
Power Saving, kW	6.285

Recommendation:

Majority of fluorescent lighting fixtures are of T5 and T8 type, their lumen output values are lower, when compared with energy efficient LED tubes. An exercise was carried of calculating existing lumen levels in the classroom and how many fixtures would be needed to get required illumination levels, when 20W LED tube-lights would be used.

3.2. Ceiling Fans:

Zeal College of Engineering has 799 number of ceiling fans for air circulation at various classrooms, staff rooms and passages across four buildings. These existing ceiling fans are with conventional inductive motor and consume 40W, 60W and 85W power each. The total connected fan load for the building is 67.9 kW.

As per NBC-2016, 5 to 7 Air changes per hour have been recommended for classrooms. Typically, most of the classrooms has 4 - 6 nos. ceiling fans

Recommendation:

Existing ceiling fans can be replaced with energy-efficient brushless DC (BLDC) fans, which consume lower power and have higher air volume sweep. The other benefits of BLDC fans are lower noise generation, which is an advantage for college environment.

The proposed power consumption, after installation of BLDC fans, would reduce form 67.95 kW to 26.4 kW; resulting in savings of 41.5 kW of power per hour of usage.

Energy Saving calculations:

Parameters	Value
Proposed quantity of ceiling fans, nos.	880
Total Power consumed by existing fans, W	67.955
Recommended power for BLDC fans, W	30
Total proposed power by all BLDC fans, W	26.4
Expected Power Savings, W	41.5
Expected energy Savings per annum, kWh	49866
Annual cost savings, Rs. Lakh	5.04
Investment required, Rs. /Fan	1850
Total Investment, Rs. Lakh	16.3
Simple payback period, years	3.2

3.3. Air Conditioning System:

Room air conditioners have been installed at Principal's office, Computer rooms, and Conference halls and at multiple Labs. The installed Split air conditioning units are BEE 2 and 3 Star labeled. The air conditioning requirement is at diverse locations, and hence, there is no possibility of installing a centralized air conditioning system. While replacing air conditioning system with new split air conditioning system, latest BEE Star labelled air conditioning system should be selected for installation. As per

BEE's notification dated 10th November 2021, the minimum Energy efficiency ratio (EER) has been published in the gazette for manufacturing companies and consumer. Star labelling

Time period: From 1st January, 2021 to 31st December, 2023

Reference (BEE STAR Labelling)		
Indian Seasonal Energy Efficiency Ratio (kWh/kWh)		
Star Level	**Minimum EER**	**Max EER**
1	3.3	3.49
2	3.5	3.79
3	3.8	4.39
4	4.4	4.99
5	5.0	

Comparison of EER and payback period-

For various operating hours we have evaluated Air conditioning selection option on operating hours. Various star rated system of same capacity has higher initial investment and different operating costs. For initial selection of AC system, we have evaluated following data

AC system for 8 Hours/day usage:

AC TR Load	Star rating	Annual energy Consumption (kWh)	Operating Cost (Rs.)	Initial Investment (Rs.)	Operating Cost Difference (Rs.)	Initial Cost Difference (Rs.)	Payback Period (Rs.)	proposition
1.0	3	1108	10,475	31,990	766	3,000	3.9	4 Star v/s 3 Star
	4	1027	9,708	34,990	883	4,000	4.5	5 Star v/s 4 Star
	5	934	8,826	38,990	1,649	7,000	4.2	5 Star v/s 3 Star
1.5	3	1663	15,712	31,499	1,150	2,321	2.0	4 Star v/s 3 Star
	4	1541	14,562	33,820	1,324	6,170	4.7	5 Star v/s 4 Star
	5	1401	13,238	39,990	2,473	8,491	3.4	5 Star v/s 3 Star
2.0	3	2217	20,949	49,499	2,857	4,491	1.6	4 Star v/s 3 Star
	4	1915	18,092	53,990	2,171	3,000	1.4	5 Star v/s 4 Star
	5	1685	15,921	56,990	5,028	7,491	1.5	5 Star v/s 3 Star

Considering 8 hours operation period, the management should select BEE 5-Star rated split air conditioning system. As the operating cost of 5-Star system is much lower than any other Star rated air conditioning system, the incremental cost of system can be easily compensated with higher usage.

AC system for 5 Hours/day usage:

AC TR Load	Star rating	Annual energy Consumption (kWh)	Operating Cost (Rs.)	Initial Investment (Rs.)	Operating Cost Difference (Rs.)	Initial Cost Difference (Rs.)	Payback Period (Rs.)	proposition
1	3	693	6,547	31,990	479	3,000	6.3	4 Star v/s 3 Star
	4	642	6,068	34,990	552	4,000	7.3	5 Star v/s 4 Star
	5	584	5,516	38,990	1,031	7,000	6.8	5 Star v/s 3 Star
1.5	3	1039	9,820	31,499	719	2,321	3.2	4 Star v/s 3 Star
	4	963	9,101	33,820	827	6,170	7.5	5 Star v/s 4 Star
	5	876	8,274	39,990	1,546	8,491	5.5	5 Star v/s 3 Star
2	3	1386	13,093	49,499	1,785	4,491	2.5	4 Star v/s 3 Star
	4	1197	11,308	53,990	1,357	3,000	2.2	5 Star v/s 4 Star
	5	1053	9,951	56,990	3,142	7,491	2.4	5 Star v/s 3 Star

Considering 5 hours operation period; the management should select BEE 4-Star rated split air conditioning system.

Considering lower operation hours and impact of power consumption, system selection of BEE 4-Star rated system would be more appropriate.

AC system for 3 Hours/day usage:

AC TR Load	Star rating	Annual energy Consumption (kWh)	Operating Cost (Rs.)	Initial Investment (Rs.)	Operating Cost Difference (Rs.)	Initial Cost Difference (Rs.)	Payback Period (Rs.)	proposition
1	3	416	3,928	31,990	287	3,000	10.4	4 Star v/s 3 Star
	4	385	3,641	34,990	331	4,000	12.1	5 Star v/s 4 Star
	5	350	3,310	38,990	618	7,000	11.3	5 Star v/s 3 Star
1.5	3	623	5,892	31,499	431	2,321	5.4	4 Star v/s 3 Star
	4	578	5,461	33,820	496	6,170	12.4	5 Star v/s 4 Star
	5	525	4,964	39,990	928	8,491	9.2	5 Star v/s 3 Star
2	3	831	7,856	49,499	1,071	4,491	4.2	4 Star v/s 3 Star
	4	718	6,785	53,990	814	3,000	3.7	5 Star v/s 4 Star
	5	632	5,971	56,990	1,885	7,491	4.0	5 Star v/s 3 Star

Considering 3 hours operation per day, the management should invest into BEE 3-Star split air conditioning system. Considering fewer operating hours per day, and power consumption of system; it would be prudent for management to select BEE 4-Star system over a BEE 3-Star rated system.

3.4. Water Pumping System:

The water pump is operated twice for one and half hour each, during the day these pumps have been installed since inception of this college and have been rewound at least 2-3 times.

Operating efficiency of these pumps was evaluated using ultrasonic flowmeter and power analyzer.

Pump Performance Evaluation:

Parameters	A Building	B Building	C Building	D Building
Voltage, V	379.9	398.5	358.9	403.2
Current, Amp	4	14.4	4	11.7
Power factor	0.687	0.996	0.749	0.929
Power, kW	1.8	9.9	1.89	7.71
Water flow rate, m3/hr	8.86	4.95	7.4	6.6
Total Head generated, mWC	15	21	21	21
Rated Motor Power, kW	3.7	7.5	3.7	7.5
Overall Pump + Motor Efficiency, %	29%	27%	32%	28%

Recommendation:

Replace these existing pumps with efficient pump, which would have 60% pump efficiency and Motor efficiency would be 80% or more. Also, by installing Automatic level controller system, the pump operations can further be optimised

Parameters	A Building	B Building	C Building	D Building
Pump Model (Kirloskar make)	KOS 538+	KOS 538+	KOS 538+	KOS 538+
Water flowrate, m3/hr	29.52	29.52	29.52	29.52
Total head generated, mWC	28	28	28	28
Powe consumed, kW	4.2	4.2	4.2	4.2
Current Operating Hours/day	1.5	2.5	1.5	2
Total Water discharged, m3/day	13.29	12.375	11.1	13.2

Time required by new pump for discharging water, hours	0.45	0.42	0.38	0.45
Energy consumed by existing Pump	2.7	24.75	2.835	15.42
Energy consumed by proposed pump	1.9	1.8	1.6	1.9
Energy Savings per annum	295	8391	458	4943
Cost Savings, Rs. /Annum	2983	84750	4629	49922
Investment for replacement of 2 Pumps (1W + 1S/B and piping)	0.45	0.45	0.45	0.45
Simple payback period, years	15.09	0.53	9.72	0.90

Since only single pump is operated for 2 hour/day and we need to replace both pumps, along with interconnecting piping, the initial investment is high; but considering vintage of these pumps, it would be prudent to replace these pumps without actually looking at payback period.

Chapter 4

Power Quality Analysis:

In the Power Quality study, the Site team carried out the power quality survey for the load. 3 Phase energy analyser was connected at the main incoming feeder for the period of 24 Hours.

The energy parameters logged were as under:

- Voltage Profile
- Current Trends
- Power trends and consumption
- Power Factor
- Frequency
- Harmonics
- Unbalance, if any

To measure the electrical parameters for the meters, a 3-phase power analyser with the following details has been connected to the main incoming for 24 hours.

Details of 3 Phase Power Analyser:	
Make	**Fluke**
Model number	**434 II**
Serial Number	**39783011**
CT Details	**iFlex CTs 6000A**

4.1. Test Method:

- As per requirement, the instruments stated above were connected at the main incoming of the panel
- Logging of electrical parameters was done for 24 hours' duration
- Measuring interval period, set on the device, was 1 min (60 reading in 1 hour) with minimum maximum and average for each reading.
- Following parameters have been measured and recorded by the instrument:
    - Voltage(V): Phase Voltage, Line Voltage, Peak Voltage, N-G voltage
    - Current(A): Line Current, Peak Current
    - Power (kW, kVA, kVAR): Active, Reactive, Apparent
    - Energy (kWh, kVAh, kVARh): Active, Reactive, Apparent
    - Harmonics (V_{THD} and I_{THD})
    - Voltage & current unbalance

- Power Factor
- Frequency (Hz)

- The readings taken, were compared with the reference standards available for tolerances. For detailed information, Electricity Supply Act or Electricity Act were also referred.

Reference Codes and Standards:

Parameters	Reference Limits	Referenced Standards
Power Frequency	Mean Value of fundamental measured over 10s +/- 2% for 99.5%	EN 50160
Voltage magnitude Variation	+/- 10% for 95% of week, mean 10mins RMS values	EN 50160
Harmonics Voltage	V_{THD} < 5%individual V-h <3%	IEEE 519
Harmonics Currents	I_{THD} %: as defined by ratio of 1 (short circuit)/ 1(Full load)	IEEE 519
Supply voltage unbalance	positive, Negative and zero sequence, 2% between line to line	EN 61000-2-12
Load Unbalance	Positive, Negative and zero sequence, leakage currents <500ma	EN 50161

Harmonic Standards:

Parameters	Benchmark
Total Harmonic Distortion in Voltage and Current (THD)	Less than 5% for 69kv and below (As per IEEE)
Individual harmonic distortion in Voltage and current	Less than 3% for 69kv and below (As per IEEE)
Neutral Current	Less than 10% of load current
Ground Leakage	Ideally Zero
Voltage Variation in transformer's secondary	Less than 3 percentage (As per Electrical Standard)

Voltage Distortion Limits		
Bus Voltage at PCC	**Individual Voltage Distortion (%)**	**Total Voltage Distortion THD (%)**
Below 69 kV	3.0	5.0

69 kV to 161 kV	1.5	2.5
161 kV and above	1.0	1.5
Note: High voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user		

Maximum % Harmonic Current Distortion of an individual Harmonic Order (Odd)						
Individual Harmonic order (Odd Harmonics)						
ISC / IL	< 11	11 < 17	17 – 20	23 < 35	35 <	TDD
< 20	4.0	2.0	1.5	0.6	0.3	6.0
20 < 50	7.0	3.5	2.5	1.0	0.5	8.0
50 < 100	10.0	4.5	4.0	1.5	0.7	12.0
100 < 1000	12.0	5.5	5.0	2.0	1.0	15.0
> 1000	15.0	7.0	6.0	2.5	1.4	20.0

Chapter 5

Water Audit:

AUDIT FINDINGS & OBSERVATIONS
Building-A

The building-A is primarily dedicated to Conducting classes of first year engineering students. All floor includes an office, meeting rooms, Labs and Classrooms.

Drinking and Domestic use water is delivered from a well situated in the campus itself into the underground domestic tank of 40,000 litter capacity. Currently, there are no re-use, reclaim, or harvested rainwater sources being used as an alternative water supply. At this time, no records could be provided to accurately determine the volume of water supply withdrawals from the deep well and spring. As such, we are unable to determine the average daily water use based on historical water use. Storage Tank is located at behind the Maim building. As to the wastewater coming from the locators, there is no existing treatment of such. Kitchen and bathroom water are sourced from the Storage Tanks.

Water is pumped to terrace with the help of 7 HP pump. Single tanks of 40000 litter's capacity are located on rooftop which provides water to entire building for domestic, drinking & washroom purpose with 2-inch pipeline.

Table 1: Building population was based on information provided by staff as follows:

Ground Floor	10 Employees & Security	Mon. – Fri.	10 hrs./day
First Floor	70 Students/7 Staff	Mon. – Fri.	10 hrs./day
Second Floor	70 Students/7 Staff	Mon. – Fri.	10 hrs./day
Third Floor	70 Students/7 Staff	Mon. – Fri.	10 hrs./day
Fourth Floor	70 Students/7 Staff	Mon. –	10 hrs./day

		Fri.	

Based on a walk-through audit of the entire facility, the following fixtures were identified and measured for flow rates of tanks.

The following is a detail of fixtures in an entire building: -

Floor	Location	Urinals		Faucets		Toilet		Bathroom	
		Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)
Ground Floor	Gents Toilet	5	2	2	1	3	7	1	30
	Ladies Toilet	0		2	1	3	7	0	
First Floor	Gents Toilet	5	2	2	1	3	7	1	30
	Ladies Toilet	0		2	1	3	7	0	
Second Floor	Gents Toilet	5	2	2	1	3	7	1	30
	Ladies Toilet	0		2	1	3	7	0	
Third Floor	Gents Toilet	5	2	2	1	3	7	1	30
	Ladies Toilet	0		2	1	3	7	0	

Tanks & Pumps Details

Tank Locations	Capacity	UoM
Domestic Water Tank	45000	Letters
Overhead Tank 1	40000	Litters
Pump Details:		
Parameters	**Measurements**	**UoM**
Water Flow	8.866	m^3/hr
Voltage	219.6	V
Current	4	A
Power	0.61	kW
Power Factor	0.687	PF
Pump Usage	1.5	Hrs/day

Total Water Consumption

Building A					
Particulars	**Quantity**	**People**	**Frequency**	**Water Per Usage (litters)**	**Total Water Used (litters)**
Toilets	22	350	0.01	7	539
Urinals	20	350	2	2	28000

Faucet	16	350	2	1	11200
					39739

Building-B

The building-B is primarily dedicated to Mechanical Engineering Department. Building consists of classrooms, Labs, Workshop, staff offices & washrooms. Domestic water is delivered from a well situated behind the building into the underground domestic tank of 25000-Litters capacity. Currently, there are no re-use, reclaim, or harvested rainwater sources being used as an alternative water supply. At this time, no records could be provided to accurately determine the volume of water supply withdrawals from the deep well and spring. As such, we are unable to determine the average daily water use based on historical water use. Storage Tank is located at backside of the Main building. As lo the wastewater coming from the locators, there is no existing treatment.

Water is pumped to terrace with the help of 1 HP pump. Two tanks' of 2000 Litters and 40000 litters capacity are located on rooftop which provides water to entire building for domestic, drinking & washroom purpose with 2-inch pipeline.

The following is a detail of fixtures in an entire building:

Floor	Location	Urinals		Faucets		Toilet		Bathroom	
		Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)
First Floor	Gents Toilet	8	2	4	2	4	7	0	
	Ladies Toilet	0		0		0		0	
Second Floor	Gents Toilet	4	2	2	2	2	7	0	
	Ladies Toilet	0		2	2	3	7	0	
Third Floor	Gents Toilet	4	2	2	2	2	7	0	
	Ladies Toilet	0		2	2	3	7	0	
Fourth Floor	Gents Toilet	4	2	2	2	2	7	0	
	Ladies Toilet	0		2	2	3	7	0	
Fifth Floor	Gents Toilet	4	2	2	2	2	7	0	
	Ladies Toilet	0		2	2	3	7	0	

Tanks & Pumps Details

Tank Locations	Capacity	UoM
Underground Tank	25000	Litters
Overhead tank-1	20000	Litters
Overhead tank-2	40000	Litters
Pump Details		

Parameters	Measurements	UoM
Voltage	230.4	V
Current	14.4	A
Power	3.30	kW
Power Factor	0.996	PF
Flow	4.95	m3/hr
Pump Usage	2.5	hr/day

Total Water Consumption

Building B					
Particulars	**Quantity**	**People**	**Frequency**	**Water Per Usage (litters)**	**Total Water Used (litters)**
Toilets	21	420	0.01	7	617.4
Urinals	28	420	2	2	47040
Faucet	20	420	2	1	16800
					64457.4

Building-C

The building-C is a dedicated for Electrical and ENTC Department for conducting Lectures and other activities. The building includes Auditorium, Reading Hall, Library, canteen, Class Rooms, And Labs and Offices. Domestic water is delivered from well situated in campus into the underground domestic tank of 45000-Litters capacity. Currently, there are no re-use, reclaim, or harvested rainwater sources being used as an alternative water supply. At this time, no records could be provided to accurately determine the volume of water supply withdrawals from the deep well and spring. As such, we are unable to determine the average daily water use based on historical water use. Storage Tank is located at backside of the Main building. As to the wastewater coming from the locators, there is no existing treatment.

Water is pumped to terrace with the help of 1 HP pump. Two tanks of 10000 Litters capacity are located on rooftop which provides water to entire building for domestic, drinking & washroom purpose with 1.5-inch pipeline.

Table 3: Building population was based on information provided by staff as follows:

First Floor	200 Students/50 Staff	Mon. – Sat.	10 hrs./day
Second Floor	80 Student/10 Staff	Mon. – Sat.	10 hrs./day
Third Floor	80 Student/10 Staff	Mon. – Sat.	10 hrs./day
Fourth Floor	80 Student/10 Staff	Mon. – Sat.	10 hrs./day
Fifth Floor	80 Student/10 Staff	Mon. – Sat.	10 hrs./day
Sixth Floor	80 Student/10 Staff	Mon. – Sat.	10 hrs./day

Based on a walk-through audit of the entire facility, the following fixtures were identified and measured for flow rates of tanks.
The following is a detail of fixtures in an entire building:

Floor	Location	Urinals		Faucets		Toilet		Bathroom	
		Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Wate per U (Litte
First Floor	Canteen								
Second Floor	Gents Toilet	3	2	1	2	2	7	0	
	Ladies Toilet	0		2	2	2	7	0	

Floor	Location	Urinals		Faucets		Toilet		Bathroom	
		Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Wate per U (Litte
Third Floor	Gents Toilet	3	2	1	2	2	7	0	
	Ladies Toilet	0		2	2	2	7	0	
Fourth Floor	Gents Toilet	3	2	1	2	2	7	0	
	Ladies Toilet	0		2	2	2	7	0	
Fifth Floor	Gents Toilet	3	2	1	2	2	7	0	
	Ladies Toilet	0		2	2	2	7	0	
Sixth Floor	Gents Toilet	3	2	1	2	2	7	0	
	Ladies Toilet	0		2	2	2	7	0	

Tanks & Pumps Details

Tank Location	Measurement	UoM
Underground Tank	45000	Litters
Overhead Tank	30000	Litters
Parameters	**Measurements**	**UoM**
Voltage	207.5	V
Current	4	A
Power	0.63	kW
Power Factor	0.749	PF
Flow	7.434	m3/hr
Pump Usage	1.5	hr/day

Total Water Consumption

Building C					
Particulars	Quantity	People	Frequency	Water Per Usage (litters)	Total Water Used (litters)
Toilets	25	420	0.01	7	735
Urinals	15	420	2	2	25200
Faucet	30	700	2	1	42000
					67935

Building-D

The building-D is dedicated for Civil, MBA, Computer and IT Department. The building includes labs classroom and offices. Domestic water is received from a well situated in campus into the underground domestic tank of 80000-Litters capacity. Currently, there are no re-use, reclaim, or harvested rainwater sources being used as an alternative water supply. At this time, no records could be provided to accurately determine the volume of water supply withdrawals from the deep well and spring. As such, we are unable to determine the average daily water use based on historical water use. Storage Tank is located at backside of the Main building. As to the wastewater coming from the locators, there is no existing treatment.

Water is pumped to terrace with the help of 2 HP pump into Two tanks of 20000 Litters and 60000 Litters capacity tanks are located for domestic, drinking & washroom purpose with 2-inch pipeline.

Table 4: Building population was based on information provided by staff as follows:

Ground Floor	40 Students /4 Staff	Mon. – Sat.	10 hrs./day
First Floor	80 Students /6 Staff	Mon. – Sat.	10 hrs./day
Second Floor	80 Students /6 Staff	Mon. – Sat.	10 hrs./day
Third Floor	80 Students /6 Staff	Mon. – Sat.	10 hrs./day
Fourth Wing	80 Students /6 Staff	Mon. – Sat.	10 hrs./day
Fifth Floor	80 Students /6 Staff	Mon. – Sat.	10 hrs./day
Sixth Floor	80 Students /6 Staff	Mon. – Sat.	10 hrs./day

Based on a walk-through audit of the entire facility, the following fixtures were identified and measured for flow rates of tanks.

The following is a detail of fixtures in an entire building:

Floor	Location	Urinals		Faucets		Toilet		Bathroom	
		Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Water per Use (Litters)	Qty	Wate per U (Litte
Ground Floor	Gents Toilet	0		0		0		0	
	Ladies Toilet	0		0		0		0	
First Floor	Gents Toilet	5	2	2	2	3	7		
	Ladies Toilet	0		2	2	4	7	0	
Second Floor	Gents Toilet	5	2	2	2	3	7		
	Ladies Toilet	0		2	2	4	7	0	
Third Floor	Gents Toilet	5	2	2	2	3	7		
	Ladies Toilet	0		2	2	4	7	0	
Fourth Floor	Gents Toilet	5	2	2	2	3	7		
	Ladies Toilet	0		2	2	4	7	0	
Fifth Floor	Gents Toilet	5	2	2	2	3	7		
	Ladies Toilet	0		2	2	4	7	0	

Tanks & Pumps Details:

Tank Locations	Capacity	UoM
Overhead Tank	80000	Litters
Underground Tank	80000	Litters
Pump Details		
Parameters	**Measurements**	**UoM**
Voltage	233.1	V
Current	11.7	A
Power	2.57	kW
Power Factor	0.929	PF
Flow	6.658	m3/hr
Pump Usage	2	hr/day

Total Water Consumption

Building D					
Particulars	Quantity	People	Frequency	Water Per Usage (litters)	Total Water Used (litters)
Toilets	42	560	0.01	7	1646.4
Urinals	30	560	2	2	67200
Faucet	24	560	2	1	26880
					95726.4

Chapter 6

Carbon Foot printing:

A Carbon Foot print is defined as the total greenhouse gas emissions, emitted due to various activities. In this we compute the emissions of Carbon-Di-Oxide, by usage of the various forms of Energy used by the College for performing its day-to-day activities. The college uses electrical energy for operating various electrical gadgets.

6.1. Basis for computation of CO2 Emissions:

The basis of Calculation for CO2 emissions due to Electrical Energy are as under 1 Unit (kWh) of Electrical Energy releases 0.8 Kg of CO2 into atmosphere Based on the above Data we compute the CO2 emissions which are being released in to the atmosphere by the College due to its Day-to-Day operations.

6.2. Month wise Consumption of Electrical Energy:

Due to the Covid-19 pandemic there is negligible energy consumption so the monthly CO2 emission is also negligible. –

Chapter 7

Rain Water Harvesting:

The system of rain water harvesting is an integral part of any educational institution. This system helps to conserve the rain water and also to use during the time of its desirable. This system helps the students to understand the basic concepts of rainwater harvesting system and their effective use in the real life.

It is seen that there is a natural slope at the Institute campus, such natural slope can be used to take the water through some specific path and absorb under the ground. There is one empty bore well in the Institute campus, such empty bore well can be charged with the use of rainwater harvesting system. In addition to this some ring wells can be prepared and rainwater, gray waste water from all the building can be taken through some specific path in these ring wells and used to charge under the ground to maintain the ground level water.

7.1. Advantages of rain water harvesting –

(a) Promotes adequacy of underground water

(b) Mitigates the effect of drought

(c) Reduces soil erosion as surface run-off is reduced

(d) Decreases load on storm water disposal system

(e) Reduces flood hazards

(f) Improves ground water quality / decreases salinity (by dilution)

(g) Prevents ingress of sea water in subsurface aquifersin coastal areas

(h) Improves ground water table, thus saving energy (to lift water)

(i) The cost of recharging subsurface aquifer is lower than surface reservoirs

(j) The subsurface aquifer also serves as storage and distribution system

(k) No land is wasted for storage purpose and no population displacement is involved

(l) Storing water underground is environment friendly

7.2. Rain water harvesting potential –

The total amount of water that is received in the form of rainfall over an area is called the rain water endowment of that area. Out of this, the amount that can be effectively harvested is called rain water harvesting potential.

All the water which is falling over an area cannot be effectively harvested, due to various losses on account of evaporation, spillage etc. Because of these factors the quantity of rain water which can effectively be harvested is always less than the rain water endowment. The collection efficiency is mainly dependent on factors like runoff coefficient and first flush wastage etc. Runoff is the term applied to the water that flows away from catchments after falling on its surface in the form of rain.

Runoff depends upon the area and type of catchment over which it falls as well as surface features. Runoff can be generated from both paved and unpaved catchment areas. Paved surfaces have a greater capacity of retaining water on the surface and runoff from unpaved surface is less in comparison to paved surface. In all calculations for runoff estimation, runoff coefficient is used to account for losses due to spillage, leakage, infiltrations catchment surface wetting and evaporation, which will ultimately result into reduced runoff. Runoff coefficient for any catchment is the ratio of the volume of water that run off a surface to the total volume of rainfall on the surface.

The runoff coefficient for various surfaces is given in following table –

Sr. No.	Type of catchment	Coefficient
1.	Roof Catchment	
	Tiles	0.8 – 0.9
	Corrugated metal sheets	0.7 – 0.
2.	Ground Surface Coverings	
	Concrete	0.6 – 0.8
	Brick Surface	0.5 – 0.6
3.	Untreated ground catchments	

	Soil on slope less than10 %	0.0 – 0.3
	Rocky natural catchments	0.2 – 0.5

Based on the above factors, the water harvesting potential of site could be estimated using the following equation:

Rain Water harvesting potential = Amount of Rainfall x area of catchment x Runoff coefficient

7.3. Rain water harvesting methods –

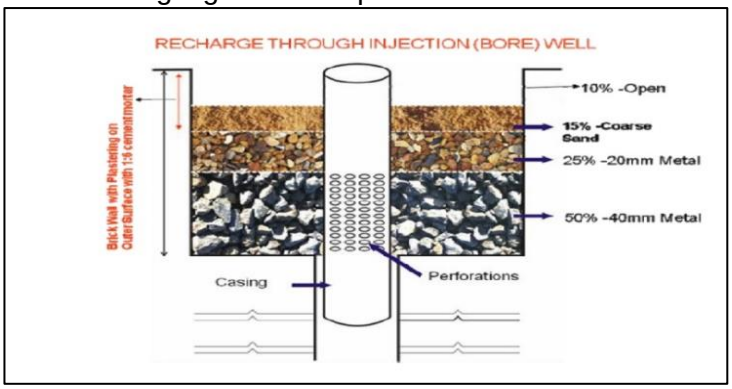
(a) Storing rain water for direct use

(b) Recharging ground water aquifers, from roof top run off

(c) Recharging ground water aquifers with runoff from ground area

According to the site of Institute the method of recharging ground water aquifers from roof top run off may be suitable. Recharging ground water aquifers from roof top run off. Rain water that is collected on the roof top of the building may be diverted by drain pipes to a filtration tank (for bore well, through settlement tank) from which it flows into the recharge well, as shown in following Figure. The recharge well should preferably be shallower than the water table. This method of rain water harvesting is preferable in the areas where the rainfall occurs only for a short period in a year and water table is at a shallow depth.

The schematic diagram of recharging water aquifers from solar roof top run off is as follows -



7.4. Existing Situation –

Institute has multiple high-rise buildings of 2 – 3 storeys each. These buildings are equipped with the rain water harvesting and water is being collected in the catchments. This collected water is being passed through the borewell present in the campus.

Chapter 8

Waste Disposal & Vermi composting:

8.1. Vermiculture Composting Culture –

Vermicomposting is basically a managed process of worms digesting organic matter to transform the material into a beneficial soil amendment. The institute has been started Vermi culture composting culture in house on 30 Sq. meter land. The main purpose of this is to reduce disposable waste in the Institute campus and after complete process of Vermi composting it is used as manure for plantation and greenery in the campus. It is also used for the demonstration and awareness in farmers to implement organic farming and its importance.

The main benefits of the process are to reduce the waste in the environment and utilized for some useful purpose and also it is cost savings process.

The earthworms being voracious eaters consume the biodegradable matter and give out a part of the matter as excreta or Vermi-castings. The Vermi-casting containing nutrients is a rich manure for the plants. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Fruits, flowers and vegetables and other plant products grown using vermicompost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production.

8.2. Process:

The process of composting crop residues / Agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built-up shallow layers. The pits are kept shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 300C is maintained. The final product generated by this process is called vermicompost which essentially consist of the casts made by earthworms eating the raw organic materials. The process consists of constructing brick lined beds generally of 0.9 to 1.5 m width and 0.25 to 0.3 m height are constructed inside a shed open from all sides. For commercial production, the beds can be prepared with 15 m length, 1.5 m width and 0.6 m height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be

increased as an increased width affects the ease of operation and an increased height on conversion rate due to heat built up. Cow dung and farm waste can be placed in layers to make a heap of about 0.6 to 0.9 m height. Earthworms are introduced in between the layers @ 350 worms per m3 of bed volume that weighs nearly 1 Kg. The beds are maintained at about 40-50% moisture content and a temperature of 20–300 C by sprinkling water over the beds. When the commercial scale production is aimed at, in addition to the cost of production, considerable amount has to be invested initially on capital items. The capital cost may work out to about Rs. 5000 to 6000 for every tonne of vermicompost production capacity. The high unit capital cost is due to the fact that large units require considerable expenditure on preparation of Vermi beds, shed to provide shelter to these beds and machinery. However, these expenditures are incurred only once. Under the operational cost, transportation of raw materials as also the finished product are the key activities. When the source organic wastes and dung are away from the production facility and the finished product requires transportation to far off places before being marketed, the operational cost would increase. However, in most of the cases, the activity is viable and bankable. Following are the items required to be considered while setting up a unit for production of Vermi-compost.

8.3. Components of a Commercial Unit –

Commercial units have to be developed based on availability of cow dung locally. If some big dairy is functioning then such unit will be an associated activity. Commercial units must not be designed based on imported cow dung.

1. Sheds

For a Vermi-composting unit, whether small or big, this is an essential item and is required for securing the Vermi beds. They could be of attached roof supported by bamboo rafters or steel trusses. Locally available roofing materials or HDPE sheet may also be used in roofing to keep the capital investment at reasonably lower level. If the size is so chosen as to prevent wetting of beds due to rain on a windy day, they could be open sheds. While designing the sheds adequate room/pathways has to be left around the beds for easy movement of the labourers attending to the filling and harvesting the beds.

2. Vermi-beds

Normally the beds have 0.3 to 0.6 m height depending on the provision for drainage of excess water. Care should be taken to make the bed with uniform

height over the entire width to avoid low production owing to low bed volumes. The bed width should not be more that 1.5 m to allow easy access to the centre of the bed.

3. **Fencing and Roads/Paths**

The site area needs development for construction of structures and development of roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and the finished products to and from the Vermi sheds. The entire area has to be fenced to prevent trespass by animals and other unwanted elements. These could be estimated based on the length of the periphery of the farm and the length and type of roads/paths required. The costs on fencing and formation of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.

4**. Water Supply System**

As the beds have to be kept moist always with about 50% moisture content, there is a need to plan for a water source, lifting mechanism and a system of conveying and applying the water to the Vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such a water supply system requires considerable initial investment. However, it reduces the operational cost on hand watering and proves economical in the long run. The cost of these items would depend on the capacity of the unit and the type of water supply chosen.

5. Transportation

For any Vermi-composting unit transport arrangement is a must. When the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require a three-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become infructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the Vermi-compost sheds could also be included in the project cost.

Recommendations –

Enertek recommends to install Waste Composting and Vermi-composting project of appropriate size.

Chapter 9

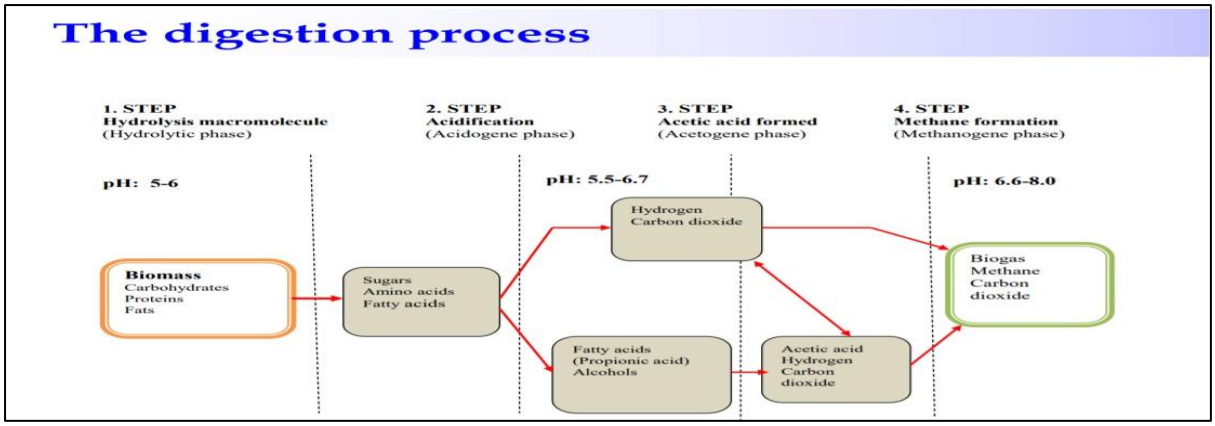
Biogas System:

9.1. Biogas system -

One of the main environmental problems of today's society is the continuously increasing production of organic wastes. In many countries, sustainable waste management as well as waste prevention and reduction have become major political priorities, representing an important share of the common efforts to reduce pollution and greenhouse gas emissions and to mitigate global climate changes. Uncontrolled waste dumping is no longer acceptable today and even controlled landfill disposal and incineration of organic wastes are not considered optimal practices, as environmental standards hereof are increasingly stricter and energy recovery and recycling of nutrients and organic matter is aimed.

Biogas typically refers to a mixture of different gases produced by the breakdown of organic matter in the absence of oxygen. Biogas can be produced from raw materials such as agricultural waste, manure, municipal waste, plant material, sewage, green waste or food waste. Biogas is a renewable energy source and, in many cases, exerts a very small carbon footprint. Biogas can be produced by anaerobic digestion with anaerobic organisms, which digest material inside a closed system, or fermentation of biodegradable materials. A wide range of micro-organisms are involved in the anaerobic process which has two main end products: biogas and digestate. Biogas is primarily methane and carbon dioxide and may have small amounts of hydrogen sulphide, moisture and siloxanes. The gases methane, hydrogen, and carbon monoxide can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat. Biogas can be compressed, the same way natural gas is compressed to CNG, and used to power motor vehicles. In the UK, for example, biogas is estimated to have the potential to replace around 17% of vehicle fuel. It qualifies for renewable energy subsidies in some parts of the world. Biogas can be cleaned and upgraded to natural gas standards, when it becomes bio-methane. Biogas is considered to be a renewable resource because its production-and-use cycle is continuous, it generates no net carbon dioxide. Organic material grows, is converted and

used and then regrows in a continually repeating cycle. From a carbon perspective, as much carbon dioxide is absorbed from the atmosphere in the growth of the primary bio-resource as is released when the material is ultimately converted to energy.



9.2. Current Situation -

There is no existing biogas system installed at the campus.

Recommendation -

Enertek recommends to install biogas system of appropriate size.

Chapter 10

Sewage Treatment Plant:

It includes physical, biological and sometimes chemical processes to remove pollutants. Its aim is to produce an environmentally safe sewage water, called effluent, and a solid waste, called sludge or biosolids, suitable for disposal or reuse. Reuse is often for agricultural purposes, but more recently, sludge is being used as a fuel source.

Water from the mains, used by manufacturing, farming, houses (toilets, baths, showers, kitchens, sinks), hospitals, commercial and industrial sites, is reduced in quality as a result of the introduction of contaminating constituents. Organic wastes, suspended solids, bacteria, nitrates, and phosphates are pollutants that must be removed. The features of wastewater treatment systems are determined by:

The nature of the municipal and industrial wastes that are conveyed to them by the sewers. The amount of treatment required to keep the quality of the receiving streams and rivers. Discharges from treatment plants are usually diluted in rivers, lakes, or estuaries. They also may, after sterilisation, be used for certain types of irrigation (such as golf courses), transported to lagoons where they are evaporated, or discharged through underground outfalls into the sea. However, sewage water outflows from treatment works must meet effluent standards set by the Environment Agency to avoid polluting the waters that receive them. In this process, aerobic bacteria digest the pollutants. To establish an aerobic bacterial colony, you must provide air for the bacteria to breathe. In a sewage treatment plant, air is continuously supplied to the Biozone either by direct Surface Aeration using Impellers propelled by pumps which whisk the surface of the liquid with air, or by Submerged Diffused Aeration using blowers for air supply through bubble diffusers at the bottom of the tank. (The most modern aerobic sewage systems use natural air currents and do not require electricity, though these are only used for small scale sewage systems at the moment. Once again, the general public leads the way!) Aerobic conditions lead to an aerobic bacterial colony being established. These achieve almost complete oxidation and digestion of organic matter and organic pollutants to Carbon Dioxide, Water and Nitrogen, thus eliminating the odour and pollution problem above. The effluent produced by this process is non-polluting and can be discharged to a watercourse

Conventional sewage water treatment involves either two or three stages, called primary, secondary and tertiary treatment. Before these treatments, preliminary removal of rags, cloths, sanitary items, etc. is also carried out at municipal sewage works.

Primary Treatment

This is usually Anaerobic. First, the solids are separated from the sewage. They settle out at the base of a primary settlement tank. The sludge is continuously being reduced in volume by the anaerobic process, resulting in a vastly reduced total mass when compared to the original volume entering the system.

The primary settlement tank has the sludge removed when it is about 30% of the tank volume.

Secondary Treatment

This is Aerobic. The liquid from the Primary treatment contains dissolved and particulate biological matter. This is progressively converted into clean water by using indigenous, water-borne aerobic micro-organisms and bacteria which digest the pollutants. In most cases, this effluent is clean enough for discharge directly to rivers.

Tertiary Treatment

In some cases, the effluent resulting from secondary treatment is not clean enough for discharge. This may be because the stream it is being discharged into is very sensitive, has rare plants and animals or is already polluted by someone's septic tank. The Environment Agency may then require a very high standard of treatment with a view to the new discharge being CLEANER than the water in the stream and to, in effect, 'Clean it up a bit'. It is usually either Phosphorous or Ammoniacal Nitrogen or both that the E.A. want reduced. Tertiary treatment involves this process. If Phosphorous is the culprit, then a continuous dosing system to remove it is the tertiary treatment. If Ammoniacal Nitrogen is the problem, then the sewage treatment plant process must involve a nitrifying and then de-nitrification stage to convert the ammoniacal nitrogen to Nitrogen gas that harmlessly enters the atmosphere.

Current Situation -

There is no existing Sewage Treatment Plant system installed at the campus.

Recommendation -

Enertek recommends to install Sewage Treatment Plant of appropriate size.