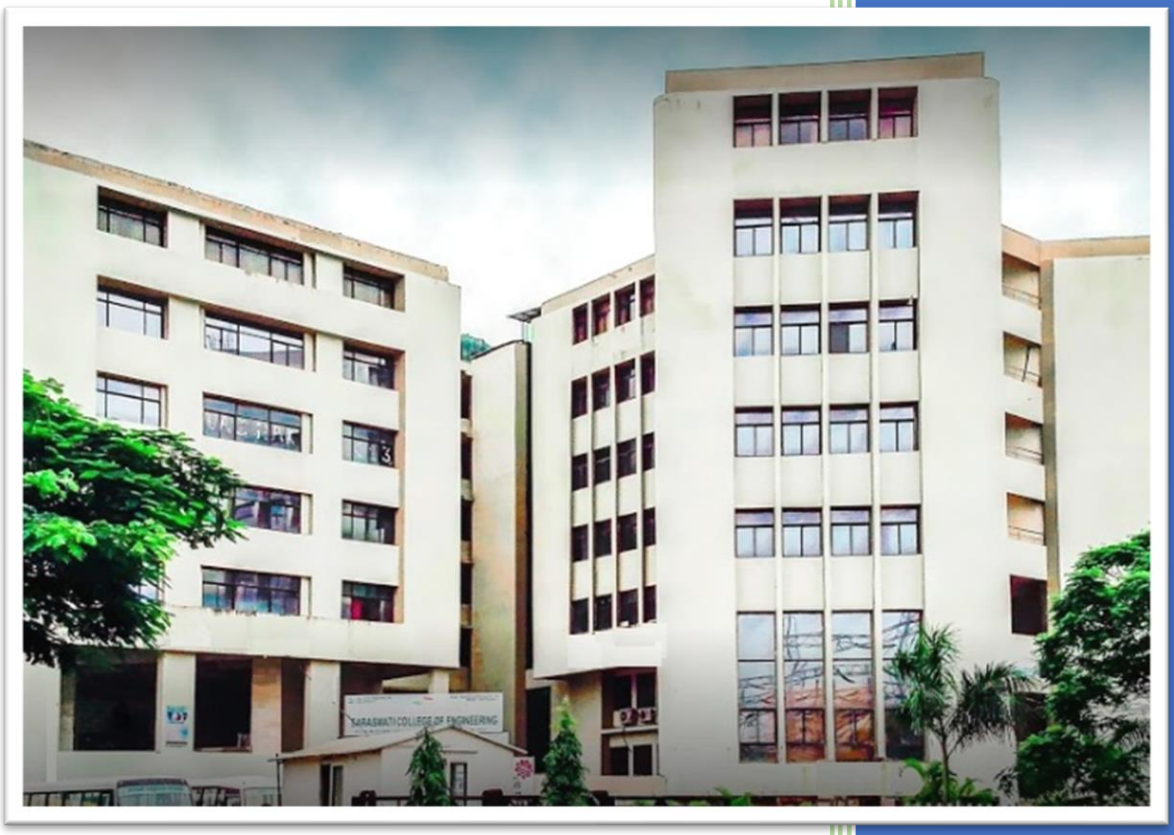
2022

Campus Environmental Audit- Saraswati College of Engineering Kharghar Navi Mumbai



Navy Blue Energy
NavyBlue Resources Integration and Solutions Pvt Ltd

ABBREVIATION

A-Ampere
AC- Air conditioner
ASHRAE – American Society of Heating, Refrigeration, and Air conditioning
BEE – Bureau of Energy Efficiency
BMS – Building Management System
CFL – Compact Fluorescent Lamp
CFM – Cubic feet per minute
DB – Distribution Board balance
DBT – Dry bulb temperature
DG – Diesel Generator
ECO – Energy Conservation Opportunities
EER- Energy Efficiency Ratio
HT- High Tension
IEEE- Institute of Electrical and Electronic Engineers
IT – Information Technology
KW – Kilowatt
KVA – Kilo Volt Ampere
LED – Light Emitting Diode
LPD – Lighting Power Density
LT – Low tension
NBC- National Building Code
ODU – Outdoor units
PAC – Precision Air Conditioning
PDU – Power Distribution Board
PF – Power factor
PSI- Pound per square inch
TR – Tonne of refrigeration
UoM – Unit of Measurement
UPS – Uninterrupted power supply
V - Voltage
VFD – Variable frequency drive
VRV – Variable Refrigerant volume
WBT – Wet Bulb Temperature

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ACKNOWLEDGEMENT

Energy Audit team of M/s. Navy Blue Resources Integration & Solutions Pvt Ltd (NBRI) conducted Campus Environmental Audit of Saraswati College of Engineering–30th March 2022- 31st March 2022

We would like to thank Hon. Principal and Management for providing us an opportunity to carry out Campus Environmental Audit at your Facility and would also like to thank all other staff of facility for providing all the support during audit and report preparations.

The purpose of this assessment is to conduct a complete energy performance assessment Mechanical & Electrical Equipment, Water Audit, Renewable Energy Feasibility, Waste Management and Green Audit within the said site to identify whether the existing systems can sufficiently handle the loads required by your operations and seeking improved workplace efficiently.

CERTIFICATE

We here by certify that we carried out Green Audit in the Saraswati College of Engineering, between 30th to 31st March 2022.

The Management is pro-active towards Green Initiative by Harvesting, Solar Energy project planning, Planting Trees, Better water conservation, Waste Management, Carbon Foot Print; A continual improvement in Green Initiative is appreciated. We appreciate the efforts of the campus management this regard.

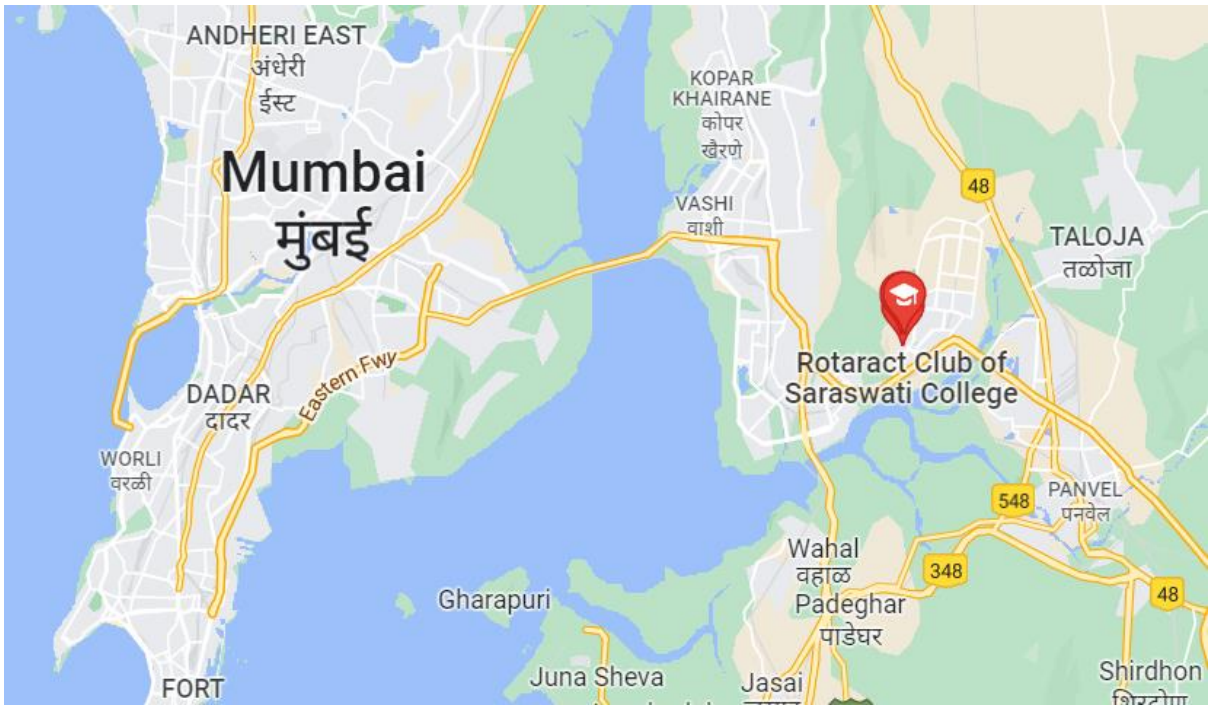
Navy Blue Resources Integration & Solutions Pvt. Ltd. ★ Navi Mumbai

Pravin J. Awatade
BEE-CEM/CEA
EA-28824

INTRODUCTION

The Saraswati College of engineering is the leading engineering institution in Navi Mumbai established in 2004. We aspire to be a leading research organization with a dream and vision of creating a knowledgeable society. SCOE is provided with spacious buildings to accommodate reception, auditorium, office, classrooms, staff rooms, drawing halls, laboratories, workshop, library, computer center, conference halls, examination hall, recreation centre, sports rooms, canteen, and placement cell. These facilities count us one of the Top Engineering colleges In Navi Mumbai.

Figure 1 Site Location on Map



Facility gets HT power supply from MSEDCL (State gov Electricity Distribution Company). In case of emergency or power failure facility having dedicated DG backup of 250 kVA set.

AUDIT STUDY TEAM MEMBERS

The Audit team comprised of following members from Navy Blue Energy.

Table 1 Audit Team Members

Sr. No	Name of Members	Designation
1	Pravin Awatade CEA-28824	Team Leader-Energy Auditor
2	Harun Sutar – CEA- 28328	Energy Manager
3.	Nehal Gupta	Energy Engineer

INSTRUMENTS USED FOR MEASUREMENTS AND ANALYSIS-

1. Three Phase Load Manager- With CT, PT
2. Ultrasonic Flowmeter
3. Single phase Instantaneous power Meters
4. Lux Meter
5. Psychrometer

EXECUTIVE SUMMARY

1. ENERGY AUDIT

Navy Blue Energy Audit team observed some energy conservation opportunity in the premises. Facility can minimize its energy consumption by executing following Energy Conservation measures.

Table 2 Executive Summary

Energy Conservation Measures (ECM)	Estimated Energy Saving	Estimated Monetary Saving	Estimated Investment	Simple Payback Period	Priority
	kWh/Year	Rs/Year	Rs	Month	
Energy Savings Potential by Improving the power factor	9787	100391	50000	5.98	High
Monetary savings potential by reducing the contract demand		1036800		Immediate	Very High
Energy Conservation Measure by Improving Pumping Performance	1982	20330	25000	14.8	Medium
Energy Conservation Measure by Improving Pumping Performance	1446	14827	20000	16.2	Medium
Energy Conservation Opportunity by replacing existing Ceiling fan by BLDC fan	7762	79613	346500	52.2	Low
TOTAL saving Opportunity	20976	1251962	441500	-	-
Energy Generation Opportunity by Installing Solar Power plant	70062	718654	2627340	43.9	Low

Navy Blue Energy Audit team has thoroughly assessed the complete facility Performance, Team has been observed that there will be around **23.95%** of Energy Savings Can be Achieved further by implementing the above-mentioned ECM's.

WATER AUDIT

Table 3 Water Conservation Measures

Water Conservation Measures	water Savings Potential kl/Year	Monetary Savings potential Rs/Year
Water conservation opportunity by replacing conventional taps with water efficient Taps	1098.1	61480
Water conservation potential By Making STP Plant Functional	2196.1	122960
Total	3294.2	184440

Navy Blue Water Audit team has thoroughly assessed the complete facility Performance, Team has been observed that there will be around **45%** of Water Savings Can be Achieved further by implementing the above-mentioned WCM's.

WASTE DISPOSAL AUDIT

Presently institute is practicing the zero waste and waste segregation on site only-good practice.

GREENERY-

Presently the campus has greenery is around the boundary, need to add some more in available areas.

CARBON FOOTPRINT-

Total 2630 kg of CO2 getting emitted by the campus per day.

OBJECTIVE OF AUDIT -

1. The objective of carrying out Green Audit is securing the environment and cut down the threats posed to human health.
2. To make sure that rules and regulations are taken care of
3. To avoid the interruptions in environment that are more difficult to handle and their correction requires high cost.
4. To suggest the best protocols for adding to sustainable development.

SCOPE OF WORK-

Scope of Green Audit shall consider following steps;

ENERGY AUDIT:

It deals with the energy conservation and methods to reduce its consumption and the related pollution. The auditor targets at the energy consuming methods adopted and find whether these methods are using the energy in a conservative way or not.

WATER AUDIT:

Evaluating the facilities of raw water intake and determining the facilities for water treatment. Water
harvesting is one of the best techniques that can be adopted by simply storing the water and using it at the time of scarcity. The concerned auditor investigates the relevant method that can be adopted and implemented to balance the demand and supply of water

WASTE DISPOSAL AUDIT:

The waste clearance measures associated to hazardous wastes and recycling are reviewed. The auditor diagnoses the prevailing waste disposal policies and suggests the best way to combat the problems.

ENVIRONMENTAL QUALITY AUDIT:

It analyses the air quality, noise level and the programs undertaken by the institute for plantation. The Green Belt should be maintained to reduce the pollution level by decreasing the Carbon dioxide level.

RENEWABLE ENERGY FEASIBILITY

Resources which can be replenished should be used such as rain, sunlight, wind, tides, etc. These resources are more advantageous as they cause least pollution. The importance of these resources is explained by the Audit team.

CARBON ACCOUNTING:

It undertakes the measure of bulk of carbon dioxide equivalents exhaled by the organization through which the carbon accounting is done. It is necessary to know how much the organization is contributing towards the sustainable development. The auditor considers several efforts practiced by the institute to lower the Green House Gases in the atmosphere in order to make the campus more environmentally friendly.

GOALS OF THE COLLEGE

In the effort to Enhancing an environmentally literate campus where students can learn the idea of protection of environment and stay healthy. The college Management is proactively working on the several facets of “Green Campus” including Plantation of more trees, Water Conservation, Efficient water usage by eliminating leaking water taps, Installation of ETP, Water Harvesting Pits and interconnecting them to Recharge the Ground Water table. Effective Waste Management which includes Food Waste, Plastic, Paper, Metal Work, Renewable Energy, carbon footprints etc.

1. To create a green campus with focus on above concepts
2. To Harness Solar Power
3. To Conserve Water by eliminating the water leakages, wastage, Rain Water Harvesting
4. To Reduce Waste management through reduction of Food waste generation, Plastic/Paper/Metal waste generation and effective disposal
5. To Reduce the Carbon Foot print
6. Enhancement of college profile

ENERGY AUDIT

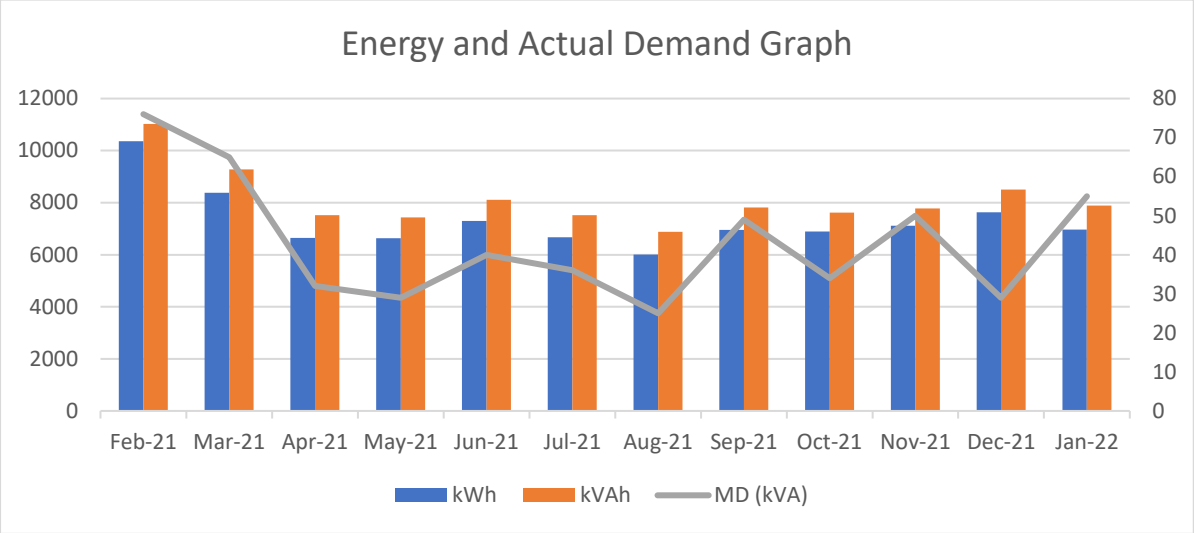
BILLING ANALYSIS-

Table 4 Billing Analysis

Month	kWh	kVAh	MD (kVA)	bill demand kVA	PF	Demand Charges	Energy Charges	Total Amount	Basic Energy Charges	Gross Energy Charges
Jan-22	6965	7895	55	300	0.882	129600	72713	252790	10.4	36.3
Dec-21	7635	8510	29	300	0.897	129600	78377	2,60,660	10.3	34.1
Nov-21	7115	7775	50	300	0.915	129600	71608	2,51,740	10.1	35.4
Oct-21	6895	7615	34	300	0.905	129600	70134	2,49,760	10.2	36.2
Sep-21	6960	7820	49	300	0.89	129600	72022	2,52,670	10.3	36.3
Aug-21	6005	6875	25	300	0.873	129600	63319	2,40,700	10.5	40.1
Jul-21	6675	7520	36	300	0.887	129600	69259	2,48,660	10.4	37.3
Jun-21	7298	8115	40	300	0.893	129600	72000	2,46,400	9.9	33.8
May-21	6640	7430	29	300	0.893	129600	68430	2,47,390	10.3	37.3
Apr-21	6650	7520	32	300	0.884	129600	69259	2,33,320	10.4	35.1
Mar-21	8385	9275	65	275	0.904	113025	87927	2,52,330	10.5	30.1
Feb-21	10355	11025	76	300	0.939	129600	101540	2,92,310	9.8	28.2
Average	7298.2	8115	43.3	297.9	0.9	128219	74715.7	252790.0	10.3	35.0
Total	87578	97375	-	-	-	1538625	8,96,589	3033480	-	-

Audit team have done billing analysis and plotted the following graph.

Graph 1 Facility Yearly Energy Consumption

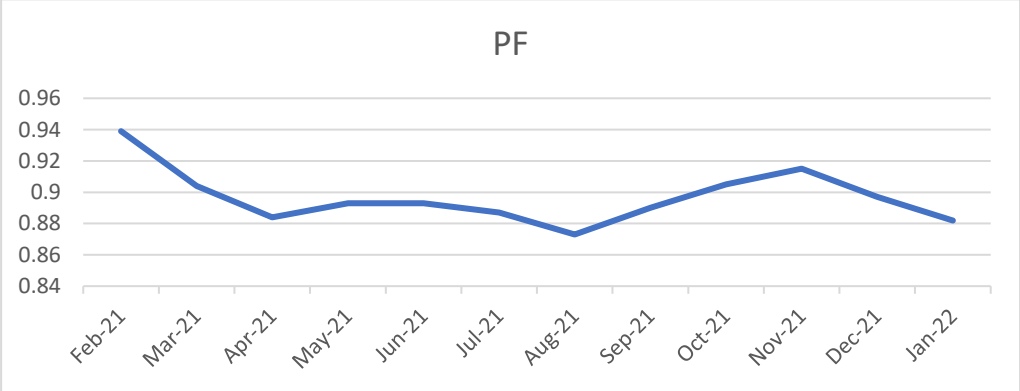


1. It is observed that the average facility energy consumption is around 7298 Units of Active energy and 8115 of total energy per month.
2. The actual maximum demand (average) is 43 kVA only whereas the billed demand is 300 kVA which is higher side than the actual demand.

POWER FACTOR IMPROVEMENT SUGGESTIONS

Observation- it is observed that the average power factor of the facility is less than the unity.

Graph 2 Average Power factor of the facility



ENERGY CONSERVATION POTENTIAL BY IMPROVING THE POWER FACTOR

Table 5 Power Factor Improvement Energy savings Potential

Parameter	UoM	Value
Average Present Power Factor	Factor	0.897
Difference Between Active and Apparent Energy	kWh/Month	816.42
Expected Power factor	Factor	0.999
Expected Difference between Active and Apparent Energy	kWh/Month	815.6
Energy Saving Potential	kWh/Year	9787.2
Monetary Savings potential	Rs./Year	100391

Estimated Investment	Rs.	50000
Simple Payback Period	Months	6.0

Above calculations mentioned the cost benefit analysis of the power factor system improvement.

MONETARY SAVINGS POTENTIAL BY REDUCING THE CONTRACT DEMAND

It is observed that the facility having excess demand than the actual demand of the facility.

Energy audit team have evaluated the summarised the cost benefit analysis by reducing the excess demand and applicable charges.

Table 6 Cost savings by reducing the demand

Parameter	UoM	Value
Present Actual Average Demand	kVA	43.3
Present Billed demand	kVA	300.0
Proposed New Billed Demand	kVA	100.00
Net Reduction in the billed demand	kVA	200.0
Demand Charges	Rs./kVA	432
Net Monetary Savings potential	Rs./month	86400
Net Monetary Savings potential	Rs./Year	1036800
Estimated Investment	Rs.	0
Simple Payback	Months	Immediate

ENERGY BALANCE

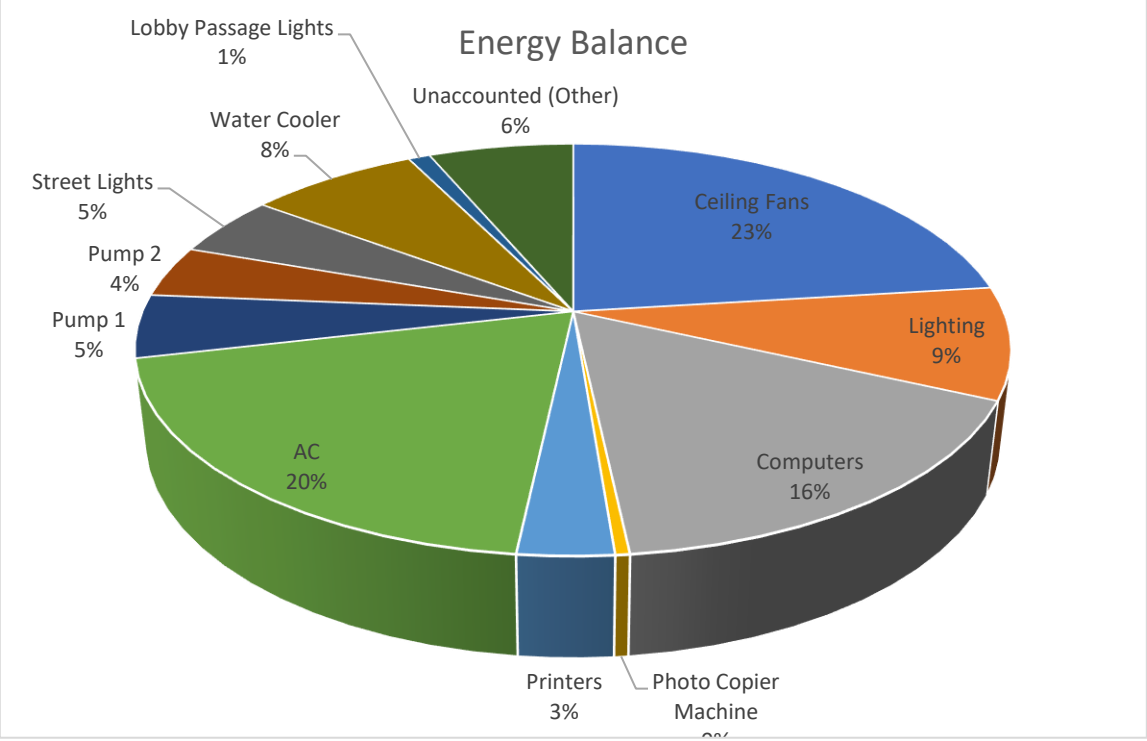
Audit team prepared the energy balance of the facility.

Table 7 Energy Balance

Parameter /Load	Rated Capacity	Quantity	Total Load	Operation Time	Usage Diversity	Total Energy
	Wattage/kW	Nos.	kW	Hrs./day	%	kWh/Day
Ceiling Fans	60	231	13.86	8	50%	55.44
Lighting	20	264	5.28	8	50%	21.12
Computers	120	550	66	6	10%	39.6
Photo Copier Machine	600	3	1.8	6	10%	1.08
Printers	150	80	12	6	10%	7.2
AC	1.8	25	45	7	15%	47.25
Pump 1	7.47	1	7.47	2	80%	11.952
Pump 2	4.06	1	4.06	3	80%	9.744
Street Lights	60	30	1.8	8	80%	11.52
Water Cooler	450	10	4.5	8	50%	18
Lobby Passage Lights	20	72	1.44	8	20%	2.304
Unaccounted (Other)						15.36
Total						241

The major energy is consumed by fans followed by AC computers and lighting.

Chart 1 Energy Balance



ENERGY CONSERVATION MEASURES

BY IMPROVING PUMPING SYSTEM EFFICIENCY

It observed that he presently installed pumps are not efficient and we are recommending to replace the pumps with new energy efficient pumps
Here is the cost benefit analysis of the same.

PUMP1- MAIN TANK TO OVERHEAD TANK PUMPING

Table 8 pump 1 performance and energy savings potential calculations

Parameter	UoM	Value
Actual Flow	m3/hr	13.5
Head	meter	30
Hydraulic Power	kW	1.10
Power Drawn by Motor	kW	4.88
System Efficiency	%	23%
Proposed System Efficiency	%	70%
Proposed Power Requirement	kW	1.58
Operating Time	hrs/day	2
Power Reducing Potential	kW	3.30
Total Energy Conservation potential	kWh./Year	1982
Monetary Savings potential	Rs./Year	20330
New pump replacement cost	Rs.	25000
Simple Payback Period	months	14.76

PUMP 2- CIDCO WATER TANK

Table 9 pump 2 energy performance and energy savings calculations

Parameter	UoM	Value
Actual Flow	m3/hr	7.46
Head	meter	20
Hydraulic Power	kW	0.41
Power Drawn by Motor	kW	2.99
System Efficiency	%	14%
Proposed System Efficiency	%	70%
Proposed Power Requirement	kW	0.58
Operating Time	hrs/day	2
Power Reducing Potential	kW	2.41
Total Energy Conservation potential	kWh./Year	1446
Monetary Savings potential	Rs./Year	14827
New pump replacement cost	Rs.	20000
Simple Payback Period	months	16.19

ENERGY CONSERVATION OPPORTUNITY BY REPLACING EXISTING CEILING FAN BY BLDC FAN

Presently Facility having conventional fans, it is recommended to replace these fans with new BLDC Energy Efficient fans, here is the cost benefit analysis.

Table 10 Energy Savings Calculations by replacing fan with BLDC Fans

Parameter	UoM	Value
Existing Fan Capacity	W	60
Proposed Fan Capacity	W	28
Present Energy Consumption by Fans	kWh/Day	55.44
Proposed Fan Energy Consumption	kWh/Day	25.872
Energy Savings Potential	kWh/Year	7761.6
Monetary Savings potential	Rs./Year	79613
Estimated Investment for replacing 50% fans	Rs.	346500
Simple Payback Period	Months	52.23

ENERGY GENERATION OPPORTUNITY BY INSTALLING SOLAR POWER PLANT

It is proposing to install a 69 kWp Solar Grid tied rooftop system to get green energy from solar.
Here is the cost benefit analysis of the same.

Table 11 Solar PV Feasibility

Parameter	UoM	Value
Annual Consumption (A B and C Zone)	kWh	82200
Estimated Replaceable units by Solar project	kWh	82200
Estimated Min. Solar Plant Annual Generation	kWh/kWp/Annum	1200
Estimated Solar Capacity	kWp	69
Energy Rate	Rs/kWh	10.26
Estimated Monetary Saving	Rs/Year	843154
Estimated Investment	Rs	30,82,500
Simple Payback Period	Month	43.87

Site photograph 1 Available Rooftop Area for Solar Installations

LUX LEVEL

Area	Avg Lux
Office Ground Floor	49.00
Pump House	16.00
Outdoor Lighting	15.75
5th Floor Lecture Hall	62.75
2nd Floor Hall	35.33
Sample Toilet	32.25
Sample Toilet	21.67

WATER AUDIT

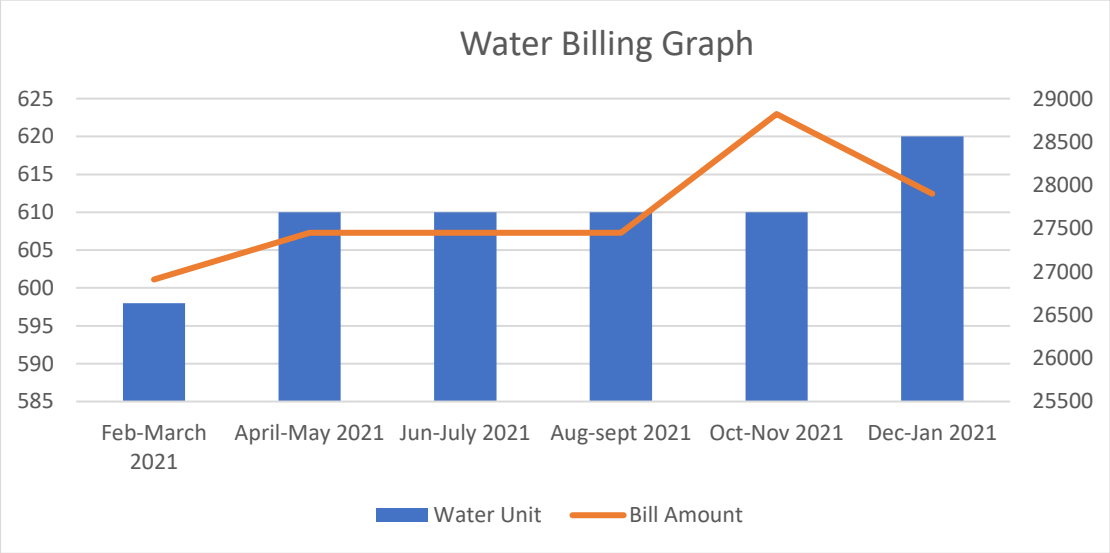
Campus Consuming around 21m3/day water.

610	m3/month
21	m3/day
7290	m3/year

Table 12 Water Consumption

Month	Water Unit	Bill Amount
Feb-March 2021	598	26910
April-May 2021	610	27450
Jun-July 2021	610	27450
Aug-sept 2021	610	27450
Oct-Nov 2021	610	28822
Dec-Jan 2021	620	27900

Graph 3 Water Billing Graph

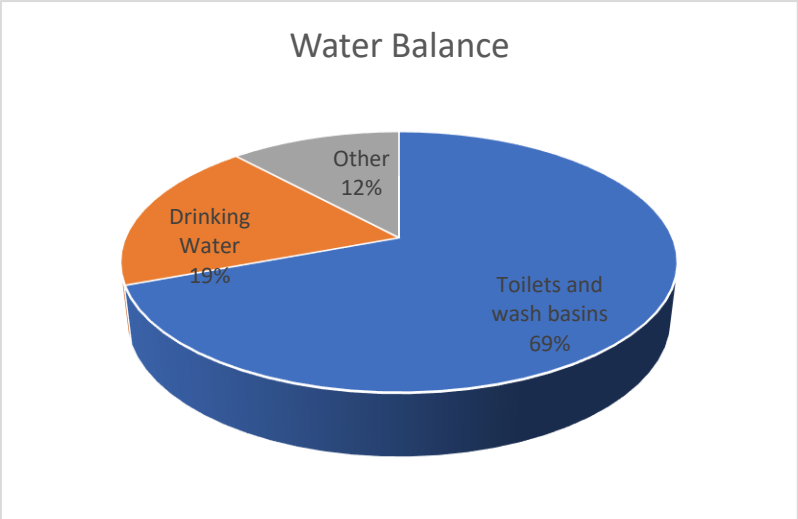


WATER BALANCE

Table 13 Water Balance

Area	Water kL per day
Toilets and wash basins	14.64
Drinking Water	4
Other	2.5
Total	21.14

Chart 2 Water Balance



The major water is got consumed by toilets and Wash Basins.

PUMPING AND ENERGY TARIFF

Parameter	UoM	Value
Water tariff	Rs./kL	45
Electricity Tariff	Rs./kWh	10.26
Pumping Energy	kWh/Kl	1.071
Pumping Cost	Rs/KL	10.99

This cost shall be considered for all the cost benefit analysis in water audit report.

WATER CONSERVATION OPPORTUNITIES

WATER SAVING OPPORTUNITY BY CONVENTIONAL TAP REPLACEMENT WITH NEW EFFICIENT TAPS

Convectional water taps consume more water than the new water efficient taps, it is recommending to replace conventional taps with new taps.
Here are the savings calculations.

Table 14 Water conservation opportunities by replacing taps

Parameter	UoM	Value
Present Tap Water Consumption	kl/day	7.32
proposed water consumption	kl/day	3.66
Yearly Water Savings Potential	kl/Year	1098.1
Monetary Savings Potential	Rs./Year	61480

Site photograph 2 Conventional Water Tap

Site photograph 3 Water efficient taps

WATER CONSERVATION POTENTIAL BY MAKING STP PLANT FUNCTIONAL

Presently Installed STP is not in operation, by making it operation we can save considerable amount of fresh water.

Table 15 Water conservation opportunity by making STP Plant Operational

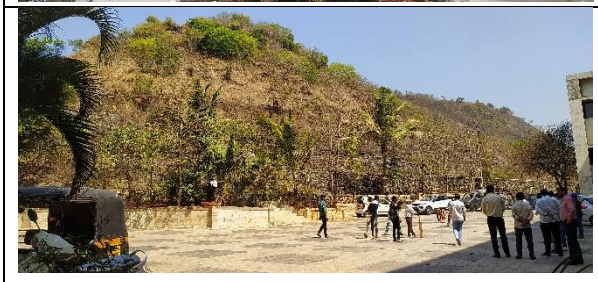
Parameter	UoM	Value
Present Toilet Water consumption	kl/day	7.32
proposed water consumption	kl/day	0.00
Yearly Water Savings Potential	kl/Year	2196.1
Monetary Savings Potential	Rs./Year	122960

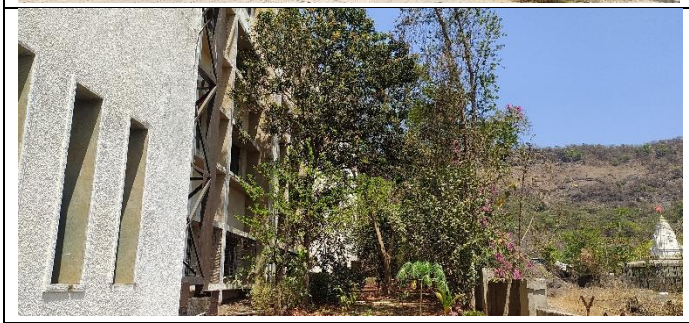
Site photograph 4 STP Plant

GREENERY SURVEY

Campus having verities of plants majorly near the boundary and container gardening.

Table 16 Campus Greenery Survey

	Container gardening near main building area
	Mango Trees
	Coconut tree in the campus- end boundary area
	Greenery Around Campus
	Pipal Tree near diploma College

	Trees at main entrance
	Near Diploma Campus Greenery

Waste Management:

1. **Bio Waste** – Mostly Food Waste is generated from the cooked food at the campus in the canteen. It is proposed to install Bio Gas plant in the campus to generate Bio Gas from the food waste, which can be used in the Food Cooking. The Procurement is in process and is installed shortly.

2. **Non-Bio Waste** – Plastic Bottles / Waste Paper / Cardboards/ Batteries etc

Non- biodegradable waste, which cannot be decomposed by biological processes, is called non- biodegradable waste. These are of two types - Recyclable: waste having economic values but destined for disposal can be recovered and reused along with their energy value. e g. Plastic, paper, old cloth etc. Non-recyclable: waste which do not have economic value of recovery. e.g. Carbon paper, thermo coal, tetra packs etc. Disposal of non-biodegradable waste is a major concern, not just plastic, a variety of waste being accumulated. There are a few ways to help non-biodegradable waste management. The impact of non-biodegradable waste on the environment and also focus on its safe disposal for sustainable environment.
Present Status: Dust bins were provided for the waste disposal the same is collected daily once and handed over the Municipal corporation.

3. **E Waste Management**

Waste Electrical and Electronic Equipment (WEEE) or E-waste is one of the fastest growing waste streams in the world. In developed countries, it equals 1% of total solid waste on an average. In developing countries, it ranges from 0.01% to 1% of the total municipal solid waste generation. In countries like China and India, though annual generation per capita is less than 1 kg, it is growing at an exponential pace.

Campus admitted a good practice of waste disposal from segregation stage, campus having dedicated bin to collect the dry, wet and electronics waste.

Table 17 Waste Disposal Practice in the Campus

Dry Waste Tag Bin at gate Diploma campus

Zero Waste Campus System

Waste Management System at Campus

CARBON ACCOUNTING / FOOT PRINT

Emission Source	Quantity	CO2 Emission Factor	total Emission per Day (kg)
Teaching and Non-teaching	200	700 gram/person/day	140
Two Wheelers	100	5 gram/km	25
Students	2500	700 gram/person/day	1750
Four-Wheeler	30	130 gram/km	195
Buses and other	8	1.3 kg/km	520
Total kg/Day			2630

Note: Assume each member travel a distance of 25 kms to college and 25 kms return to home.

Mode of Transit	CO_2 released (per km driven per person)	CO_2 released during production of vehicle
Car	271 g	313 g
Bus	101 g	---
Bicycle	16 g (This is from the fuel of the rider – food)	16 g

	Pounds CO2	Kilograms CO2	Pounds CO2	Kilograms CO2
Carbon Dioxide (CO_2) Factors:	**Per Unit of Volume or Mass**	**Volume or Mass**	**Million Btu**	**Million Btu**
FOR HOMES AND BUSINESSES				
Propane	12.70/gallon	5.76/gallon	139.05	63.07
Butane	14.80/gallon	6.71/gallon	143.2	64.95
Butane/Propane Mix	13.70/gallon	6.21/gallon	141.12	64.01
Home Heating and Diesel Fuel (Distillate)	22.40/gallon	10.16/gallon	161.3	73.16
Kerosene	21.50/gallon	9.75/gallon	159.4	72.3
Coal (All types)	4,631.50/short ton	2,100.82/short ton	210.2	95.35
Natural Gas	117.10/thousand cubic feet	53.12/thousand cubic feet	117	53.07
Gasoline	19.60/gallon	8.89/gallon	157.2	71.3
Residual Heating Fuel (Businesses only)	26.00/gallon	11.79/gallon	173.7	78.79
OTHER TRANSPORTATION FUELS				
Jet Fuel	21.10/gallon	9.57/gallon	156.3	70.9
Aviation Gas	18.40/gallon	8.35/gallon	152.6	69.2
INDUSTRIAL FUELS AND OTHERS NOT LISTED ABOVE				
Flared natural gas	120.70/thousand cubic feet	54.75/thousand cubic feet	120.6	54.7
Petroleum coke	32.40/gallon	14.70/gallon	225.1	102.1
Other petroleum & miscellaneous	22.09/gallon	10.02/gallon	160.1	72.62

NONFUEL USES				
Asphalt and Road Oil	26.34/gallon	11.95/gallon	166.7	75.61
Lubricants	23.62/gallon	10.72/gallon	163.6	74.21
Petrochemical Feedstocks	24.74/gallon	11.22/gallon	156.6	71.03
Special Naphthas (solvents)	20.05/gallon	9.10/gallon	160.5	72.8
Waxes	21.11/gallon	9.57/gallon	160.1	72.62
COAL BY TYPE				
Anthracite	5,685.00/short ton	2,578.68/short ton	228.6	103.7
Bituminous	4,931.30/short ton	2,236.80/short ton	205.7	93.3
Subbituminous	3,715.90/short ton	1,685.51/short ton	214.3	97.2
Lignite	2,791.60/short ton	1,266.25/short ton	215.4	97.7
Coke	6,239.68/short ton	2,830.27/short ton	251.6	114.12
OTHER FUELS				
Geothermal (average all generation)	NA	NA	16.99	7.71
Municipal Solid Waste	5,771.00/short ton	2,617.68/short ton	91.9	41.69
Tire-derived fuel	6,160.00/short ton	2,794.13/short ton	189.54	85.97
Waste oil	924.0/barrel	419.12/barrel	210	95.25
Source: U.S. Energy Information Administration estimates. Note: To convert to carbon equivalents multiply by 12/44. Coefficients may vary slightly with estimation method and across time.				
Carbon Dioxide Emissions Coefficients by Fuel				
Detailed factors (discontinued)				

Pravin J. Awatade
BEE-CEM/CEA
EA-28824

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Report Complied By:
Energy Audit Team,
M/s. Navy Blue Resources Integration and Solutions Pvt Ltd.
003 | plot Number 24 | Sector 05 | Ghansoli
Navi Mumbai- 400701.
www.nbri.in | sales@nbri.in | +91-9764047776.