Energy Audit, Green Audit & Environment Audit

ABES Engineering College, Ghaziabad

Estd. 2000

October 2020

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Acknowledgement

Energy audit, Green Audit and Environment Audit of affiliated Colleges are important tool to analyze wastage of energy and create healthy environment of any Institution. GTD Power Systems Pvt. Ltd Ghaziabad have been entrusted to carry out these audits by the management of ABES Engineering College, Ghaziabad.

GTD Power Systems Pvt. Ltd is thankful to the Director and Management of the ABES Engineering College, Ghaziabad for entrusting processes of Green auditing with us. We thank faculty and non-teaching staff who took pain along with us to gather data through survey. We also thank the office staff who helped us during the document verification.

For GTD Power Systems Pvt. Ltd.

Director

(S. K. MAHESHWARI)

Director

Executive Summary

A Nation's growth starts from its educational institutions, where the ecology is thought as a prime factor of development associated with environment. A clean and healthy environment aids effective learning and provides a conducive learning environment. Educational institutions now a day are becoming more sensitive to environmental factors and more concepts are being introduced to make them eco-friendly. To preserve the environment within the campus, various viewpoints are applied by the several educational institutes to solve their environmental problems such as promotion of the energy savings, recycle of waste, water reduction, water harvesting etc. The activities pursued by colleges can also create a variety of adverse environmental impacts. To protect such situation Energy Audit, Green Audit and Environment Audit are required to be conducted in these institutions. Energy Audit pave the way to save energy consequently reducing Carbon Emissions. Environmental auditing is a process whereby an organization's environmental performance is tested against its environmental policies and objectives. Green audit is defined as an official examination of the effects a college has on the environment. It must also be under stood that Energy Audit, Green Audit and Environment Audit are inter related to each other. If you save Energy, it will save Environment. If you save trees or plant trees, it will save Environment and energy. If you clean Environment, it will save human life and save energy.

Thus it is imperative that the college evaluate its own contributions toward a sustainable future. As environmental sustainability is becoming an increasingly important issue for the nation, the role of higher educational institutions in relation to environmental sustainability is more prevalent.

In ABES Engineering College, Ghaziabad the audit process involved initial interviews with management to clarify policies, activities, records and the co- operation of staff and students in the implementation of mitigation measures. This was followed by staff and student interviews, collection of data through the questionnaire, review of records, observation of practices and observable outcomes. In addition, the approach ensured that

the management and staff are active participants in the green auditing process in the college.

The baseline data prepared for the ABES Engineering College, Ghaziabad will be a useful tool for campus greening, resource management, planning of future projects, and a document for implementation of sustainable development of the college. Existing data will allow the college to compare its programmes and operations with those of peer institutions, identify areas in need of improvement, and prioritize the implementation of future projects. We expect that the management will be committed to implement the recommendations.

We are happy to submit the Energy audit, Green Audit and Environment Audit report to the ABES Engineering College authorities.

For GTD Power Systems Pvt. Ltd.

Director

(S. K. MAHESHWARI)

Director

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Chapter 1
Introduction

1.0 Preamble

Energy Audit, Green Audit and Environment Audit are the useful tools for a college to determine how and where they are using the most energy or water or resources; the college can then consider how to implement changes and make savings. They can also be used to determine the type and volume of waste, which can be used for a recycling project or to improve waste minimization plan. These can also create health consciousness and promote environmental awareness, values and ethics. They provides staff and students better understanding of Green impact on campus. These auditing promote financial savings through reduction of resource use.

1.1 Introduction

ABES Engineering College is a self-financed engineering college, situated in Ghaziabad (Uttar Pradesh), NCR, India. The Institute is approved by All India Council of Technology and Engineering (AICTE). The institute is affiliated to Dr. A.P.J. Abdul Kalam Technical University, Lucknow (Uttar Pradesh) and the students are admitted on the basis of State Entrance Examination, commonly known as UPSEE. The college was earlier affiliated to Mahamaya Technical University until 2013, when the two universities (GBTU and MTU) were again united and the institute came under the jurisdiction of the current university.

1.2 Location of ABES Engineering College

The ABES engineering College is located just 0.4 Km away from the Ghaziabad Railway Station and is very well connected with roads and Delhi Metro services. One of the busiest airports of the country IGI Airport of Delhi is just 60 Km away from the campus.

1.3 Quick facts about ABES Engineering College:

- The private, self-financed institution was established in the year 2000.
- The Institute is accredited by National Assessment and Accreditation Council (NAAC)
- Four branches of the Institute are accredited by the National Board of Accreditation (NBA).
- The Institute comes under 200-250 rank band in National Institutional Ranking Framework (NIRF), 2019-20.
- The Institute is ranked in band 'C' (i.e. within 50) by ARIIA, under the category of private/self-financed Institutions.

1.4 Campus

Institute's campus, spread over 15.3 acres (**63859.39** m^2), is situated at Lal Kuan, Delhi-Hapur bypass Road, NH-24 (Now NH-09), Ghaziabad, Uttar Pradesh. The institute has a cricket sports ground (day and Night), semi-Olympic size swimming pool, Badminton Court, Volley ball court and indoor sports facilities like Table Tennis and Billiards (only for hostel students).

Figure-1.1: Campus View of ABES Engineering College

1.41 Total Campus Area & College Building Spread Area

Campus area	63859.39 m^2
Built up area	62087.02 m^2
Green Area	12371.50 m^2

Table-1.1: Total Campus Area & College Building Spread Area

ABES Engineering College has the best infrastructure facilities available for students including a serene external environment through thoughtful landscaping efforts. This creates a vibrant campus and motivates students to remain lively and jubilant. Well equipped library, high quality classroom interiors, well equipped seminar rooms and a state of art auditorium. To add to all this eateries are available within the campus offering healthy and hygienic options to students at reasonable rates.

1.5 Vision

To take ABES Engineering College to such a level that, it is at par with the leading Institutions of the world in providing leadership to the international education system and be amongst the top rated institutions of the world by providing a transformative education to create leaders and innovators embedded in traditional Indian values.

1.6 Mission

- To create an ambiance for healthy teaching-learning process.
- To nurture the students and infuse in them
- A passion to excel professionally
- A spirit to be of utmost use to the industry, corporate sector and the society at large
- An intense desire to take challenging responsibilities and leadership roles
- To develop an environment for creating new knowledge through research and by thriving to explore innovative ideas

1.7 Organizational Structure

The Organ gram of ABES Engineering College has been shown in Figure-1.2

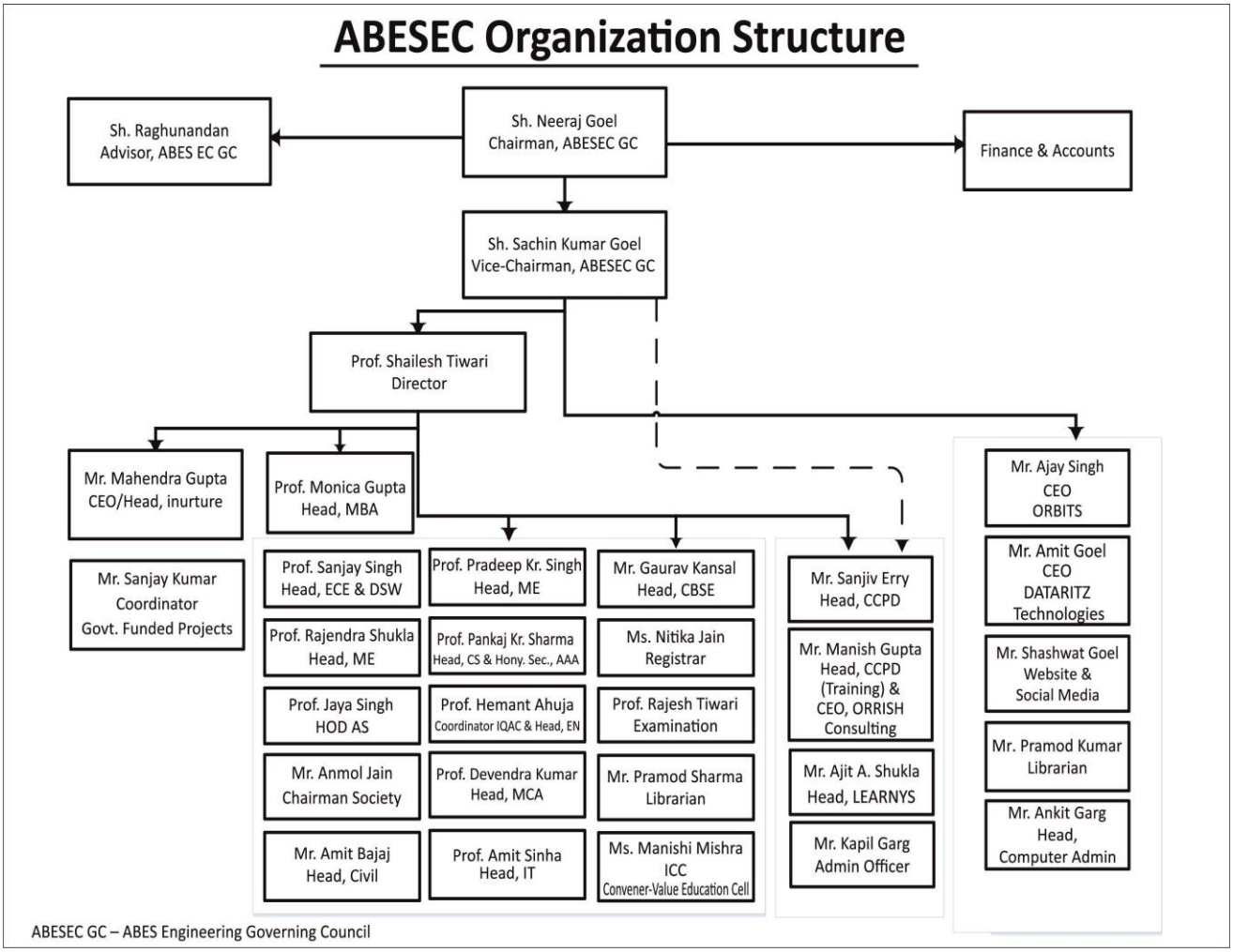


Figure-1.2: Organogram of ABES Engineering College

1.8 Other Silent Features

1.81 Hostel Facility - Accommodation available

Hostels	No. of rooms	No. of Students accommodated
Hostel for Boys	461	1081
Hostel for Girls	265	596

Table-1.2: Accommodation available in Hostel

1.82 Auditorium-Capacity- 500 persons

1.83 Other facilities

i. Gymnasium,
ii. Yoga center,
iii. Cricket stadium,
iv. Volley-ball and Badminton courts,
v. Table tennis and other indoor games.
vi. Swimming Pool

1.9 Staff, other manpower, Students and Visitors

Sl. No.	Designation	Regular	Casual/Contractual	Total
1	Staff	516	98	**614**
2	Students			**4360**
3	Daily Visitors			**25**

Table1.3-: Staff, other manpower, Students and Visitors

Based on above data given in Table-1.2 and Table-1.3, the residents living in Campus (Day and Night) and Students/persons coming in Day time are as follows:

1.9.1 Nos. of Day and Night residents in the Institute

Sl. No	Particulars	Nos.
1	Nos. of Hostlers Students	1677
2	No of Staff	10
Total Residents Population		**1687**

Table-1.4: Nos. of Day and Night residents in the Institute

1.9.2 Nos. of Day Time persons in the Institute

Sl. No.	Particulars	Nos.
1	Nos. of Non-Hostlers Students	2683
2	No of Staff	604
3	No of Daily Visitors	25
Total Daytime Population		**3312**

Table-1.5: Nos. of Day Time persons in the Institute

1.10 Quality Policy

To continuously thrive to provide a congenial and wholesome academic environment and a healthy culture for faculty, staff and students which would motivate teachers' full participation with passion and develop an intense desire in the students to acquire comprehensive education and hence become a useful and confident human resource for the industry and academia. IQAC Members (2019-20) are as follows:

S.No.	Name	Designation	Status in IQAC
1	Dr. Shailesh Tiwari	Director, ABESEC	Chairman
2	Dr. Hemant Ahuja	HOD EN	Coordinator IQAC
3	Mr. Sachin Goel	Vice President, ABESEC	Member (Management)
4	Ms. Nitika Jain	Registrar, ABESEC	Member (Administration)
5	Mr. Kapil Garg	Admin Officer, ABESEC	Member (Administration)
6	Dr. Abhijit Das	Professor, MBA	Member (Faculty)
7	Dr. Nimisha	Associate Professor, ASH	Member (Faculty)
8	Mr. Amit Agarwal	Associate Professor, CSE	Member (Faculty)
9	Mrs. Gaganpreet	Associate Professor, ME	Member (Faculty)
10	Mr. Ankit Tayal	Sr. Assistant Professor, EN	Member (Faculty)
11	Mr. Vinod Kumar	Sr. Assistant Professor, MCA	Member (Faculty)
12	Ms. Deepali Dev	Assistant Professor, IT	Member (Faculty)
13	Mr. Ayush	Assistant Professor, CE	Member (Faculty)
14	Ms. Arpita	Assistant Professor, ECE	Member (Faculty)
15	Mr. Sanjay Kumar	Ex-DRDO	Member (Stake holder-Parent)
16	Ms. Shruti Jha	Sr. Brand Representative Moon Beverages (Coca Cola India)	Member (Alumni)
17	Mr. R.R. Tanwar	Chairman, EEDB, IEI	Member (Local Society)
18	Ms. Surabhi Verma	III Year Electrical & Electronics Engineering	Member (Student)
19	Mr. Rajit Sikka	Head, Academic Relations, Tata Consultancy Services Ltd	Member (Employer)
20	Mr. Shashank Jain	GM Operations, Fabcon India	Member (Industrialist)

Table 1.6: List of IQAC Members

1.11 About GTD Power Systems Pvt. Ltd.

GTD Power System was established on 15th November 2011. The company's ideology is to provide consultancy, based on practical approach. We have a team of professionals, having 35 to 38 years professional experience in Power Distribution, Power Generation and Power Transmission. We have specialization in following fields:

- Power Distribution
- Central/ State Government Schemes
- Industrial Units
- Conventional Power Generation Projects
- Solar Power Projects
- Energy Audit
- Fire Audit/ Safety Audit

1.12 List of Staff engaged in the Assignment

1. S. K. Maheshwari (EA-2986)
2. Vishwa Nath Nirmal (EA-8951)

Chapter 2
Pre-Audit Stage

2.1 A pre-audit meeting provides an opportunity to reinforce the scope and objectives of the audit and discussions were held on the practicalities associated with the audit. This meeting is an important prerequisite for the audit because it is the first opportunity to meet the audit team and deal with any concerns. The pre-audit meeting was held at ABES Engineering College, Ghaziabad. The meeting was an opportunity to gather information that the audit team can study before arriving on the site. The audit protocol and audit plan was handed over at this meeting and discussed in advance of the audit itself. In ABES Engineering College pre-audit meeting was conducted successfully and necessary documents were collected directly from the college before the initiation of the audit processes. Actual planning of audit processes were discussed in the pre-audit meeting.

2.2 Management's Commitment

The Management of the college has shown the commitment towards the green auditing during the pre-audit meeting. They were ready to encourage all green activities. It was decided to promote all activities that are environment friendly such as awareness programs on the environment, campus farming, planting more trees on the campus etc., after the green auditing. The management of the college was willing to formulate policies based on green auditing report.

2.3 Report Formulation Planning

This report has been divided in following three parts:

1. Energy Audit,
2. Green Audit,
3. Environment Audit

The detailed discussions of these Audits will be done in subsequent chapters.

Chapter-3

Energy Audit

3.1 Sources of Energy being used in the Institute

The Institute is using both conventional and non conventional sources of energy.

3.1.1 Conventional Electrical Energy Source

3.1.1.1 Electricity Distribution System:

The electric supply of ABES Engineering is fed from 33/11 KV Substation, of Paschimanchal Vidyut Vitran Nigam Ltd. through 11 KV feeder. Eleven KV feeder emanating from Rathi Ispat Electricity Substation feed electricity need of the College through one no 11/0.4 KV LT Substation situated inside the Campus. The substation consist one no 11/0.4 KV Transformer of capacity 1600 KVA. There is an MCB Panel control room inside the Campus called old Panel control room. Electrical energy is supplied from this MCB panel (Fig-3.1).

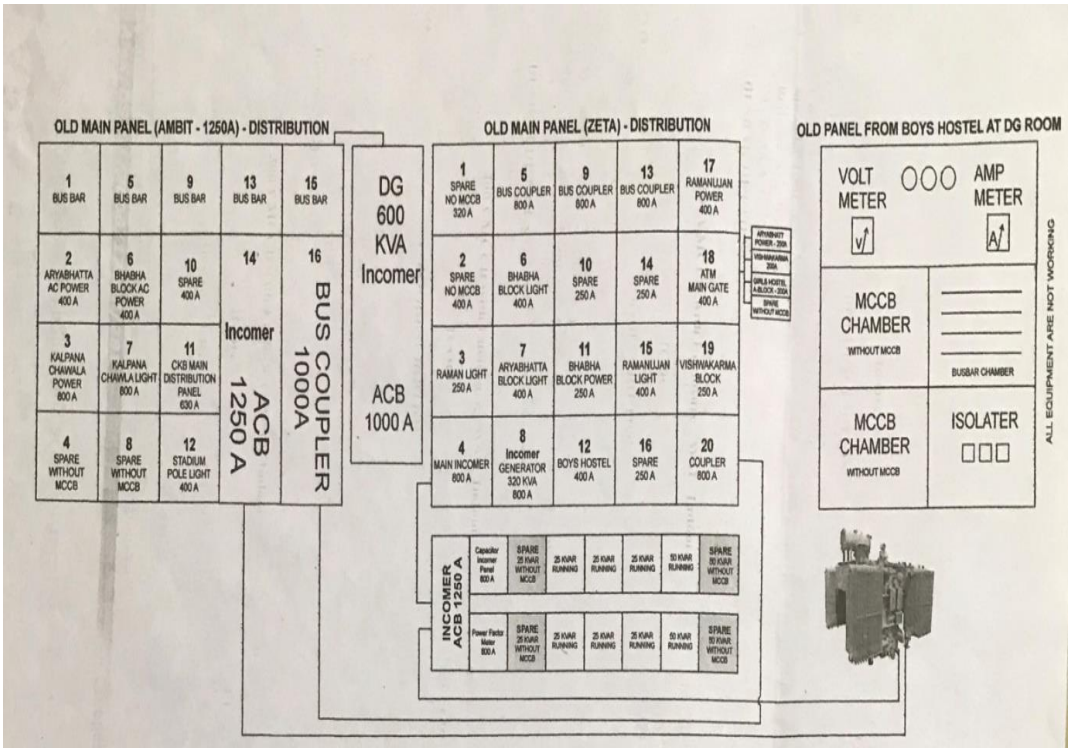


Figure-3.1: Old Distribution MCB Panel Block Diagram

The new Distribution Panel (under planning, Fig-3.2) is proposed as under:

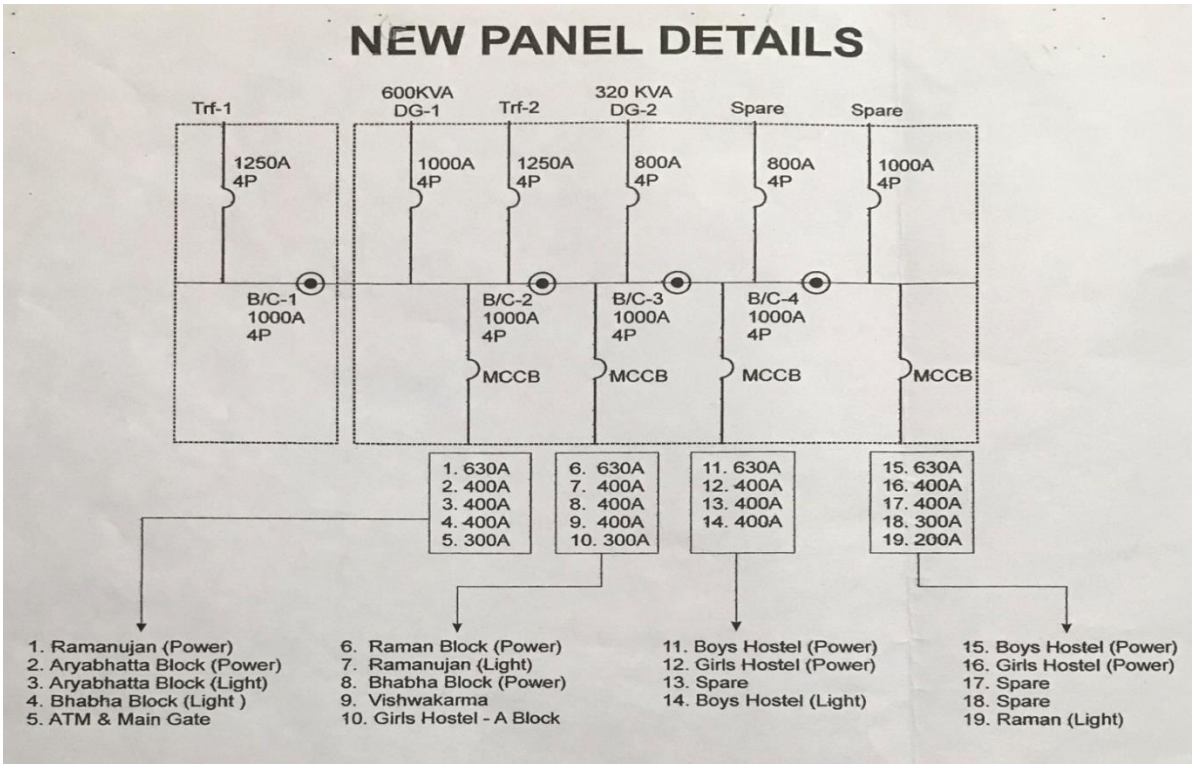


Figure-3.2: New Distribution MCB Panel Block Diagram

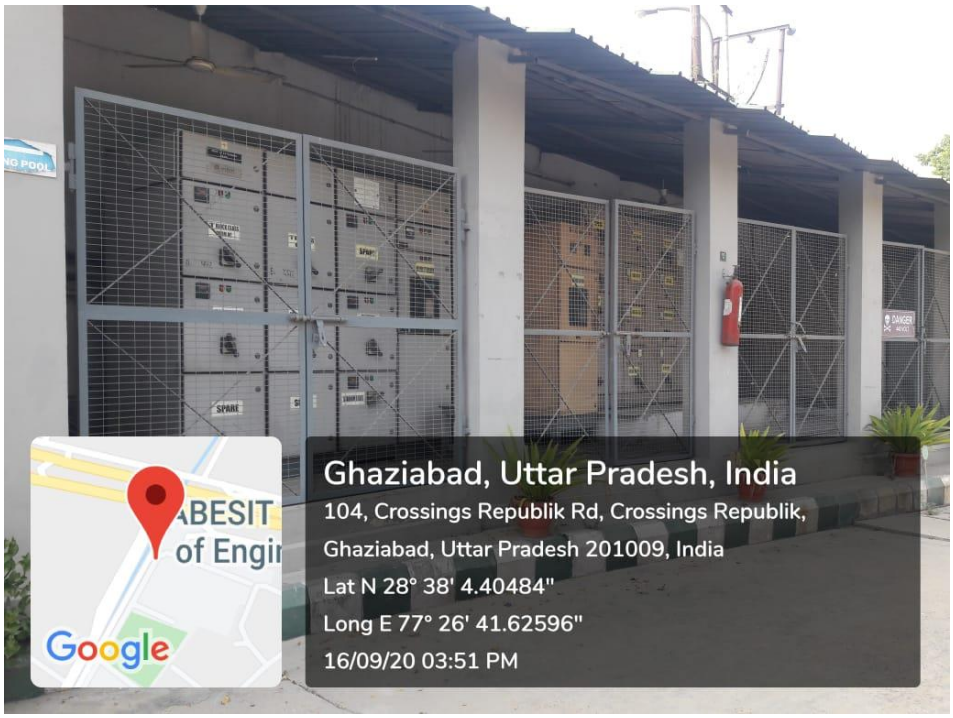


Figure-3.3: MCB Panel Room

Figure 3.4: MCB Panel Room

3.1.1.2 Electrical Energy Consumption from Grid

The details of consumption of Grid energy has been shown in Table-3.1

S. No.	Month	Consumption in KWhr		
		Year 2019	Year 2018	Year 2017
1	January	50286	70289	75002
2	February	46430	64788	73747
3	March	63402	90330	87551
4	April	143820	150157	207768
5	May	191477	192337	251039
6	June	101635	133172	146482
7	July	106622	129455	157882
8	August	205063	220577	241676
9	September	228181	192178	241748
10	October	97772	117082	158154
11	November	56046	55386	90725
12	December	45420	54242	78618
	Total	**1336156**	**1469993**	**1810393**

Table-3.1: Energy Consumption from Grid (KWH)

3.1.2 Non Conventional Electrical Energy Source

There are two nos. Solar Plants in the institute:

I. Own Solar Plant of capacity 200 KVA

II. Jackson Plant of 300 KW Capacity

3.1.2.1 Own Solar Plant of capacity 200 KVA: These Solar plants have been installed by the Institute from their own resources. The Plant has started generation in April 2019.The details of units produced which were made available w. e. f. November 2019 has been shown in Table-3.2.

S. No.	Month/Year	Power Generation (KWh)		
		Boys Hostel (100 KW)	Girls Hostel (100 KW)	Total (200 KW)
1	Nov-19	7469	7230	14699
2	Dec-19	6084	5862	11946
3	Jan-20	8268	8000	16268
4	Feb.-20	10805	10353	21158
5	March-20	13663	13138	26801
6	April-20	14454	13999	28453
7	May-20	12898	12277	25175
8	June-20	12131	11102	23233
9	July-20	11196	10481	21677
10	August-20	10311	9572	19883
11	Sept-20	12349	11958	24307
Total		**119628**	**113972**	**233600**

Table-3.2: Own Solar Plant Generation (KWh)

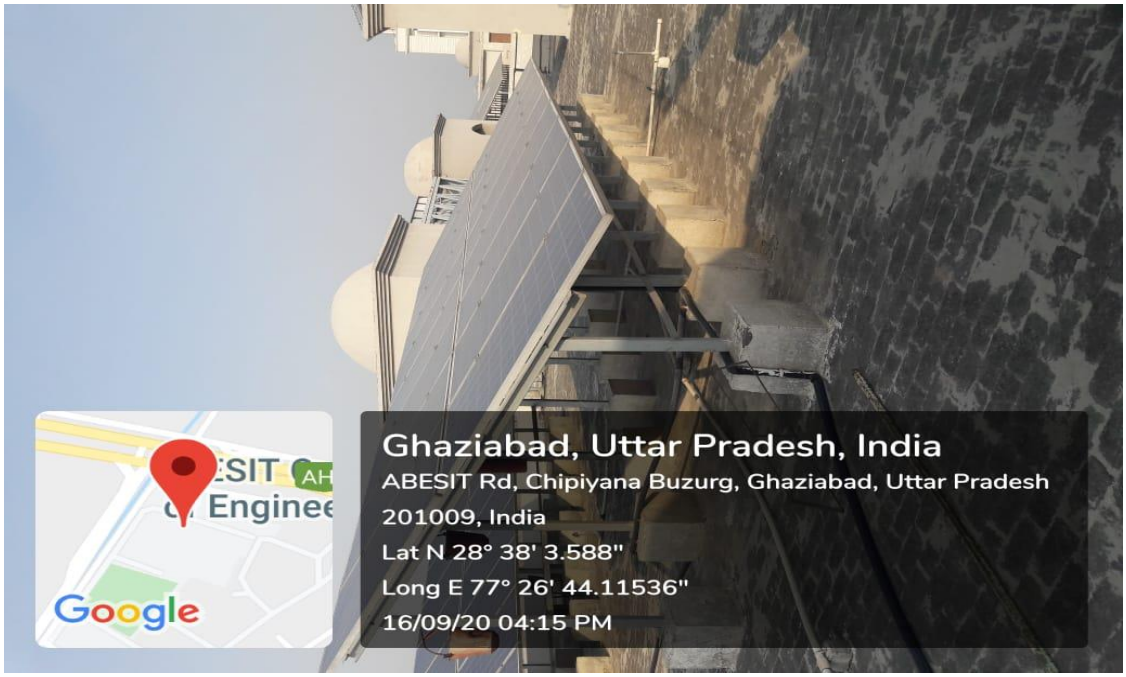


Figure-3.5: Rooftop Solar Panel

3.1.2.2 Jackson Plant of 300 KW Capacity

This Solar plant has been installed by M/S Jackson Ltd, a private company on Investment model basis. There is agreement between M/S Jackson and ABES Engineering College to supply the energy at fixed rate as per agreement. The current rate is Rs. 4.5/Unit. The Energy generated by the plant w.e.f. June 2018 (date of start) has been shown in Table-3.3.

S. No.	Month	Date		Energy Generation (KWh)	Rate (Rs/Unit)	Amount (Rs)
		From	To			
1	June-18	21.5.18	9.7.18	43238	4.5	194571.00
2	July-18	9.7.18	7.8.18	24328	4.5	109476.00
3	Aug-18	7.8.18	4.9.18	26289	4.5	118300.50
4	Sept-18	4.9.18	27.9.18	22322	4.5	100449.00
5	Oct-18	27.9.18	30.10.18	29771	4.5	133969.50
6	Nov-18	30.10.18	5.12.18	25002	4.5	112509.00
7	Dec-18	5.12.18	4.1.19	22338	4.5	100521.00
	Total during Year			**193288**		
8	Jan-19	4.1.19	31.1.19	24888	4.5	111996.00

9	Feb-19	31.1.19	27.2.19	27074	4.5	121833.00
10	March-19	27.2.19	1.4.19	39918	4.5	179631.00
11	April-19	1.4.19	30.4.19	42589	4.5	191650.50
12	May-19	30.4.19	31.5.19	45188	4.5	203346.00
13	June-19	31.5.19	28.6.19	39077	4.5	175846.50
14	July-19	28.6.19	31.7.19	33020	4.5	148590.00
15	Aug-19	31.7.19	31.8.19	32969	4.5	148360.50
16	Sept-19	31.8.19	3.10.19	33750	4.5	151875.00
17	Oct-19	3.10.19	31.10.19	29381	4.5	132214.50
18	Nov-19	31.10.19	30.11.19	24711	4.5	111199.50
19	Dec-19	30.11.19	31.12.19	20156	4.5	90702.00
	Total during Year			**392721**		
20	Jan-20	31.12.19	31.01.20	24771	4.5	111469.50
21	Feb-20	31.01.20	28.02.20	29997	4.5	134986.50
22	Mar-20	28.02.20	3.04.20	43404	4.5	195318.00
23	April-20	3.4.20	1.5.20	44624	4.5	200808.00
24	May-20	1.5.20	2.6.20	42615	4.5	191767.50
25	June-20	2.6.20	30.6.20	34169	4.5	153760.50
26	July-20	30.6.20	06.8.20	42424	4.5	190908.00

Table-3.3: Solar Energy Generation-from Jackson Plant (300 KW)

3.2 Total Electrical Energy Consumption

Total Electrical Energy Consumption of the Institute (Conventional and Non- conventional) has been shown in Table-3.4

Sl. No.	Month	Year 2019	Year 2018	Year 2017
1	January	75174	70289	75002
2	February	73504	64788	73747
3	March	103320	90330	87551
4	April	186409	150157	207768
5	May	236665	192337	251039
6	June	140712	176410	146482
7	July	139642	153783	157882

8	August	238032	246866	241676
9	September	261931	214500	241748
10	October	127153	146853	158154
11	November	95456	80388	90725
12	December	77522	76580	78618
	Grand Total	**1677998**	**1663281**	**1810392**

Table-3.4: Total Electrical Energy Consumption (KWh)

The graphical presentation of total Electrical Energy Consumption during past three years of the Institute (Conventional and Non- conventional) has been shown in Figure-3.6.

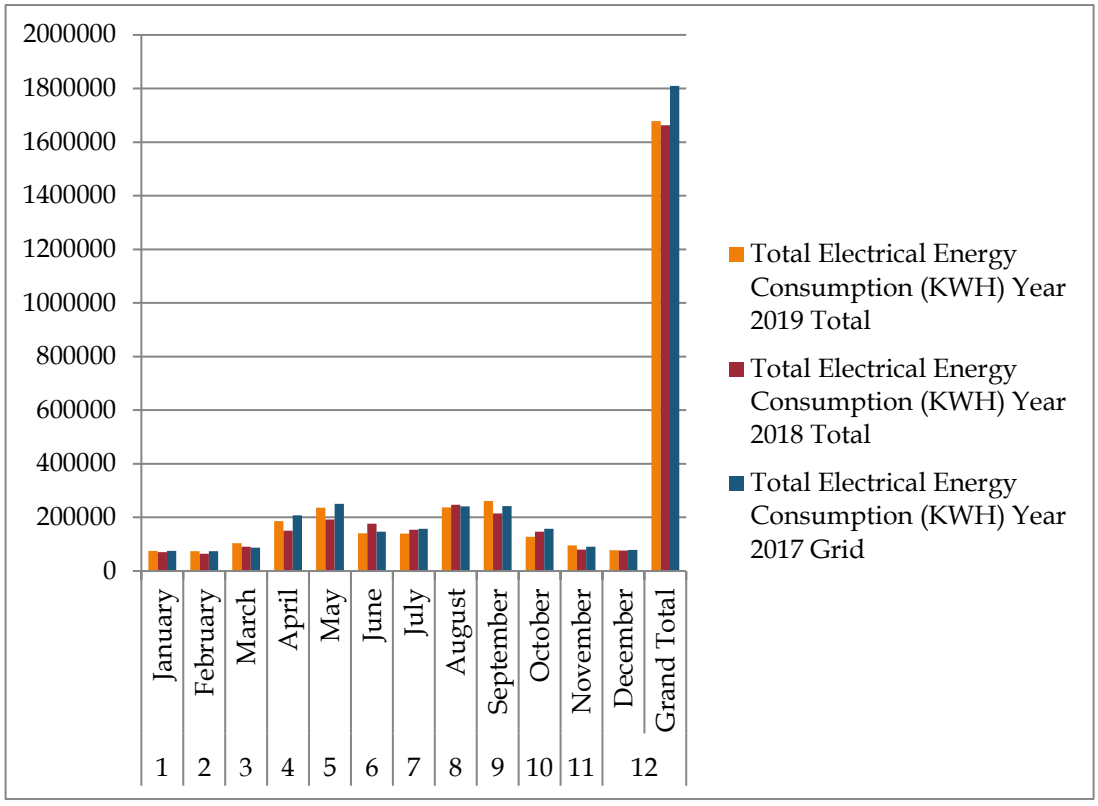


Figure-3.6: Total Electrical Energy Consumption (KWh) during past three years

From the above it is clear that the Electrical Energy consumption of the Institute reduced from 1810392 units in Year 2017 to 1663281 units (8.13%) in Year 2018. Thereafter it has become 0.88% higher from **1663281 to 1677998**. This needs to be analyzed by the Institute. Non Energy Efficient appliances further needs to be replaced by Energy Efficient appliances.

3.3 Other Conventional Sources of Energy

Apart from Electrical Energy, the other sources of energy used in ABES Engineering College are Diesel, PNG and LPG. The consumption of these types of these types of energy sources have been discussed in subsequent Para.

3.3.1 Statement of Diesel Consumption of D G Sets-320 KVA & 600 KVA

Sl. No.	Month & Year	320 KVA			600 KVA		
		Diesel Consumption (Ltrs)	Monthly Running Hrs.	Fuel Consumption (Ltr/Hrs.)	Diesel Consumption (Ltrs)	Monthly Running Hrs.	Fuel Consumption (Ltr/Hrs.)
1	Aug-17	2456	64.7	38.0	2054	34.6	59
2	Sep-17	2017	70.3	28.7	1053	16.3	65
3	Oct-17	1665	55.6	29.9	663	11.4	58
4	Nov-17	1216	34.3	35.5	1098	20.7	53
5	Dec-17	2306	63.3	36.4	NIL		
6	Jan-18	2079	56.6	36.7	95	2.6	37
7	Feb-18	1784	49.8	35.8	2408	66	36
8	Mar-18	1865	50.8	36.7	182	4.9	37
9	Apr-18	1390	39.4	35.3	2646	64.5	41
10	May-18	1917	61	31.4	5276	94	56
11	Jun-18	1697	55.2	30.7	930	18.5	50
12	Jul-18	892	28.5	31.3	2060	36.6	56
13	Aug-18	941	25.7	36.6	1907	35.4	54
14	Sep-18	1164	37	31.5	3354	66	51
15	Oct-18	1240	43.6	28.4	676	16.1	42
16	Nov-18	753	26.8	28.1	168	4.7	36
17	Dec-18	982	35	28.1	140	4.1	34
18	Jan-19	730	26.1	28.0	NIL		
19	Feb-19	596	19.5	30.6	195	5.8	34
20	Mar-19	293	11.2	26.2	450	13.7	33
21	Apr-19	913	23.8	38.4	1103	22	50
22	May-19	1660	57.5	28.9	3707	61.3	60

23	Jun-19	2330	75.2	31.0	1440	26.7	54
24	Jul-19	7464	303	24.0	8865	181.4	45
25	Aug-19						
26	Sep-19						
27	Oct-19						
28	Nov-19						
29	Dec-19						
30	Jan-20						
31	Feb-20						
32	Mar-20						
33	Apr-20						
34	May-20						
35	Jun-20						
36	Jul-20	42	2.4	17.5	375	15.4	24

Table-3.5: Statement of Diesel Consumption

3.3.2 PNG Consumption

S. No	Month	Year - 2017-18			Year - 2018-19			Year - 2019-20		
		Rate	Vol. in Kg	Amount	Rate	Vol. in Kg	Amount	Rate	Vol. in Kg	Amount
1	April	39.25	3411.34	133895	28.24	4754.07	134255	29.30	4062.08	119019
2	May	40.05	3380.32	135382	28.84	4356.90	125653	30.00	5729.17	171875
3	June	40.05	570.49	22848	28.84	1654.61	47719	30.00	5809.40	174282
4	July	40.23	1809.74	72806	28.84	1327.05	38272	30.00	2081.60	62448
5	August	40.23	5167.36	207883	28.84	5131.00	147978	30.50	5913.93	180375
6	September	40.23	5902.11	237442	28.84	5137.03	148152	30.50	5413.21	165103
7	October	38.72	4244.89	164362	29.47	5554.77	163699	30.10	4050.00	121905
8	November	38.72	6756.25	261602	31.60	3400.92	107469	30.10	4878.77	146851
9	December	38.72	6128.25	237286	30.45	4846.17	147566	30.10	4470.07	134549
10	January	39.90	5180.53	206703	29.30	498.74	14613	30.10	4907.31	147710
11	February	27.64	4241.35	117231	29.30	5004.16	146622	30.10	4927.21	148309
12	March	27.64	4091.64	113093	29.30	4062.08	119019	30.10	1885.25	56746
Total			**50884**	**1910533**		**45728**	**1341017**		**54128**	**1629172**

Table-3.6: PNG Consumption

3.3.3 LPG Gas

LPG is used in the Institute Canteen. The average consumption is 120 cylinders per year i.e. 2280 Kg based on commercial cylinder.

3.4 Total Energy Consumption of ABES Engineering College

Table-3.7 summarize the various sources of energy and their usesage in ABES Engineering College during Year 2019.

Sl. No.	Particulars	Quantity
1	Electricity (KWh)	1677998
2	LPG (Kg)	2280
3	PNG (Kg)	54128
3	Diesel (Litres)	16329

Table-3.7: Total Energy Consumption

For conversion of units of all sources of Energy into KWh, Conversion Factors have been shown in Table-3.8.

Electricity/Fuel	Conversion factor
1 kWh	860 k Cal
1 Kg HSD	11840 k Cal (Density = 0.7087 Kg/Liter) or as per suppliers latest certificate
1 Kg LPG	11,500 k Cal or as per suppliers latest certificate
1 Kg PNG	8488 k Cal

Table-3.8: Energy Conversion Factors

Total Energy Consumption of ABES Engineering College from different sources in Year 2019 in terms of KWh has been shown **in** Table-3.9.

Energy Consumption from Different Sources (Year 2019)		
Sl. No	**Particulars**	**Equivalent Units in KWh**
1	Electricity	1677998
2	LPG	30488
3	PNG	534231
3	Diesel	159321
	Total	**2402038**

Table-3.9: Energy Consumption from different Sources

The share of energy consumption of all forms of energy with respect to total energy consumption of ABES Engineering College has been shown in Fig-3.7.

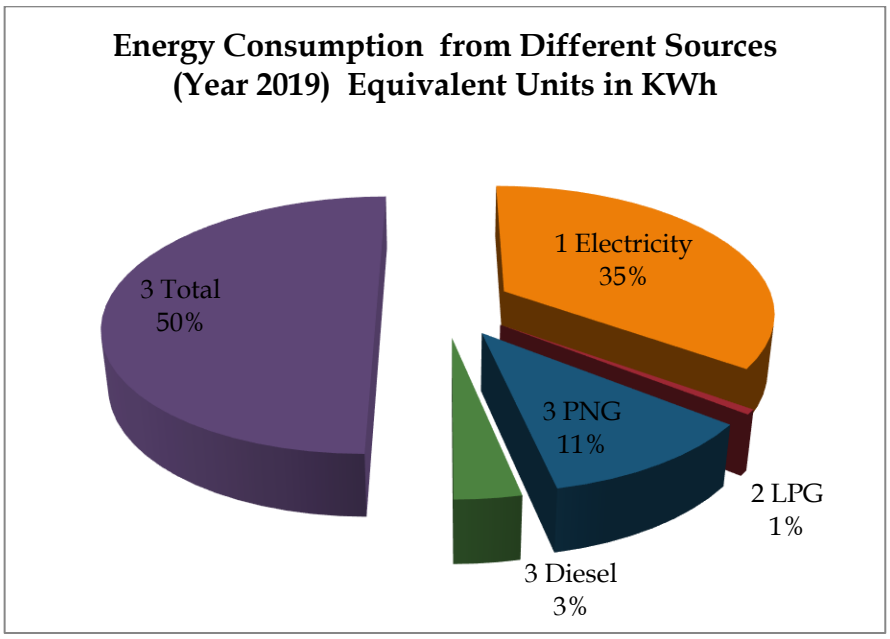


Figure-3.7: Energy Consumption from different Sources

3.5 Total Energy vs. Green Energy Current Scenario

i. The generation of Solar Energy from own Solar Plant (200 KVA) during December 2019: 11946 KWh

ii. The generation of Solar Energy from M/S Jackson Solar Plant (300 KVA) during December 2019: 20156 KWh

iii. Total generation of Solar Energy of the Institute: 32103 KWh

iv. Total consumption of Electrical energy during December 2019: 77522 KWh

v. Percentage share of Solar Energy (Green Energy) w.r.t. total energy based on December 2019: 41.41%

Thus the share of Green Energy used in the Institute has been found in very good proposition.

3.6 Load Pattern

3.6.1 Sanctioned Load:

The sanctioned load of the Institute is 1000 KVA.

3.6.2 Connected Load of Electrical Appliances

Connected Load of ABES Engineering College is as shown in Table-3.10.

Sl. No	Name of Item	Capacity (watts)	Total Nos.	Connected Load (KW)	Sl. No	Name of Item	Capacity (watts)	Total Nos.	Connected Load (KW)
1	CFL	36	92	3.312	11	Packaged Air Conditioners			
		12	36	0.432		5.5 T	7750	7	54.25
2	LED Lamps	15	115	1.725		5.83 T	8100	90	729
		9	112	1.008		8.5 T	12750	11	140.25
		7	7	0.049		11 T	16500	6	99
3	Tube light	40	386	15.44	12	Desert Coolers	500	18	9
		28	782	21.896	13	Computer system	150	2861	429.15
4	LED Tubelite	20	1872	37.44	14	Printers	300	125	37.5
		18	235	4.23	15	Photocopier	500	25	12.5
5	Pole Lights	400	2	0.8	16	Blower Heater	2000	14	28
		250	9	2.25	17	Room Heaters	800	17	13.6
		70	3	0.21	18	Refrigerator	500	7	3.5
6	LED Pole Lights	90	24	2.16	19	Projectors	800	250	200
		72	32	2.304	20	Pumps			
		40	30	1.2		Pump 3HP	2237	2	4.474
		25	7	0.175		Pump17.5 HP	13050	2	26.1
7	Fans	55	3098	170.39	21	Motors			
		75	4	0.3		0.5 HP	373	12	4.476
8	Ceiling Fan 2HP	1500	1	1.5		2.0 HP	1491	2	2.982
9	Exhaust Fan					3.0 HP	22137	1	22.137
	18 inch	410	18	7.38		1.0 HP	746	6	4.476
	15 inch	160	31	4.96	22	Fire Motors			
	12 inch	50	45	2.25		15.0 HP	11185	1	11.185
	9 inch	40	56	2.24		7.5 HP	5593	14	78.302
10	Air Conditioners					10 HP	7460	1	7.46
	1.0 T	1100	4	4.4		Sub Total			1917.342
	1.5 T	1700	342	581.4	Grand Total				3124.393
	2.0 T	3400	84	285.6					
	4.0 T	6500	8	52					
	Sub Total			1207.051					

Table-3.10: Connected Load of ABES Engineering College

3.6.3 Electricity demand based on Grid Load

Year wise month wise Grid Energy Demand of past 3 years has been shown in Table-3.11

S. No.	Month	2019	2018	2017
1	January	199.44	223.44	246.77
2	February	187.20	230.64	243.84
3	March	288.48	306.96	772.32
4	April	743.04	672.24	876.72
5	May	814.08	828.72	912.00
6	June	742.80	763.44	741.12
7	July	799.44	945.84	882.96
8	August	938.40	1010.4	999.12
9	September	975.84	901.2	967.92
10	October	563.04	776.4	977.52
11	November	281.58	245.04	267.84
12	December	199.20	234.72	212.64

Table-3.11: Electricity demand based on Grid Load (KVA)

The graphic presentation of Year wise month wise Grid Energy Demand of past three years has been shown in Fig-3.8.

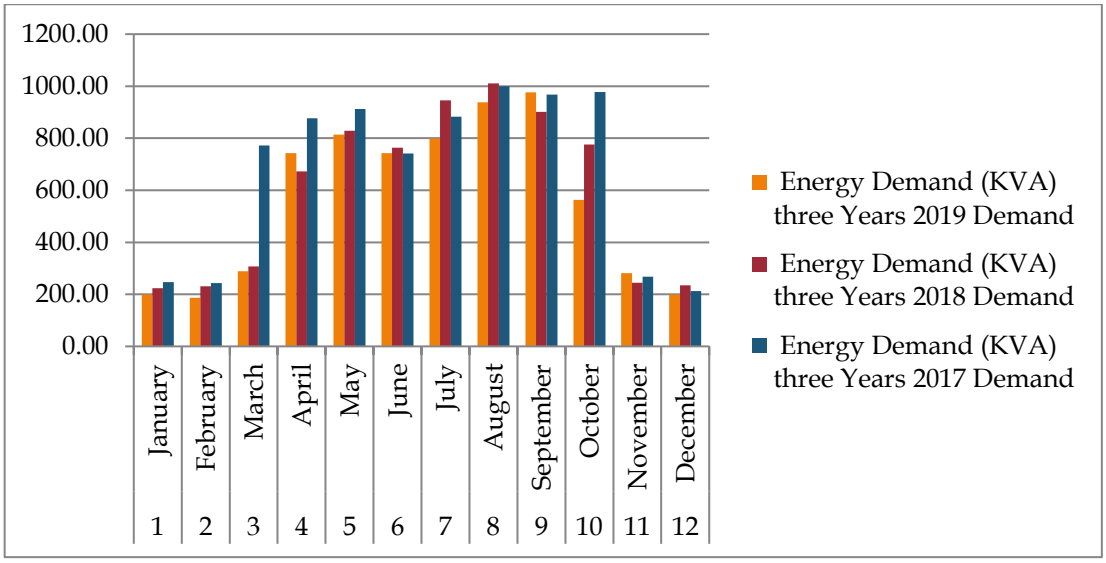


Fig-3.8: Electricity demand based on Grid Load (KVA)

3.7 Illumination Level of various Buildings of ABES Engineering College

Sl. No.	Name of Bldg.	Average Illumination Level (Lumens)	Sl. No.	Name of Bldg.	Average Illumination Level (Lumens)
1	Bhabha Block		4	Kalpna Chawala Block	
	Registrar office	121		LT-52	112
	Director Office	95		Chemistry Lab	130
	LT-17	140		LT-62	121
	LT-24	155		Kitchen	95
	Faculty Office	350		CCPD computer Lab	105
2	Aryabhatt Block		5	Raman Block	
	LT-01	170		Conference Hall	126
	Conference Room	200		LT-69	105
	HOD Office	150		Seminar Hall-04	126
	LT-10	156	6	Vishvakarma Block	
	TR-07	165		ASL Center	102
3	Ramanujam Block				
	HOD Office	509			
	LT-42	126			
	LT-33	125			
	Project Lab	165			
	Electrical Lab	155			

Table-3.12: Illumination Level of various Buildings

Illumination Level of various Buildings of the Institute appears to be in Range.

3.8 Energy Efficiency strategies

Two technologies which have been identified in the Demand Side Management are as follows:

i. Replacement of CFL with LED Lamps
ii. Replacement of T12 lamps with T5 lamps
iii. Replacement of conventional ceiling fans with Efficient ceiling fans
iv. Replacement of conventional air-conditioners with EE star rated ACs
v. Replacement of 150 watt HPSV with LEDs
vi. Replacement of all the Street light fixtures with LEDs and CFLs.

3.8.1 Replacement of CFL with LED Lamps

There are 92 nos. CFL of 36 W and 36 nos CFL of 12 W. These may be replaced by LED Lamps of capacity as shown in Table-3.13. The payback will be calculated on 11 Hrs per day and 365 days basis.

Sl. No	Name of existing Fixture	Name of EE Fixture to be replaced	Qty. (Nos.)	Unit rate (Rs.)	Total cost (Rs.)	Yearly power saving on av. 11hrs/ day basis (KWh)	Cost of power saved @ Rs. 7 per unit (Rs.)	Pay back period (Years)
1	CFL 36 W	LED Lamp (15 W)	92	150	13800	7756.98	54298.86	0.25
2	CFL 12 W	LED Lamp (6 W)	36	100	3600	867.24	6070.68	0.59
Total					**17400**	**8624.22**	**60369.54**	**3.56**

Table-3.13: The Pay Back calculations of Replacement of CFL with LED Lamps

3.8.2 Replacement of 40 W traditional Tube lights with energy efficient 18 W LED Tub-elite.

There are T12 FTLs of 52W including the 12W electrical choke which can be replaced by 18 W LED Tub-elite. By replacing T12 FTLs to 18 W LED Tub-elite saving of 34 W can be achieved for each of the fixtures for 250 days per year on 10 hrs per day basis for institute. Thus each lamp will save 85 KWh per year in the institute.

Particulars	Nos./Rs.	Unit
Number of 40 W FTLs to be replaced by 18 W LED Tub-elite	386	Nos.
Cost of installation @ Rs 550 per 18 W LED Tub-elite	2.123	Rs. Lakh
Energy saved by replacing 40 W FTLs by 18 W LED Tube-elite @ 85 units per year per Tube Light for institute	32810	KWh
Cost of electricity savings per year @ Rs 7 per unit	2.297	Rs. Lakh
Payback period	0.92	Years

Table-3.14: Pay Back Calculations for replacement of Traditional Tube lights to LED Tub-elite

Thus, on replacing the FTLs by 18 W LED Tub-elite, we can save around 32810 units of the energy on annual basis, which is equivalent to Rs. 2.30 Lakh per Annum. The simple pay back is will be of 0.92 years.

3.8.3 Replacement of conventional ceiling fans with Efficient ceiling fans

Replacing conventional fans with star rated fans can save substantial amount of electrical energy and money. We recommend replacement of 4002 existing fans (75 W) with new energy efficient fans (50 W). It will cost Rs. 109.42 Lakh @ Rs. 1400/- each. It will save 25 W on each fan i.e. 63 KWH per fan per year based on 10 Hrs. running

per day for 250 days during the year. The energy cost of the same will be Rs. 13.68 lakhs @ prevailing tariff of Rs.7.0 per KWH. As such the payback period of this work will be 3.63 years.

Particulars	Nos./Rs.	Unit
Number of Conventional fan to be replaced by EE Fans	3102	Nos.
Cost of installation @ Rs 1600 per fan	49.63	Lakh
Energy saved by replacing 3102 Conventional Fans by EE Fans @ 63 units per year per fan	195426	Units
Cost of electricity savings per year @ Rs 7 per Unit	13.68	Lakh
Payback period	3.63	Years

Table-3.15: Pay back calculations of Replacement of conventional ceiling fans with Efficient Ceiling fans

3.8.4 Replacement of air-conditioners with EE Five star rated ACs

We recommend replacement of 1.5 TR Window/Split ACs (Non Five Star) with equivalent BEE 5 Star rated AC.

Particulars	Unit	1.5 TR Split	1.5 TR Window
Average EER as per energy audit	(W/W)	2.5	2.3
New EER as per BEE standards	(W/W)	3.5	3.3
Existing Power Input considering 1.5 TR generation	W	2110	2293
New Power Input	W	1507	1598
Power Saved per unit	W	603	695
Daily operating hrs	Hrs/day	7	7
Energy Saved per day per unit	KWh/day	4.221	4.865
Operating days per year	days/yr	210	210
Annual energy saved per AC	KWh/yr	886.41	1021.65
Unit rate	Rs./kWh	7	7
Total annual monetary benefit per unit	Rs./yr	6204.87	7151.55
Total Investment per unit	Rs.	43000	35000
Payback	**Years**	**6.93**	**4.89**

Table-3.16: Pay back calculations for replacement of one unit of AC's to 5 Five Star AC

Nos. of Total Non Five Star Air Conditioners are as follows:

I. Window Air Conditioners: 278

II. Split Air Conditioners: 30

The Energy saving and Pay back will be as per Table-3.17.

Sl. No	Particulars	Nos.	Annual Energy saved (KWh)	Annual money saved (Rs)	Total Investment (Rs.)	Payback period (Years)
1	Window AC	278	284019	1988130	9730000	4.89
2	Split AC	64	56730	397112	2752000	6.93
	Total	342	340749	2385242	12482000	5.23

Table-3.17: Energy saving and Pay Back period of Air-conditioners with EE Five star rated ACs

3.8.5 EE measures in Street Lighting

Street lighting is one of the major sources of energy consumption. The different lighting appliances to be replaced in in ABES Engineering college, their savings are shown in Table-3.18.

Sl No	Name of existing Street Light Fixture	Name of EE Fixture to be replaced	Qty. (Nos.)	Unit rate (Rs.)	Total cost (Rs.)	Yearly power saving on av. 11hrs/ day basis (KWh)	Cost of power saved @ Rs. 7 per unit (Rs.)	Pay back period (Years)
1	Fitting (400 W)	LED Fitting (150 W)	2	20000	40000	2007	14052	2.85
2	Fitting (250 W)	LED Fitting (100 W)	9	15000	145000	5420	37942	3.82
Total					**185000**	**7427**	**51994**	**3.56**

Table-3.18: EE measures in Street Lighting

3.8.6 Sensor based Energy Conservation

No sensors/timers have been installed in the Institute for conservation of light. It is recommended that sensors/timers may be installed at common places such street lights,

lobbies of hostels, lobbies of institute buildings, Toilets and lecture halls etc. The connected load of lightening system is as per Table-3.19.

Sl. No	Name of Item	Capacity (Watts)	Nos.	Connected Load (KW)
1	CFL	36	92	3.312
		12	36	0.432
2	LED Lamps	15	115	1.725
		9	112	1.008
		7	7	0.049
3	Tube Lights	40	386	15.44
		28	782	21.896
4	LED Tube Lights	20	1872	37.44
		18	235	4.23
5	Pole Lights	400	2	0.8
		250	9	2.25
		70	3	0.21
6	LED Pole Lights	90	24	2.16
		72	32	2.304
		40	30	1.2
		25	7	0.175
Total connected load of Light Points (KW)				**94.631**

Table-3.19: Total connected load of Light Points

As shown above the connected load of Lightening System is 94.631 KW. No separate metering for measurement of Lightening Load has been done in the Institute but based on diversity factor of 0.3, lightening load may be assumed as 28.38 KW. Out of this 30% may be assumed as Load of above mentioned area, which will be 8.5 KW. Based on average 10 hours operation for 300 days per year, the Electricity Consumption per Year of these areas can be estimated as 25500 KWh/Year. We can save 20% of

this consumption i. e. 5100 KWh energy by installing sensors/timers at common places such street lights, lobbies of hostels, lobbies of institute buildings, Toilets and lecture halls etc. The estimated saving due to this will amount to be Rs. 35700 per year. The estimated expenditure on installation of sensors/timers will be Rs 100000/- and the Payback period will be 2.80 Years.

3.9 Summary of EE Strategy The estimated potential of energy savings has been shown in Table-3.20

Sl. No.	Name of EE Measures	Qty.	Investment (Lac INR)	Energy saved/Yr (KWh)	Cost of Energy saved/Yr (Rs. Lac)	Pay back (Years)	Emission Reduction (Tonnes)
1	Replacement of 12 & 36 W CFL with 6/15 W LED Lamps as per **Table-**	128	0.174	8624	0.604	0.29	7.011312
2	Replacement of 40 W traditional Tube lights with energy efficient 28 W T5 Tub-elite	386	2.123	32810	2.297	0.92	26.67453
3	Efficient ceiling fans to replace conventional ceiling fans	3102	49.63	195426	13.68	3.63	158.8813
4	Replacement of conventional air-conditioners with EE star rated ACs	342	124.82	340749	23.85	5.23	277.0289
5	EE measures in Street Lighting	11	1.85	7427	0.52	3.56	6.038151
6	Installation of Sensor based switches	LS	1	5100	0.36	2.8	4.1463
	Total		**179.597**	**590136**	**41.31**	**4.35**	**479.78**

Table-3.20 Summary of EE Strategy

3.10 Instruments Used:

Followings Instruments were used for carrying Energy audit of the Institute:

i. Digital Lux meter,
ii. Digital Earth Resistance Tester,
iii. Digital Thermo Hygrometer,
iv. Digital Thermometer,
v. Digital Capacitance meter,
vi. Digital Clamp on Power, current, voltage meter
vii. GPS Device,
viii. Digital Camera,
ix. Measurement Tape

Chapter-4

Green Audit

4.1 Scope and Goals of Green Auditing

A clean and healthy environment aids effective learning and provides a conducive learning environment. There are various efforts around the world to address environmental education issues. Green Audit is the most efficient and ecological way to manage environmental problems. It is a kind of professional care which is the responsibility of each individual who are the part of economical, financial, social, environmental factor. It is necessary to conduct green audit in college campus because students become aware of the green audit, its advantages to save the planet and they become good citizen of our country. Thus Green audit becomes necessary at the college level.

4.1.1 Benefits of the Green Auditing

- More efficient resource management
- To provide basis for improved sustainability
- To create a green campus
- To enable waste management through reduction of waste generation, solid-waste and water recycling
- To create plastic free campus and evolve health consciousness among the stakeholders
- Recognize the cost saving methods through waste minimizing and managing
- Authenticate conformity with the implemented laws
- Empower the organizations to frame a better environmental performance
- Enhance the alertness for environmental guidelines and duties
- Impart environmental education through systematic environmental management approach and Improving environmental standards
- Benchmarking for environmental protection initiatives
- Financial savings through a reduction in resource use
- Development of ownership, personal and social responsibility for the College and its environment

4.2 Target Areas of Green Auditing

Green audit forms part of a resource management process. Although they are individual events, the real value of green audits is the fact that they are carried out, at defined intervals, and their results can illustrate improvement or change over time. Target areas included in the green auditing are

I. Water,
II. Waste,
III. Green campus

4.3 Auditing for Water Management

The world's water resources are finite but exist on a planet with a constantly growing population. The development of water resources to man's benefit has been a fundamental factor in the evolution of civilizations throughout history. But, as our populations continue to grow and shift, the availability of quality water resources is in decline. Pollution, climate change and construction of cities in dry regions are some of the factors exacerbating evolving supply/demand imbalances. Many innovative technologies have been developed in recent times to assist the efficient delivery and utilization of drinking water. Water audits provide a rational, scientific framework that categorizes all water use in your system. It is a tool to overcome drought related problem, shortage, leakage and losses.

4.3.1 Advantage of Water Audit:

a. Water audits provide decision making tools to utility managers, directors, and operators. i.e., knowing where water is being used in your system allows you to make informed decisions about investing resources such as time, labour and money.
b. Water audits allow managers to efficiently reduce water losses in the system.
c. Reducing water used at the source may even result in delaying or avoiding capital investments such as a new well, more treatment technology or additional water rights.
d. Water audits also identify which water uses are earning revenue for the utility and which water uses are not. Thus, System personnel can increase revenue by

ensuring all appropriate uses are being accurately measured and billed. This leads to more financial capacity in the water system, reduced cost per customer and better management of the water resource.

e. Creating awareness among water users i.e., customers can see and understand that the utility is taking proactive steps to manage wasted water and save for the future.
f. It is an effective educational and public relations tool for the water system.

4.3.2 Water Usage in the Institute

Both Treated water and Raw water are used in the Institute depending on the use such as for drinking purpose and non drinking purpose.

4.3.2.1 Drinking Water System

Two nos. Pumps have been installed one near Girls Hostel and another near Boys Hostel for supply of water to overhead concrete tank of capacity 4 Lakh Liters (400 Cubic Meters).

Figure 4.2: Bore Well Submergible Water Pump

Specifications of both Pumps are as detailed below:

- Capacity: 17.5 HP
- Make: KSB Model BPD 302
- Date of purchase: 14-12-2013 and 21-05-2014 respectively
- Height of overhead Tank: 90 Feet

Flow diagram of Drinking water system of the Institute has been shown in Fig-4.3.

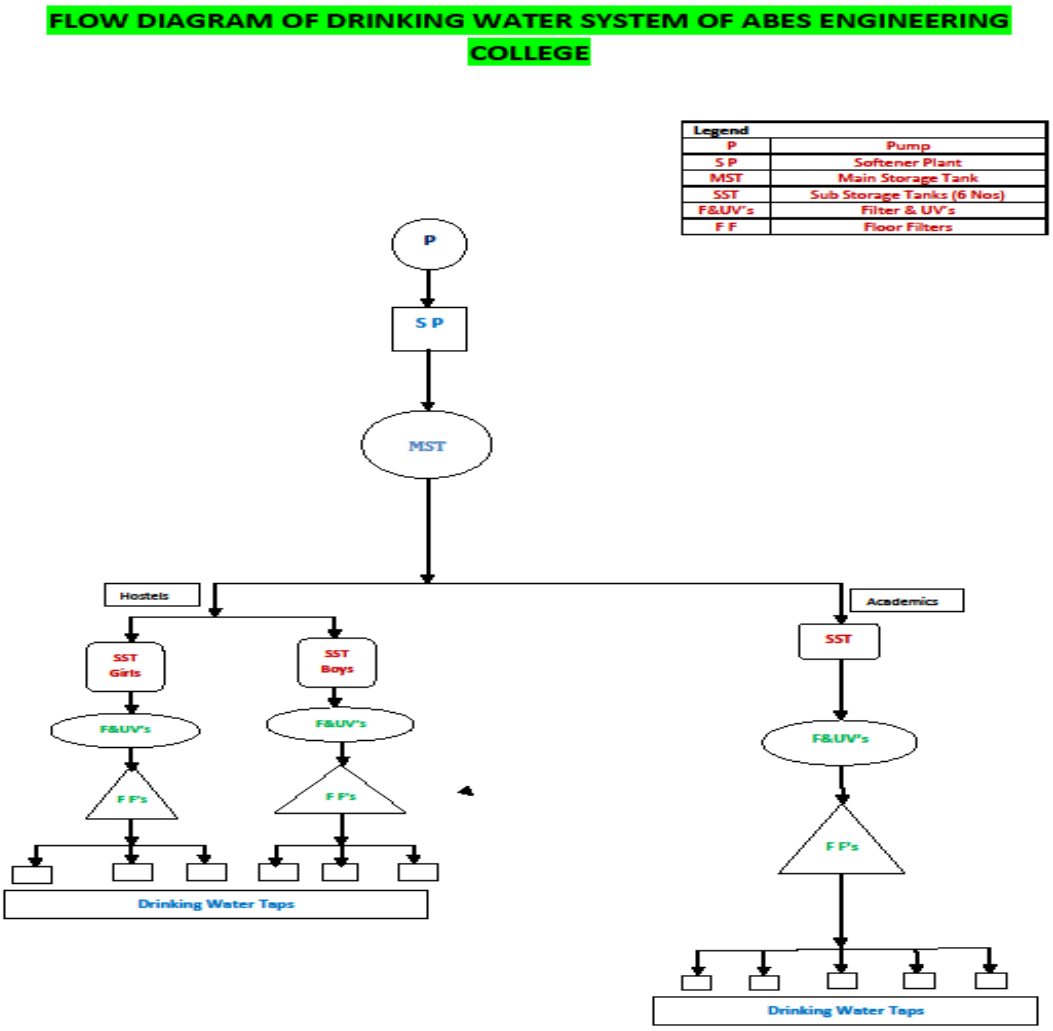


Figure 4.3: FLOW DIAGRAM OF DRINKING WATER SYSTEM

Out of both Pumps, one remain under operation and other remain as stand by. The average operative hour per day are 6 hrs. No technical details of Pump were available with the Institute. The pump make is old and details were not available in manufacture's catalogue. Based on similar capacity pump of company, it's Discharge on full load must be 100 Cu Meter per hour. As per operator of Pump, empty Tank get filled in 8 hours. As such the pump operate on 50% capacity i. e. 50 Cu Meter per Hour. Based on 6 hrs operation of pump, the consumption of Drinking water of the Institute is 300 Cubic Meter per Day.

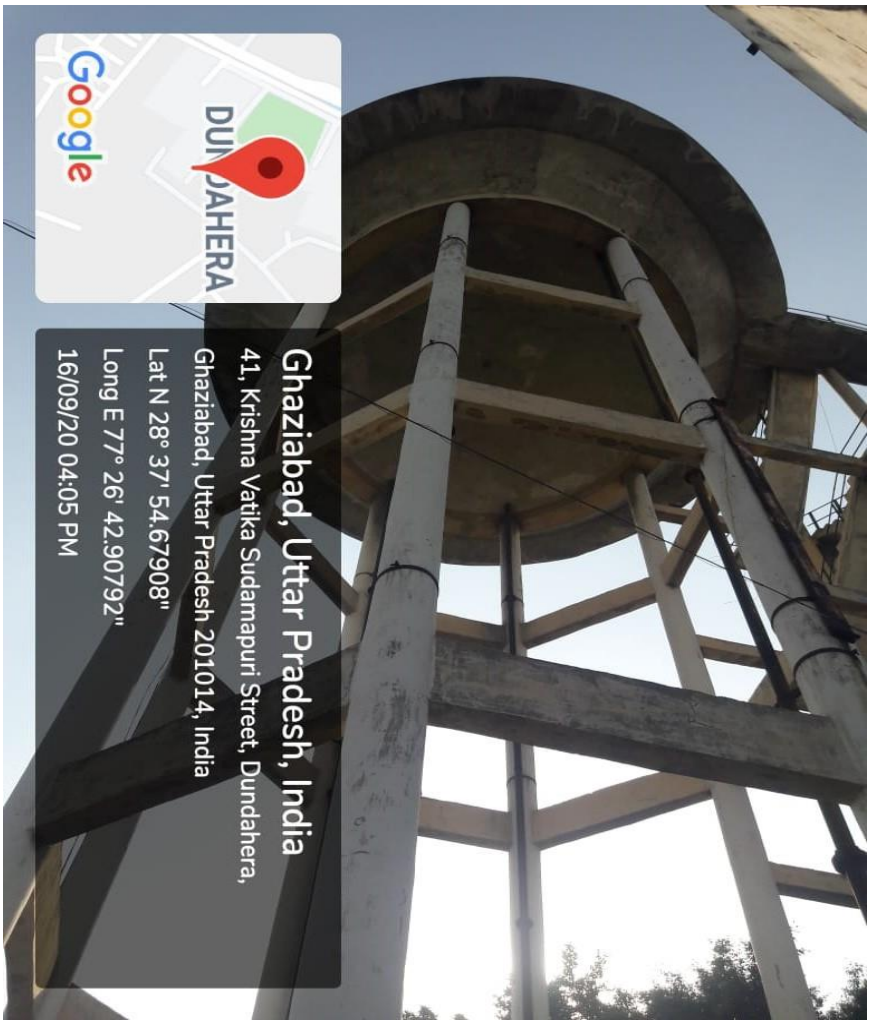


Figure 4.4: Overhead Water Tank

Figure-4.5: Drinking water Treatment System

4.3.2.2 Water Quality of Drinking water:

Water quality of Drinking water is regularly monitored by U P Jal Nigam (Uttar Pradesh Government PSU). Drinking water samples are also taken and checked by Institute's staff regularly and the action is taken by the staff accordingly. The Test Reports are shown in Fig-4.6 to Fig-4.8:

U.P. JAL NIGAM, GHAZIABAD

TRNo. 000993

Letter No.- 2660 / जेनि0 / 1265 Dated : 07-12-2018

DRINKING WATER ANALYSIS REPORT (N)

Sample Sealed	:	Yes
Name of person Collected Sample	:	Sh. Satyendra Kumar Sharma
Date & Time of Sample Collection	:	28.11.2018
Particulars/Source of Sample	:	1. Water sample from Boys Hostel (VKS) ABES Engineering College, Ghaziabad.
Date of receipt of sample at Lab	:	28.11.2018
Sender Ref. No.	:	ABES/AO/021/18-19 Dated : 28.11.2018
	By	Administration Officer ABES Engg. College, 19th Stone, NH-24, Ghaziabad.
Laboratory analysis Ref. No	:	HM-3827 Date: 07.12.2018

Test Results:Physico-Chemical & Heavy Metal Characteristics As per IS 10500 : 2012 as Amendment No. 1 June 2015

Sl.No.	Characteristic	Expressed as	Analysed result	Acceptable limit	Permissible limit
1	Turbidity	NTU	0.3	1	5
2	pH		7.8	6.5 to 8.5	No relaxation
3	Total Dissolved Solids	mg/l	490	500	2000
4	Total Hardness (as $CaCO_3$)	mg/l	196	200	600
5	Chloride (as Cl)	mg/l	35	250	1000
6	Sulphate (as SO_4)	mg/l	47	200	400
7	Fluoride (as F)	mg/l	0.56	1.0	1.5
8	Nitrate (as NO_3)	mg/l	10.5	45	No relaxation
9	Calcium (as Ca)	mg/l	32	75	200
10	Magnesium (as Mg)	mg/l	28.2	30	100
11	Iron (as Fe)	mg/l	0.04	0.3	No relaxation
12	Residual Chlorine	mg/l	Nil	0.2	1.0
13	Arsenic (as As)	mg/l	BDL	0.01	0.05
14	Lead (as Pb)	mg/l	0.008	0.01	No relaxation
15	Cadmium (as Cd)	mg/l	0.002	0.003	No relaxation
16	Manganese (as Mn)	mg/l	0.017	0.3	0.5

Note :- (i) Figures in Col-5 are the limits upto which drinking water is acceptable to the consumers.
(ii) Figures in excess of Col-6 render the water not acceptable, but still may be tolerated (upto the limit indicated in the Col-6) in the absence of alternative and better source.
(iii) The water sample is not collected by us.
(iv) BDL - Below Detection Limit

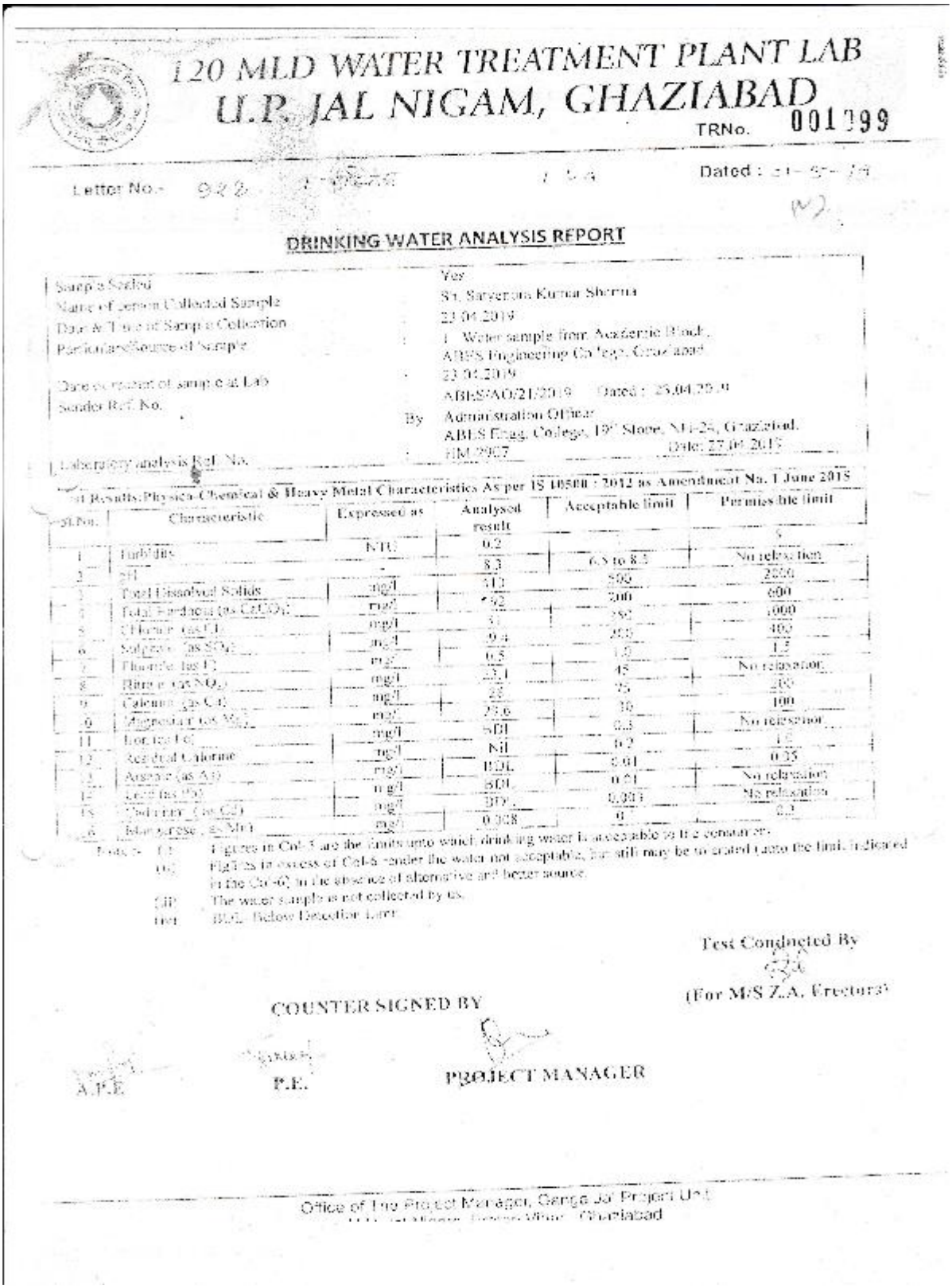
Test Conducted By
(For M/S Z.A. Freefors)

COUNTER SIGNED BY

A.P.E. P.E. PROJECT MANAGER

Office of The Project Manager, Ganga Jal Project Unit
U.P. Jal Nigam, Pratap Vihar, Ghaziabad
Telefax - 120-2746484, Ph.: 7599201512, E-mail : pmganga.gzb@yahoo.com

Figure-4.6: Copy of Test Report dated 07.12.2018



120 MLD WATER TREATMENT PLANT LAB
U.P. JAL NIGAM, GHAZIABAD

TRNo. 001999

Letter No.- 922 Dated : 01-05-19

DRINKING WATER ANALYSIS REPORT

Sample Sealed	:	Yes
Name of person Collected Sample	:	Sri. Satyendra Kumar Sharma
Date & Time of Sample Collection	:	23.04.2019
Particulars/Source of Sample	:	1. Water sample from Academic Block, ABES Engineering College, Ghaziabad
Date of receipt of sample at Lab	:	23.04.2019
Sender Ref. No.	:	ABES/AO/21/2019 Dated : 25.04.2019
	By	Administration Officer, ABES Engg. College, 19th Stone, NH-24, Ghaziabad.
Laboratory analysis Ref. No.	:	HM/2907 Date: 27.04.2019

Test Results: Physico-Chemical & Heavy Metal Characteristics As per IS 10500 : 2012 as Amendment No. 1 June 2015

Sl.No.	Characteristic	Expressed as	Analysed result	Acceptable limit	Permissible limit
1	Turbidity	NTU	0.2	1	5
2	pH	-	8.3	6.5 to 8.5	No relaxation
3	Total Dissolved Solids	mg/l	410	500	2000
4	Total Hardness (as CaCO3)	mg/l	252	200	600
5	Chloride (as Cl)	mg/l	70	250	1000
6	Sulphate (as SO4)	mg/l	9.6	200	400
7	Fluoride (as F)	mg/l	0.5	1.0	1.5
8	Nitrate (as NO3)	mg/l	25.1	45	No relaxation
9	Calcium (as Ca)	mg/l	48	75	200
10	Magnesium (as Mg)	mg/l	25.6	30	100
11	Iron (as Fe)	mg/l	BDL	0.3	No relaxation
12	Residual Chlorine	mg/l	Nil	0.2	1.0
13	Arsenic (as As)	mg/l	BDL	0.01	0.05
14	Lead (as Pb)	mg/l	BDL	0.01	No relaxation
15	Cadmium (as Cd)	mg/l	BDL	0.003	No relaxation
16	Selenium (as Se)	mg/l	0.008	0	0.01

Note :- (1) Figures in Col-5 are the limits upto which drinking water is acceptable to the consumers.
(2) Figures in excess of Col-5 render the water not acceptable, but still may be tolerated upto the limit indicated in the Col-6, in the absence of alternative and better source.
(3) * The water sample is not collected by us.
(4) BDL- Below Detection Limit

Test Conducted By

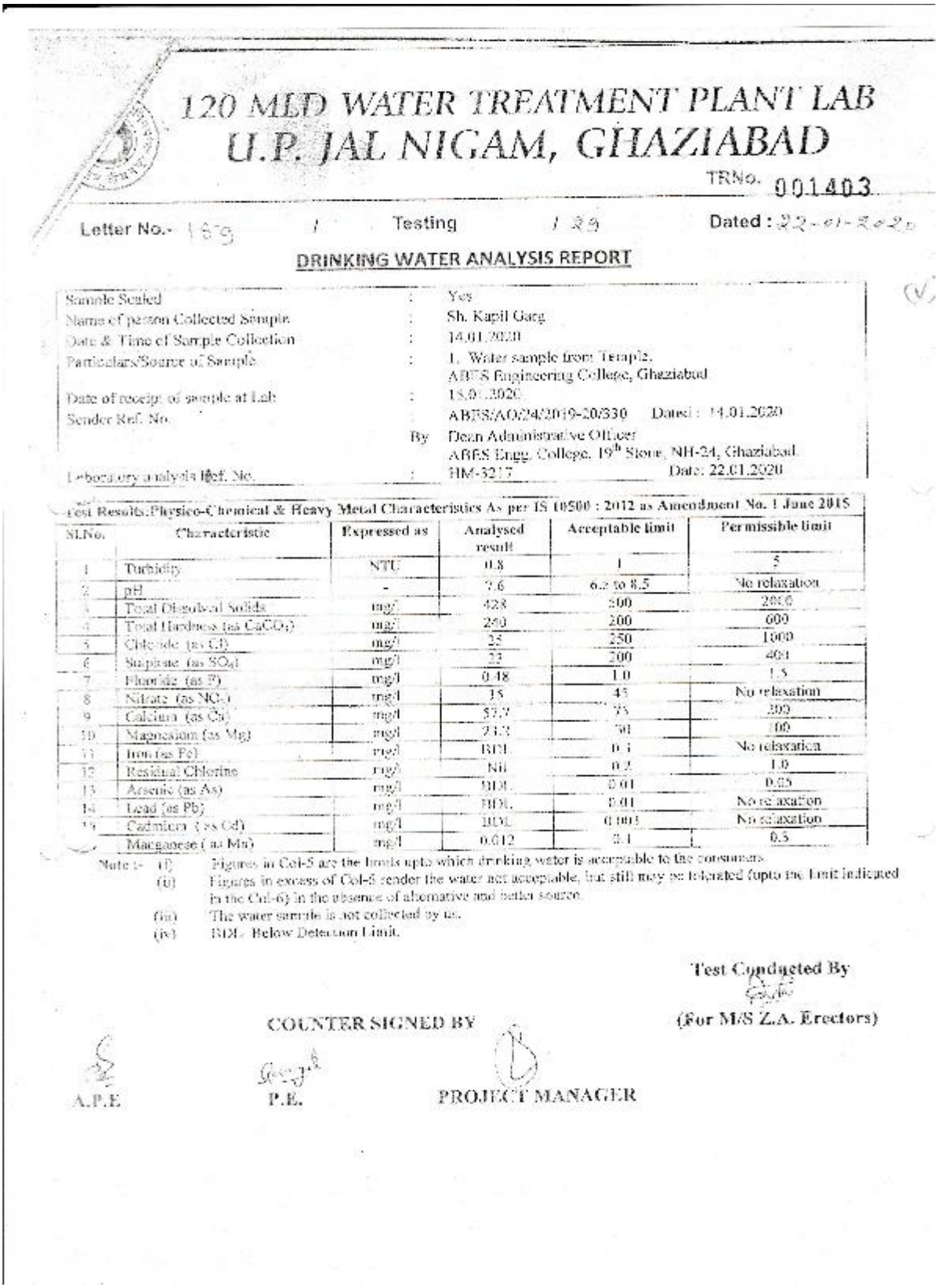
(For M/S Z.A. Erectors)

COUNTER SIGNED BY

A.P.E. P.E. PROJECT MANAGER

Office of the Project Manager, Ganga Jal Project Unit, Ghaziabad

Figure-4.7: Copy of Test Report dated 01.05.2019



120 MLD WATER TREATMENT PLANT LAB
U.P. JAL NIGAM, GHAZIABAD

TRNo. 001403

Letter No.- 165 / Testing / 20 Dated : 22-01-2020

DRINKING WATER ANALYSIS REPORT

Sample Sealed	:	Yes
Name of person Collected Sample	:	Sh. Kapil Garg
Date & Time of Sample Collection	:	14.01.2020
Particulars/Source of Sample	:	1. Water sample from Temple, ABES Engineering College, Ghaziabad
Date of receipt of sample at Lab	:	15.01.2020
Sender Ref. No.		ABES/AO/24/2019-20/330 Dated : 14.01.2020
	By	Dean Administrative Officer, ABES Engg. College, 19th Stone, NH-24, Ghaziabad
Laboratory analysis Ref. No.	:	HM-3217 Date: 22.01.2020

Test Results: Physico-Chemical & Heavy Metal Characteristics As per IS 10500 : 2012 as Amendment No. 1 June 2015

Sl.No.	Characteristic	Expressed as	Analysed result	Acceptable limit	Permissible limit
1	Turbidity	NTU	0.8	1	5
2	pH	-	7.6	6.5 to 8.5	No relaxation
3	Total Dissolved Solids	mg/l	428	500	2000
4	Total Hardness (as $CaCO_3$)	mg/l	250	200	600
5	Chloride (as Cl)	mg/l	25	250	1000
6	Sulphate (as SO_4)	mg/l	23	200	400
7	Fluoride (as F)	mg/l	0.48	1.0	1.5
8	Nitrate (as NO_3)	mg/l	35	45	No relaxation
9	Calcium (as Ca)	mg/l	57.7	75	200
10	Magnesium (as Mg)	mg/l	21.3	30	100
11	Iron (as Fe)	mg/l	BDL	0.3	No relaxation
12	Residual Chlorine	mg/l	Nil	0.2	1.0
13	Arsenic (as As)	mg/l	BDL	0.01	0.05
14	Lead (as Pb)	mg/l	BDL	0.01	No relaxation
15	Cadmium (as Cd)	mg/l	BDL	0.003	No relaxation
16	Manganese (as Mn)	mg/l	0.012	0.1	0.5

Note :- (i) Figures in Col-5 are the limits upto which drinking water is acceptable to the consumers.
(ii) Figures in excess of Col-5 render the water not acceptable, but still may be tolerated upto the Limit indicated in the Col-6) in the absence of alternative and better source.
(iii) The water sample is not collected by us.
(iv) BDL - Below Detection Limit.

Test Conducted By
(For M/S Z.A. Erectors)

COUNTER SIGNED BY

A.P.E P.E. PROJECT MANAGER

Figure-4.8: Copy of Test Report dated 22.01.2020

4.3.2.3 Water Pumps for non Drinking purpose

Details of other Water Pumps for non drinking Purpose are as follows:

Sl. No	Location	Capacity (HP)	Make	Tentative Discharge (Cu Meter /Hour)	Average Operating Hrs per day	Associated Tank Capacity (Liters)
1	Behind Arya Bhatt Block	10	KSB	50	2.0	14000
2	Behind Arvindo Bhawan (Boys Hostel)	05	Pluga	25	1	5000
3	Behind Vivekanand Bhawan (Boys Hostel)	03	KSB	15	1	5000
4	Stadium Water Tank	03	Pluga	15	1	5000
	Total					**29000**

Table-4.1: List of other Water Pumps

No specific data is available for use of non drinking water. Assuming full use of water of these Tank capacities, the consumption of water for non drinking purpose is 29000 Liters (29 Cu Meter) per day.

Thus the total water consumption per day is as follows:

I. Consumption of Drinking water per day: 300000 Liters
II. Consumption of Non Drinking water per day: 29000 Liters

Total Water consumption per Day: 329000 Liters/Day, which includes water consumption for irrigation purpose (5000 Liters per day) i.e. 324000 Liters/Day by Residents and Day-time users.

Water charges paid - No water charges (No municipal water supply)

4.3.2.4 Baseline of water consumption

In India, the design of water supply systems has been done using certain standards. Currently the standard being used is BIS 1172: 1993, reaffirmed in 1998. This specifies a consideration of use of the following:

For communities with a population of between 20,000 to 100,000 – 100 to 150 liters per head per day

For communities with a population of over 100,000 – 150 to 200 liters per head per day. In its previous avatar there was also an attempt made in IS 1172 to understand the break-up of this demand which was then put as 135 liters per person per day. The break-up was as follows:

I. Bathing: 55 liters
II. Toilet flushing: 30 liters
III. Washing of clothes: 20 liters
IV. Washing the house: 10 liters
V. Washing utensils: 10 liters
VI. Cooking: 5 liters
VII. Drinking: 5 liters.

Based on above standard water consumption of Campus residents should be maximum 135 Liters per person and Day time person should be maximum 40 Liters per person.

As per Para 1.81 and 1.82 of Chapter-1, the details of the residents living in Campus (Day and Night) are as per Table-4.2:

Sl. No	Particulars	Nos
1	Nos. of Hostlers Students	1677
2	No of Staff	10
Total Residents Population		**1687**

Table-4.2: Nos. of Campus residents in the Institute

The details of Persons coming in Day time are as per Table-4.3

Sl. No	Particulars	Nos
1	Nos. of Non-Hostlers Students	2683
2	No of Staff	604
3	No of Daily Visitors	25
Total Daytime population		**3312**

Table-4.3: Nos. of Day Time persons in the Institute

Thus total maximum permissible water Consumption as per Standards laid under IS 1172 is as given in Table-4.4.

Sl. No.	Particulars	Nos.	Maximum water consumption per Person per day (Liters)	Total Maximum water consumption Liters per Day
1	Nos. of Campus full time residents	1687	135	227745
2	Nos. of Day time persons	3312	40	132480
	Grand Total			**360225**

Table-4.4: Total permissible water Consumption as per Standards laid under IS 1172

Actual water consumption as per Para 4.3 is 324000 Liters per day, which is 10.06% less than total permissible water Consumption of 360225 Liters per day, as per Standards laid under IS 1172 shown in per Table-4.4

4.4 Rainwater Harvesting

Rainwater harvesting is the accumulation and deposition of rainwater for reuse on-site, rather than allowing it to run off. Rainwater can be collected from roofs, and in many places the water collected is redirected to a deep pit (well, shaft, or borehole), a reservoir with percolation. Its uses include water for gardens, livestock, irrigation, domestic use with proper treatment etc. The harvested water can also be used as drinking water, longer-term storage and for other purposes such as groundwater recharge.

Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply. It provides water when there is a drought, can help mitigate flooding of low-lying areas, and reduces demand on wells which may enable groundwater levels to be sustained. It also helps in the availability of potable water as rainwater is substantially free of salinity and other salts. Application of rainwater harvesting in urban water system provides a substantial benefit for both water supply and wastewater subsystems by reducing the need for clean water in water distribution system, less generated storm water in sewer system, as well as a reduction in storm water runoff polluting freshwater bodies.

Supplying rainwater that has gone through preliminary filtration measures for non-

potable water uses, such as toilet flushing, irrigation, and laundry, may be a significant part of a sustainable water management strategy.

4.4.1 Details of Rain Water Harvesting Borings in the Institute

S. No.	Particulars	L x B x Pipe Size
1	Main Gate	
2	Raman Block (Near Diesel Tank)	29'x9' x 4"
3	Stadium (4 wheeler Parking Corner)	13'x7.5' x4"
4	Stadium (IT Side)	20'x9.5' x4"
5	Boys' Hostel Main Gate	19'x9' x4"
6	Girls' Hostel Main Gate	8'x7' x4"
7	Workshop Main Gate (near Girls' Hostel)	16'x10' x6"

Table-4.5: Details of Rain Water Harvesting Borings in the Institute

Every Rain Water Harvesting has a pit of 4' x 4' covered with Iron Jalli from where water goes inside in rain water harvesting.

4.5 Auditing for Waste Management

Pollution from waste is aesthetically unpleasing and results in large amounts of litter in our communities which can cause health problems. Plastic bags and discarded ropes and strings can be very dangerous to birds and other animals. This indicator addresses waste production and disposal, plastic waste, paper waste, food waste, and recycling. Solid waste can be divided into two categories: general waste and hazardous waste. General wastes include what is usually thrown away in homes and schools such as garbage, paper, tins and glass bottles. Hazardous waste is waste that is likely to be a threat to health or the environment like cleaning chemicals and petrol. Unscientific landfills may contain harmful contaminants that leach into soil and water supplies, and produce greenhouse gases contributing to global climate change.

Furthermore, solid waste often includes wasted material resources that could otherwise be channeled into better service through recycling, repair, and reuse. Thus the

minimization of solid waste is essential to a sustainable college. The auditor diagnoses the prevailing waste disposal policies and suggests the best way to combat the problems. It is therefore essential that any environmentally responsible institution examine its waste processing practices.

4.5.1 Quantity of Waste Generated

No data could be provided by the Institute regarding the quantity of waste (Biodegradable, Non biodegradable and E Waste) generated in the Institute

4.5.2 Disposal of Waste generated

(A) Biodegradable

Canteen waste

It was shared by the authorities that Canteen waste is being disposed to local Cattle Keepers to feed the waste to their animals.

Leaves and others:

Leaves and others are used to prepare Vermi post, which is used as manure in the Institute. Different methods such as pit composting, vermi-composting, are used to treat the this waste. Paper waste is sold to Venders.

(B) **Non biodegradable**

(C) This waste including metals, bottles, plastics, cans, broken glass wares, tins etc., are sold out. Authorities are advised to dispose the Non biodegradable waste to only Government authorized Venders only and keep proper accounting.

(D) **E Waste**:

E Waste is disposed to Local Venders. Authorities are advised to dispose the E Waste to only Government authorized Venders only and keep proper accounting.

4.5.3 Solid Waste Management System

The Flow diagram of solid waste management system has been shown in Figure-4.9.

Solid Waste Management System in ABES Engineering College

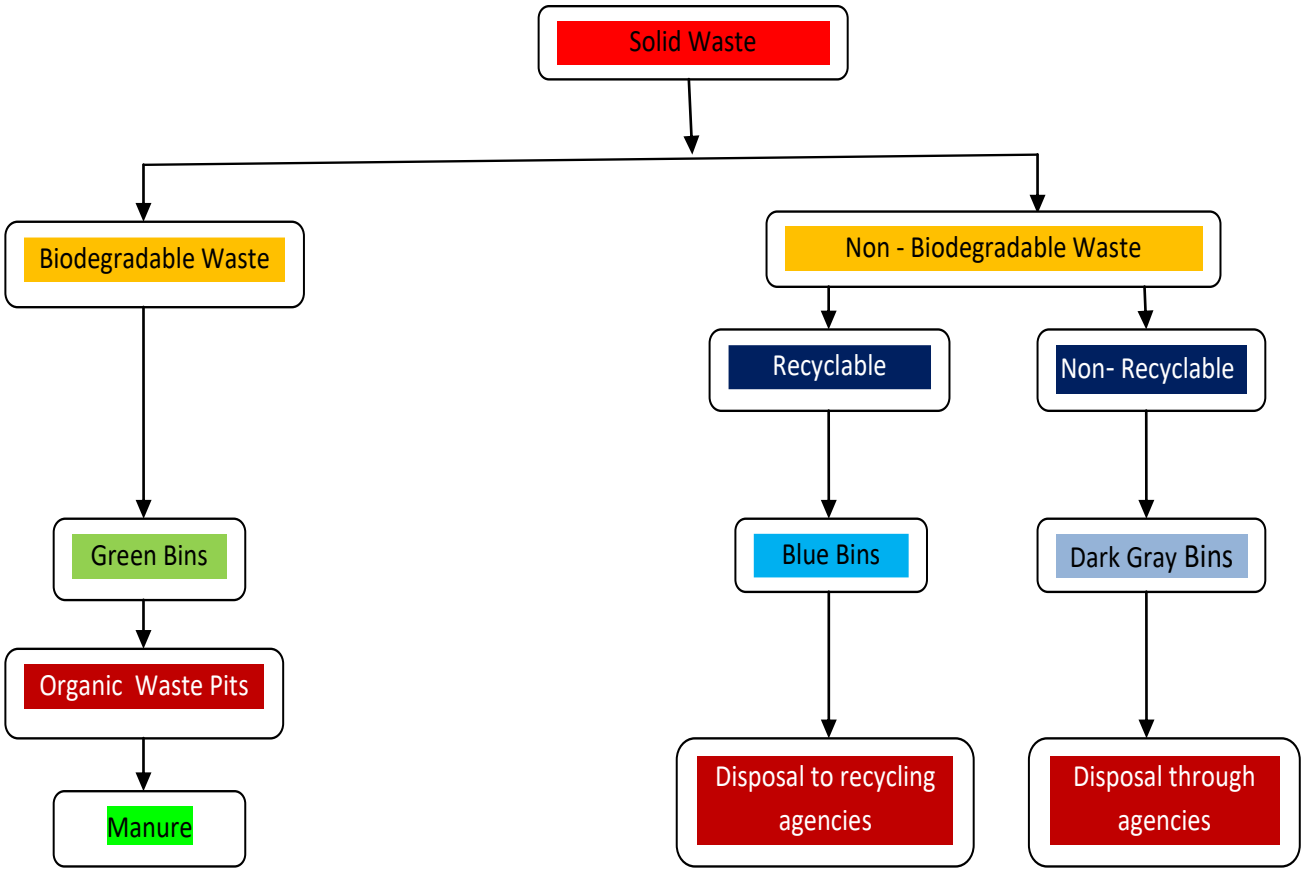


Figure-4.9: Flow diagram of solid waste management system in the Institute

4.5.4 Liquid Waste Management System

There is no Sewage Treatment Plant in the Institute.

4.6 Auditing for Green Campus Management

Unfortunately, biodiversity is facing serious threats from habitat loss, pollution, over consumption and invasive species. Species are disappearing at an alarming rate and each loss affects nature's delicate balance and our quality of life. Without this variability in the living world, ecological systems and functions would break down, with detrimental consequences for all forms of life, including human beings. Newly planted and existing trees decrease the amount of carbon dioxide in the atmosphere. Trees play an important ecological role within the urban environment, as well as support

improved public health and provide aesthetic benefits to cities. In one year, a single mature tree will absorb up to 48 pounds of carbon dioxide from the atmosphere, and release it as oxygen. The amount of oxygen that a single tree produces is enough to provide one day's supply of oxygen for people. So while you are busy studying and working on earning those good grades, all the trees on campus are also working hard to make the air cleaner for us. Trees on our campus impact our mental health as well; studies have shown that trees greatly reduce stress, which a huge deal is considering many students are under some amount of stress.

Figure-4.10: Green Trees and Field

4.6.1 Methodology of Green Auditing

The purpose of the audit was to ensure that the practices followed in the campus are in accordance with the Green Policy adopted by the institution. The criteria, methods and recommendations used in the audit were based on the identified risks. The methodology includes: preparation and filling up of questionnaire, physical inspection of the campus, observation and review of the document, interviewing responsible persons and data analysis, measurements and recommendations.

4.6.1.1 List of Garden Trees in the Campus

List of Trees in the Institute Campus are as per Table-4.6.

Sl. No	Name of Tree/Plant	Nos.	Sl. No	Name of Trees/Plant	Nos
1	Alstonia	78	24	Harshingar	2
2	Amla	2	25	Jamun	2
3	Amun	13	26	Jatrupa	9
4	Ananas	2	27	Kachnar	4
5	Anar	2	28	Kadam	47
6	Ashoka	51	29	Kanak Champa	9
7	Bargad	1	30	Kanher	25
8	Bel patra	4	31	Kathal	1
9	Bismarckia	6	32	Mango	17
10	Bottle Plant	18	33	Mosambi	6
11	Casuarina	102	34	Money Plant	1000
12	Chakresia	42	35	Neem	27
13	Champa	133	36	Nimbu	6
14	Chandan	2	37	Papdi	1
15	Chandani	11	38	Peepal	2
16	Chiku	4	39	Rubber Plant	7
17	Ephobia Mili	400	40	Samuel	3
18	Ficus	214	41	Semul	24
19	Gajraula	4	42	Siasum	2
20	Golden	5	43	Silbhar	38
21	Guawa	15	44	Sopen	1
22	Gular	2	45	Shinghonium	1000
23	Gulmohar	41		Sub Total	2233
	Sub Total	1152		**Grand Total**	**3385**

Table-4.6: ABES Engineering College Trees Details

4.7 Evaluation of Audit Findings

4.7.1 Major Audit Observations in General

- There is no Green policy/Environmental policy statement indicating the commitment of the college towards its environmental performance.
- Gardens inside the college premises are found well maintained.
- Use of notice boards and signs are inadequate to reduce over exploitation of natural resources.
- Programs on green initiatives have to be increased.
- Environmental education programs have to be strengthened.

4.7.2 Water Audit

- The college does not have waste water treatment for waste water generated from laboratories, canteen, hostel kitchen, toilets, bathrooms and office rooms.
- The waste water from laboratories, canteen and kitchens are not suitably controlled and are not used for gardening.
- Display boards against the misuse of water use are lacking.

4.7.3 Waste Audit

- Solid waste management systems established are insufficient. Bio degradable waste may be used for non conventional Energy Generation or Steam Generation for cooking food/Washing cloths etc.
- The college should has proper communication with the local body for regular collection of solid waste from the campus.
- Implementation of sustainable projects to attain set environmental goals is not in place.
- Waste bins in the class rooms, veranda, canteen and campus are inadequate.

- Bio gas plant should be installed

4.7.4 Green Campus Audit

- Display boards to all plants identified are lacking.

4.8 Preparation of Action Plan

There should be Committee formation for energy Audit, Green Audit and Environmental Audit involving Faculties and Students. Policies referring to college's management and approach's towards the use of resources need to be considered. The college should have a green policy/environmental policy for its sustainable development. The environmental policy formulated by the management of the college should be implemented meticulously. The college should have a policy on awareness raising or training programs (for ground staff or kitchen staff for example) and college also should have a procurement policy (the College's policy for purchasing materials).

4.9 Criteria wise List of Recommendations

4.9.1 Water

- Manual water Taps should be replaced with Auto closed water Taps
- Drip irrigation for gardens and vegetable cultivation can be initiated.
- Establish water treatment systems to recycle drain water
- Awareness programs on water conservation to be conducted.
- Install display boards to control over exploitation of water.

4.9.2 Waste

- A model solid waste treatment system to be established.
- Practice of waste segregation to be strengthened.
- Establish a plastic free campus.
- Use paper plates and cups in place of Plastic for all functions in the college.

4.9.3 Green Campus

- Grow potted plants at both verandah and class rooms.
- Create automatic drip irrigation system during summer holidays.
- Not just celebrating environment day but making it a daily habit.
- Beautify the college building with maximum use of oxygen generating indoor plants
- Encouraging students not just through words, but through action for making the campus green
- Conducting competitions among departments for making students more interested in making the campus green.
- All trees in the campus should be named scientifically.

Chapter -5
Environmental Audit

5.1 Current Scenario

Ghaziabad is a city in the state of Uttar Pradesh of India. It is sometimes referred to as the "Gateway of UP" because it is close to New Delhi, on the main route into Uttar Pradesh. It is a part of the National Capital Region of Delhi. It is a large and planned industrial city, with a population of 2,358,525. Well connected by roads and railways, and is the administrative headquarters of Ghaziabad District as well as being the primary commercial, industrial and educational centre of western Uttar Pradesh and a major rail junction for North India. Recent construction works have led to the city being described by a City Mayors Foundation survey as the second fastest-growing in the world. Situated in the Upper Gangetic Plains, the city has two major divisions separated by the Hindon River, namely: Trans-Hindon on the west and Cis-Hindon on the east side.

Although connected by railway since 1865, it was not until 1940 that the first modern industry appeared in Ghaziabad. However, it was in the post-independence period that industry really expanded, with a further 22 factories opening in the four years after 1947. This development can be attributed to the influx of people from the newly formed Pakistan and the relocation of businesses from what was now the Pakistani province of Punjab. Subsequently, the Mohan Meakin breweries were also set up in the year 1949. This period also saw the development of Ghaziabad as one of India's most famous centers of the Oil Engines industry.

The period (1967-1970) also saw the emergence of the Electronics industry, with the setting up of Bharat Electronics Limited and Central Electronics Limited Over the years, planned Industrial development saw participation from major industrial houses of the country including Mohans (Mohan Nagar Industrial Estate, 1949), Tatas (Tata Oil Mills), Modis (Modinagar, 1933; International Tobacco Co. 1967), Shri Rams (Shri Ram Pistons, 1964), Jaipurias etc. and also significant participation through foreign capital in concerns such as Danfoss India Ltd., Indo-Bulgar Food Ltd. and International Tobacco Company (estd. 1967).

ABES Engineering College is situated in Ghaziabad on National Hiway-24. It is very close to Bulandshahr Road Industrial Area. Continental Carbon Factory is in front of the Institute. Crossings Republic, a large township of Ghaziabad is in nearby vicinity of the Institute. The size of the Institute is very small in comparison to nearby areas. As such, Environment control of the Institute largely depend upon policies of Ghaziabad Development Authority, which govern environmental pollution of Ghaziabad. At present widening of NH-24 work is going on in full swing, it is impacting the pollution in the Institute.

Ambient Air is being monitored regularly by the Central Pollution Control Board. At source emission monitoring i.e. stack monitoring of industries is also being done regularly and action is being taken accordingly on the basis of analysis report. If any industry is found violating the standards firstly show-cause notice is issued to the industry followed by closure under Air (Prevention and Control of Pollution) Act, 1981.

5.2 Sources Of Pollution in Ghaziabad

The main sources of air pollution in Ghaziabad city are Vehicular, Road dust, Construction & Demolition activities, Industries (Point source & Areas source), Garbage burning & Agriculture waste burning etc. Data obtained from Continuous Ambient Air Quality Monitoring System (2018) at Ghaziabad showed values of CO 1.80 (mg/m^3); O_3 42.1 ($\mu g/m^3$); NO_2 71.1($\mu g/m^3$); SO_2 28.0 ($\mu g/m^3$); $PM_{2.5}$ 127.0 ($\mu g/m^3$); NH_3 52.8 ($\mu g/m^3$); and Benzene 0.74($\mu g/m^3$), Toluene 9.91($\mu g/m^3$), Xylene 1.08($\mu g/m^3$).

Data recorded by Central Pollution Control Board that the pollution levels are increasing year by year and the air quality index is getting worst. If we do not take steps now, this can lead to severe consequences.

5.3 Air Quality Reports

Air Quality Reports of near by Area Crossing Republic (within 100 meter) and Sanjay Nagar (10 KM) are as follows:

5.3.1 Air Quality Report of Bitspi Air Pollution dated 05.08.2020, Time: 7 PM at Crossings Republic (100 meters away) is as shown in Figure-5.1.

Bitspi AirPollutionAPI

Chttps://airpollutionapi.com/aqi/india/uttar-pradesh/crossing-republik-glass-entrance-bus-stopurrent
Air Quality Index in Crossings Republik, Ghaziabad, Uttar Pradesh 201009, India (05.08.2020, 7 pm)

61

Satisfactory
Updated On: 4 hour ago
Main pollutant: PM10
Temp.: 31°C broken clouds

NO2	49.1 µg/m³, AQI 61 Satisfactory
O3	2.31 µg/m³, AQI 2 Good
SO2	5.4 µg/m³, AQI 5 Good
PM10	61.0 µg/m³, AQI 61 Satisfactory
CO	930.0 µg/m³, AQI 46 Severe
Humidity	59.0 %
Barometric Pressure	994.0 hPa
Wind Speed	7.31 m/s
Wind Direction	109.0 degrees

Source: CPCB, Sanjay Nagar, Ghaziabad UPPCB

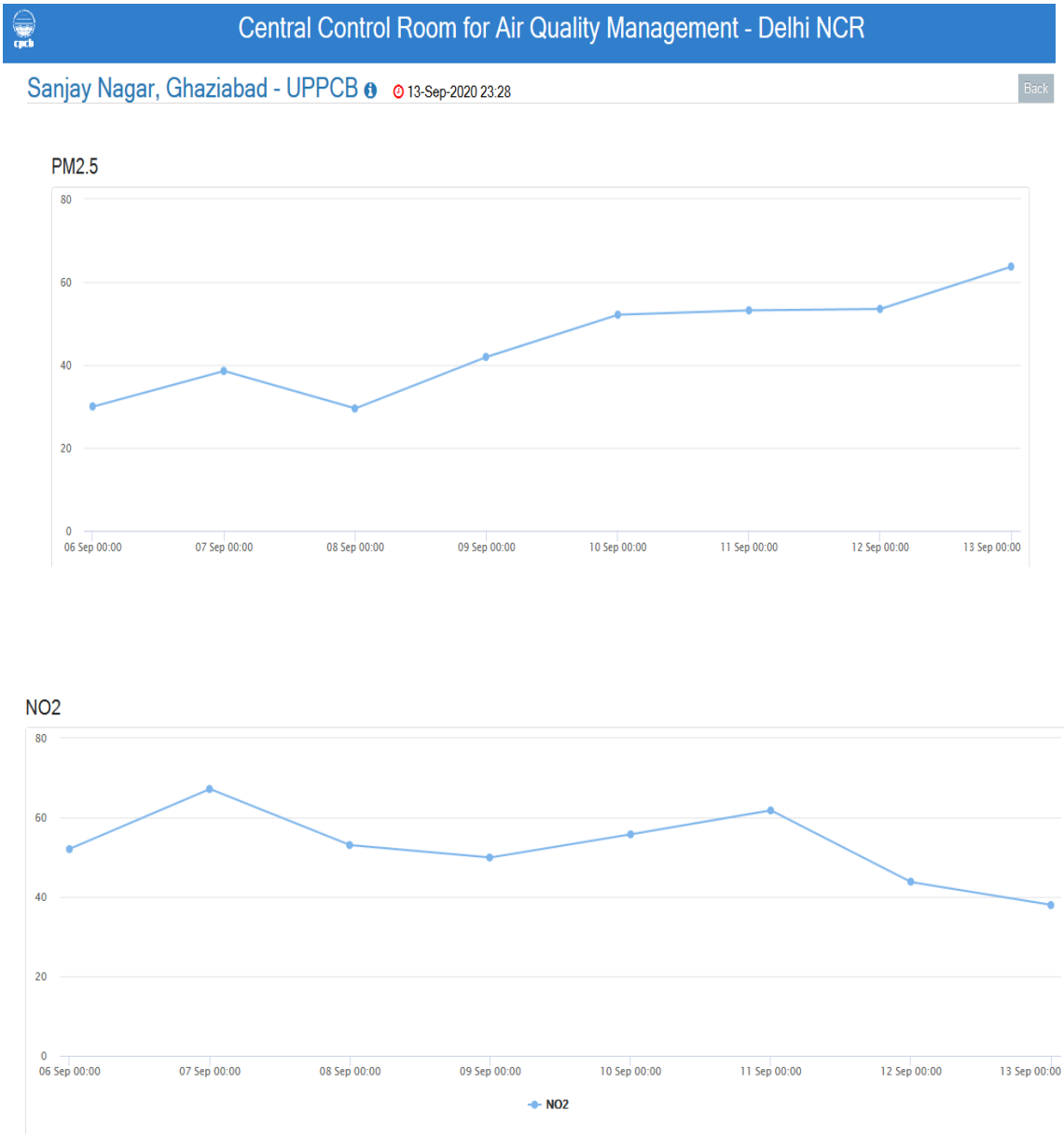
Table-5.1: Air Quality Index Report

AQI Category, Pollutants and Health Breakpoints								
AQI Category (Range)	**PM_{10} (24hr)**	**$PM_{2.5}$ (24hr)**	**NO_2 (24hr)**	**O_3 (8hr)**	**CO (8hr)**	**SO_2 (24hr)**	**NH_3 (24hr)**	**Pb (24hr)**
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40	0-200	0-0.5
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80	201-400	0.5-1.0
Moderately polluted (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380	401-800	1.1-2.0
Poor (201-300)	251-350	91-120	181-280	169-208	10-17	381-800	801-1200	2.1-3.0
Very poor (301-400)	351-430	121-250	281-400	209-748	17-34	801-1600	1200-1800	3.1-3.5
Severe (401-500)	430+	250+	400+	748+	34+	1600+	1800+	3.5+

Table- 5.2: Air Quality Index Standards

5.4 Graphic Presentation of various Constituents

The Graphic Charts of various constituents of Air Quality at Sanjay Nagar Center of Ghaziabad from dated 6.09.2020 to 13.09.2020 are as shown below in Figure 5.1:



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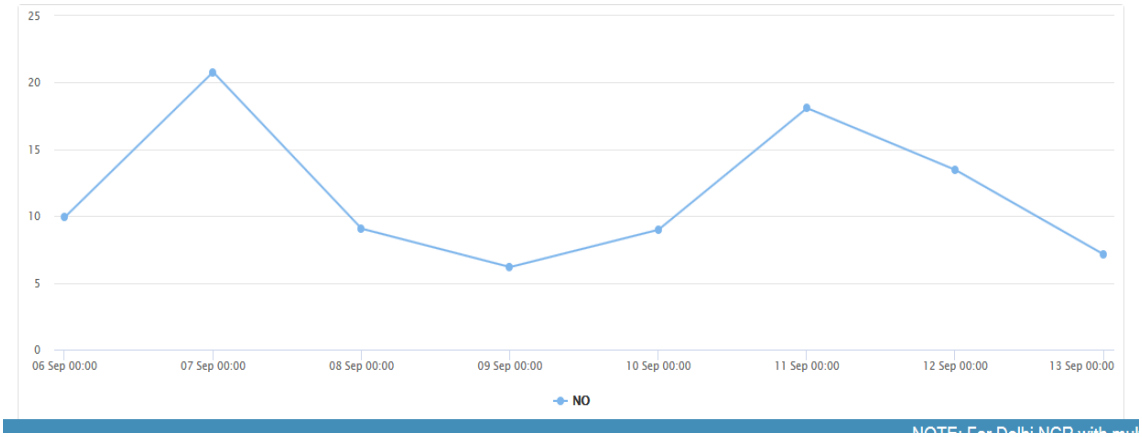
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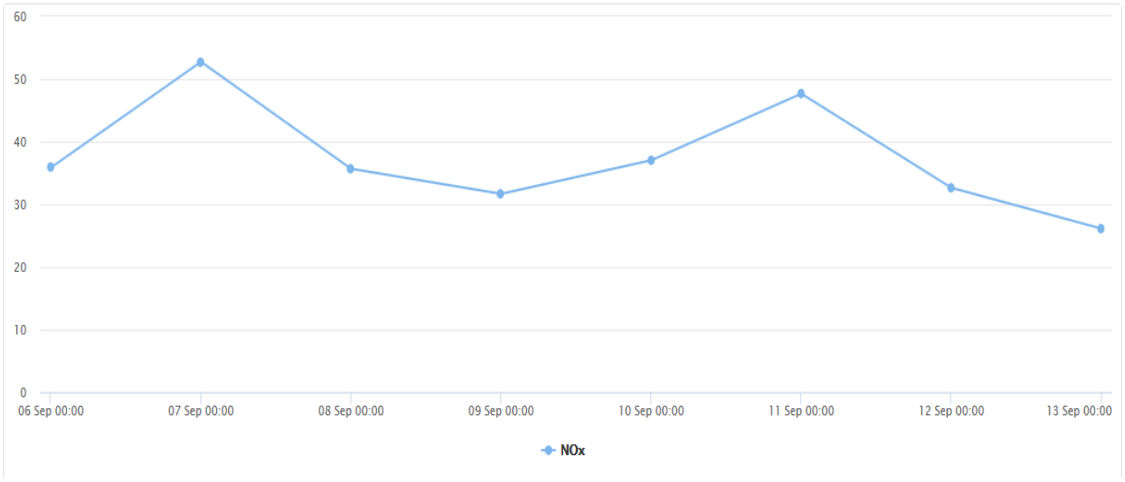
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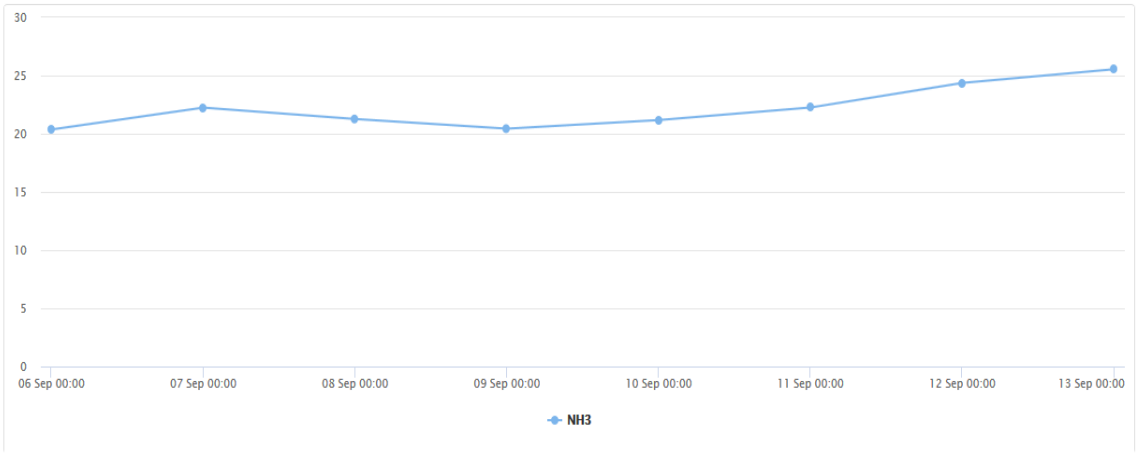
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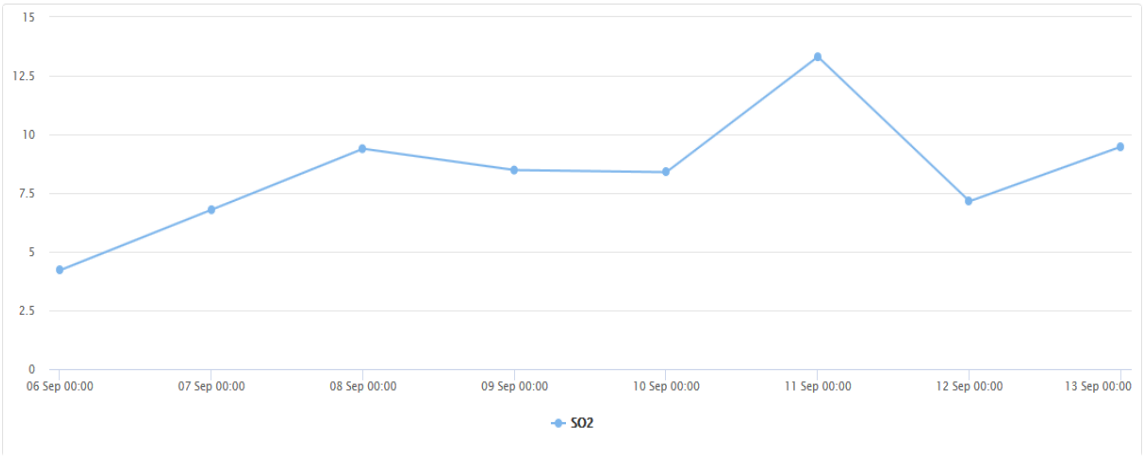
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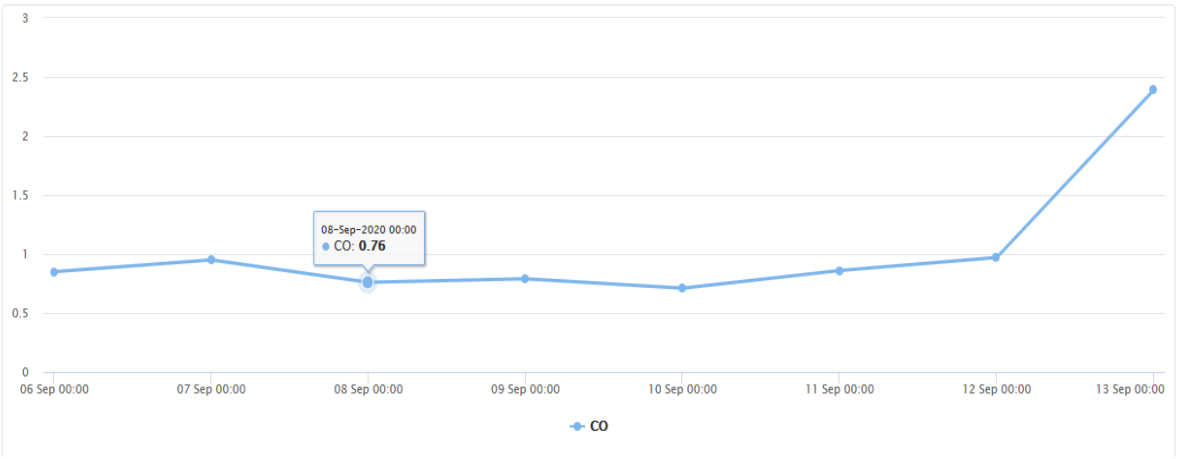
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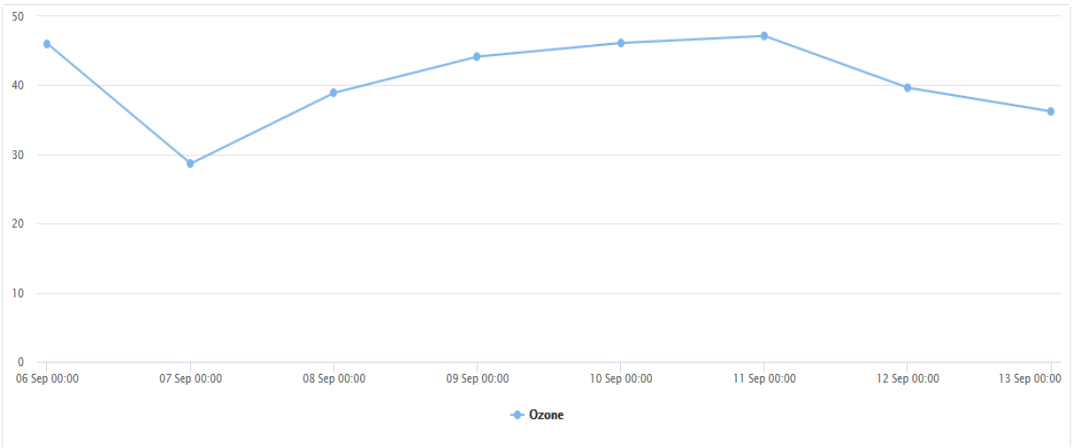
CO

Ozone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30
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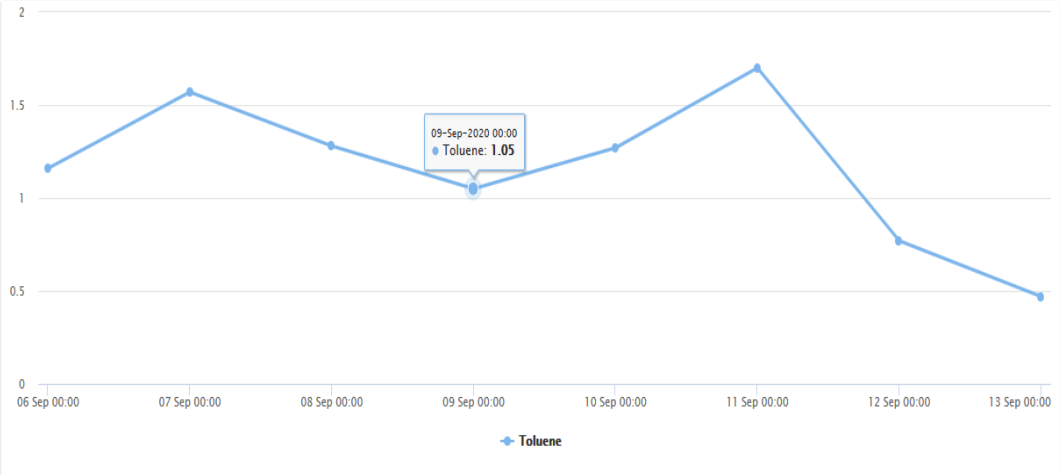
13 Sep 00:00
Ozone

Benzene

Toluene



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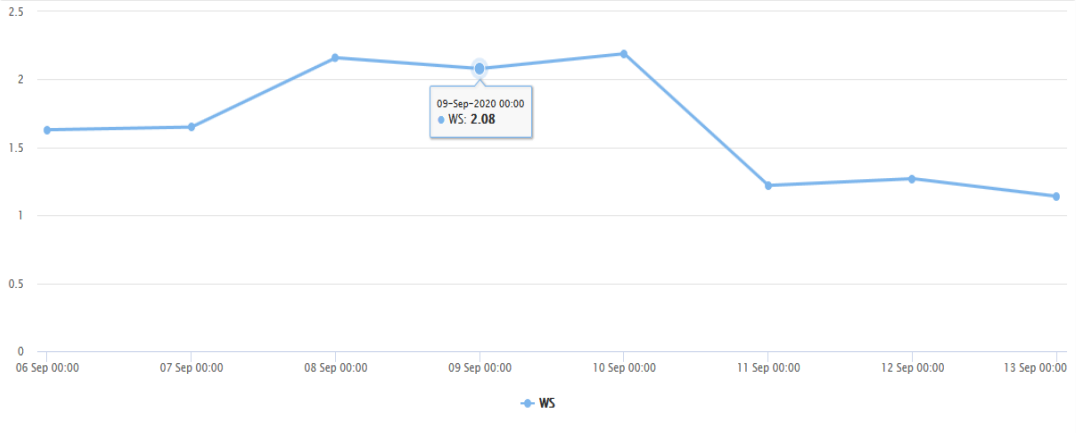

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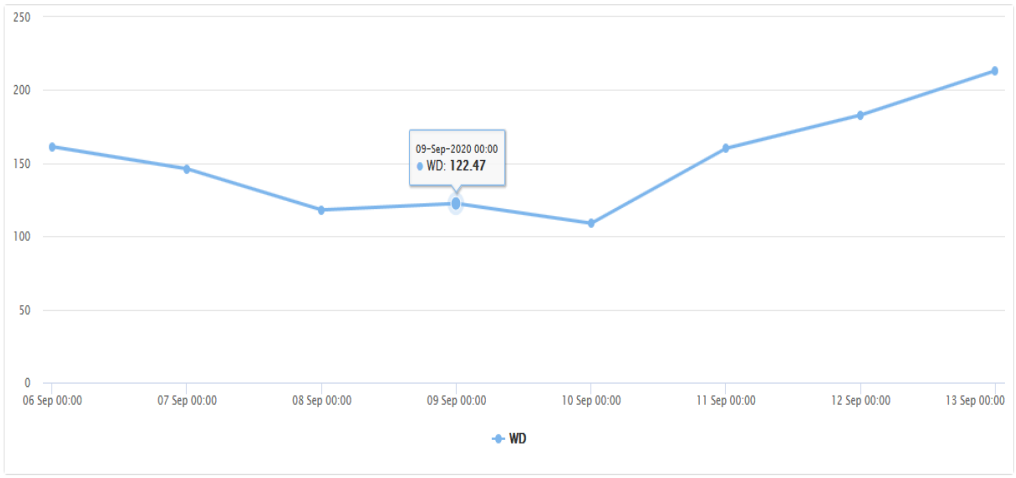
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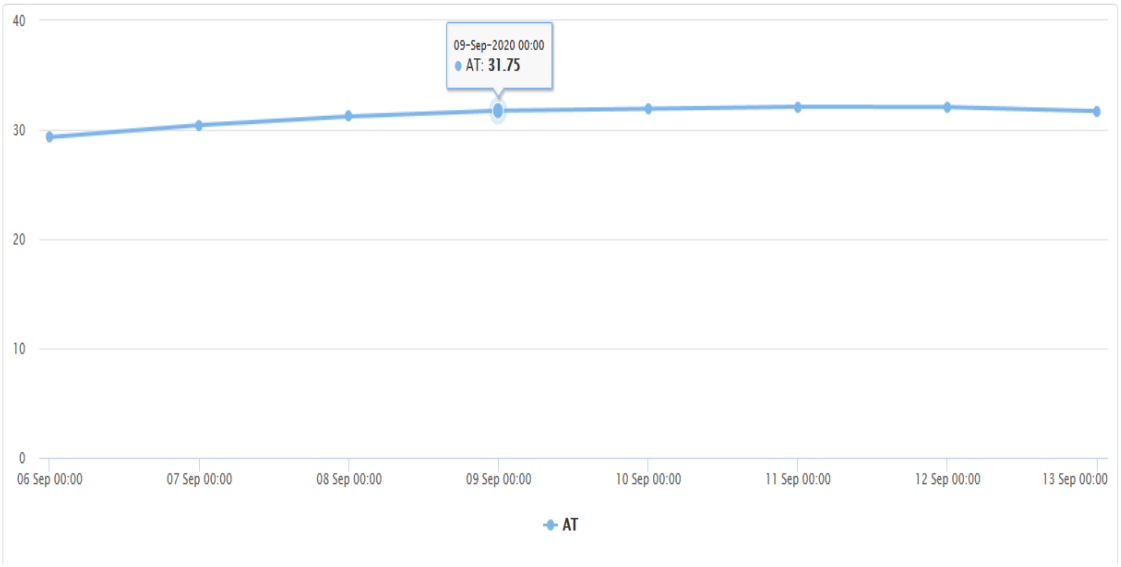
WD

AT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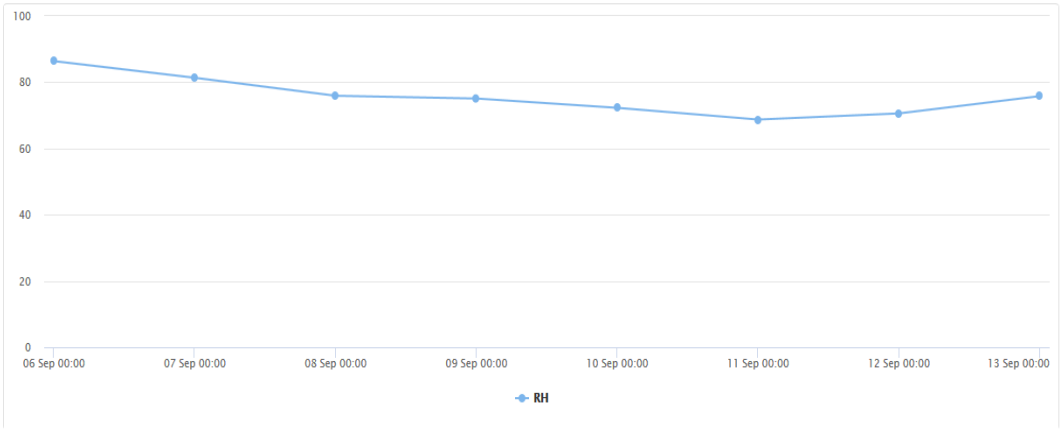
RH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RH

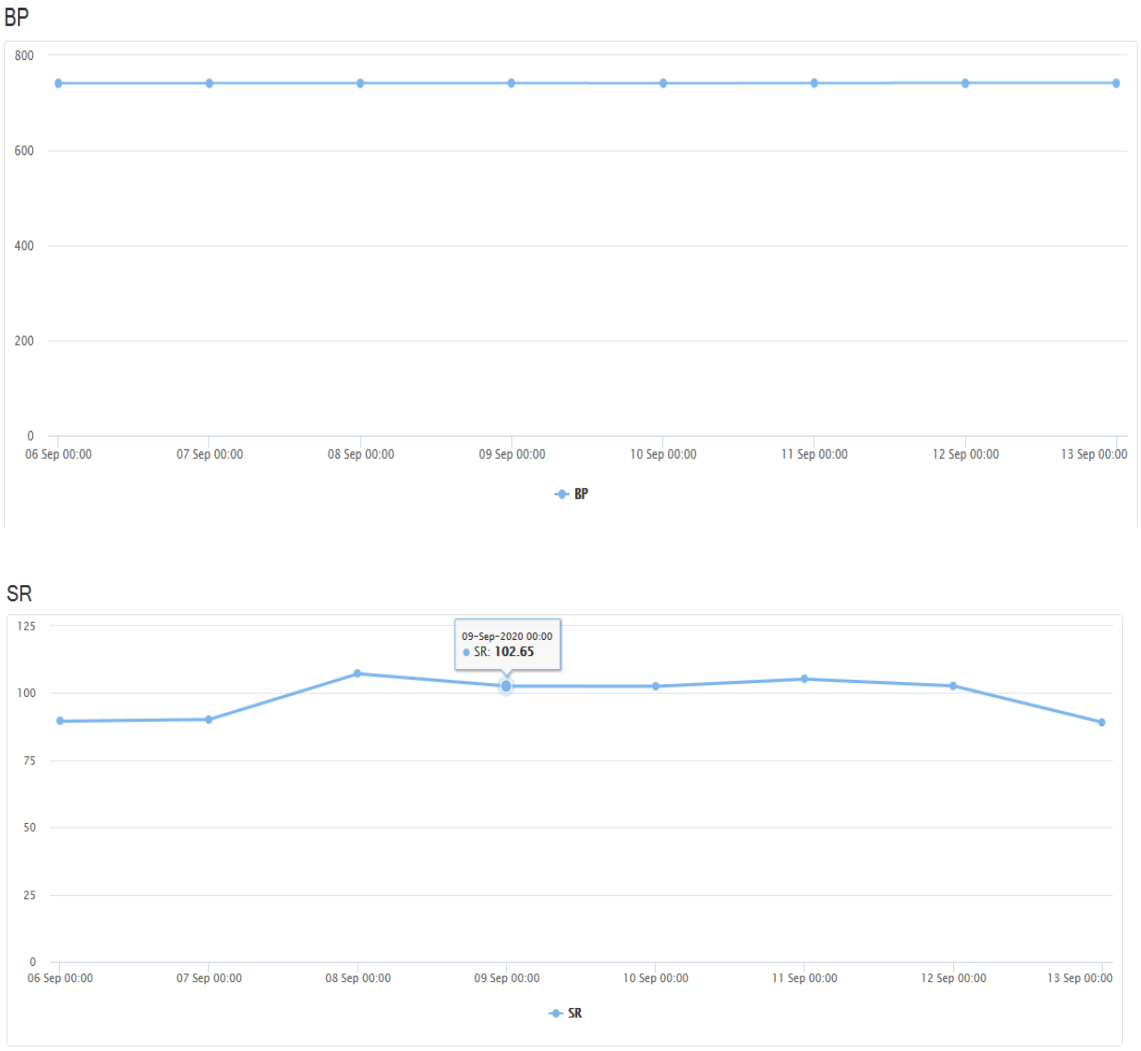

Figure-5.1: Graphical reports of different constituents of air quality Index

5.5 Auditing for Carbon Footprint

Commutation of stakeholders has an impact on the environment through the emission of greenhouse gases into the atmosphere consequent to burning of fossil fuels (such as petrol). The most common greenhouse gases are carbondioxide, water vapour, methane, nitrous oxide and ozone. Of all the greenhouse gases, carbon dioxide is the most prominent greenhouse gas, comprising 402 ppm of the Earth's atmosphere. The release of carbon dioxide gas into the Earth's atmosphere through human activities is commonly known as carbon emissions.

An important aspect of doing an audit is to be able to measure your impact so that we can determine better ways to manage the impact. In addition to the water, waste, energy and biodiversity audits we can also determine what our carbon footprint is, based on the amount of carbon emissions created. One aspect is to consider the distance and method traveled between home and college every day. 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 sustainable development. It is therefore essential that any environmentally responsible institution examine its carbon footprint.

5.6 Carbon footprint

- Establish a system of car pooling among the staff to reduce the number of four wheelers coming to the college.
- Introduce college bus services to the students and staff.
- Encourage students and staff to use cycles.
- Establish a more efficient cooking system to save gas.
- Discourage the students using two wheelers for their commutation.
- More use of generators every day should be discouraged.

Chapter-6

Energy Conservation Tips

6.1 Lighting System

- One of the best energy-saving devices is the light switch. Turn off lights when not required.
- Many automatic devices can help in saving energy used in lighting. Consider employing infrared sensors, motion sensors, automatic timers, dimmers and solar cells wherever applicable, to switch on/off lighting circuits.
- As for as possible use task lighting, which focuses light where it's needed. A reading lamp, for example, lights only reading material rather than the whole room.
- Dirty tube lights and bulbs reflect less light and can absorb 50 percent of the light; dust your tube lights and lamps regularly.
- Fluorescent tube lights and CFLs convert electricity to visible light up to 5 times more efficiently than ordinary bulbs and thus save about 70% of electricity for the same lighting levels.
- Ninety percent of the energy consumed by an ordinary bulb (incandescent lamp) is given off as heat rather than visible light.
- Replace your electricity-guzzling ordinary bulbs (incandescent lamps) with more efficient types. Compact fluorescent lamps (CFLs) use up to 75 percent less electricity than incandescent lamps.
- A 15-watt compact fluorescent bulb produces the same amount of light as a 60-watt incandescent bulb.

6.2 Room Air Conditioners

- Use ceiling or table fan as first line of defence against summer heat. Ceiling fans, for instance, cost about 30 paisa an hour to operate - much less than air conditioners (Rs.10.00 per hour).
- You can reduce air-conditioning energy use by as much as 40 percent by shading your home's windows and walls. Plant trees and shrubs to keep the day's hottest sun off your house.

- One will use 3 to 5 percent less energy for each degree air conditioner is set above22°C (71.5°F), so set the thermostat of room air conditioner at 25°C (77°F) to provide the most comfort at the least cost.
- Using room ceiling or room fans allows you to set the thermostat higher because the air movement will cool the
- A good air conditioner will cool and dehumidify a room in about 30 minutes, so use a timer and leave the unit off for some time.
- Keep doors to air-conditioned rooms closed as often as possible.
- Clean the air-conditioner filter every month. A dirty air filter reduces airflow and may damage the unit. Clean filters enable the unit to cool down quickly and use less energy.
- If room air conditioner is older and needs repair, it's likely to be very inefficient. It may work out cheaper on life cycle costing to buy a new energy-efficient air conditioner.

6.3 PUMPS

- Operate pumping near best efficiency point.

- Modify pumping to minimize throttling.

- Adapt to wide load variation with variable speed drives or sequenced control of smaller units.

- Stop running both pumps -- add an auto-start for an on-line spare or add a booster pump in the problem area.

Use booster pumps for small loads requiring higher pressures.

- Increase fluid temperature differentials to reduce pumping rates.

- Repair seals and packing to minimize water waste.

- Balance the system to minimize flows and reduce pump power requirements

Use siphon effect to advantage: don't waste pumping head with a free-fall (gravity) return