

# **REPORT OF ENVIRONMENTAL/GREEN AND ENERGY AUDIT**

**of**

**Hajee Karutha Rowther Howdia College**

**(Autonomous)**

**Uthamapalayam, Theni District**

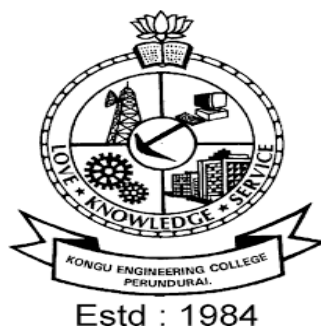
**EXECUTED BY**

**DEPARTMENT OF MECHANICAL ENGINEERING  
&  
ELECTRICAL AND ELECTRONICS ENGINEERING**

**INDUSTRY- INSTITUTE PARTNERSHIP CELL**

**KONGU ENGINEERING COLLEGE**

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## **Acknowledgement**

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<b>1.</b>	<b>EXECUTIVE SUMMARY</b>
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Hajee Karutha Rowther Howdia College, Uthamapalayam had agreed to provide access to Kongu Engineering College to undertake Environmental/Green and Energy Audit related measurements at their campus. This Audit has been conducted by a team of faculty members from Mechanical and Electrical Engineering Department of Kongu Engineering College. As there is no standard model for such an audit, the committee brainstormed and evolved a questionnaire. The data was collected, compiled and was finally analysed by the audit team members. The remaining data which involved measurement using sophisticated instruments were done by the audit team members. By and large, the audit reveals a healthy environment in the campus. The committee has made short term and long-term suggestions to protect environment at higher levels and it is hoped that this will receive due attention of authorities and all stakeholders of the College.

<b>2.</b>	<b>OBJECTIVES OF THE AUDIT STUDY</b>
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The goals of the present environmental/green and energy audits typically include:

- To recognize, diagnose and resolve the environmental problems.
- To recognize the effects of an organization on the environment and vice versa.
- To identify and control the impact of activities of organizations on environment.
- To suggest the best protocols for sustainable development of organization and environment.
- To assess environmental performance and the effectiveness of the measures to achieve the defined objectives and targets.
- To identify the different pressures on organization to improve their environmental performance.
- To ensure that the natural resources are utilized properly as per national policy of environment.
- To establish the parameters for maintaining health and welfare of the community of the organization.

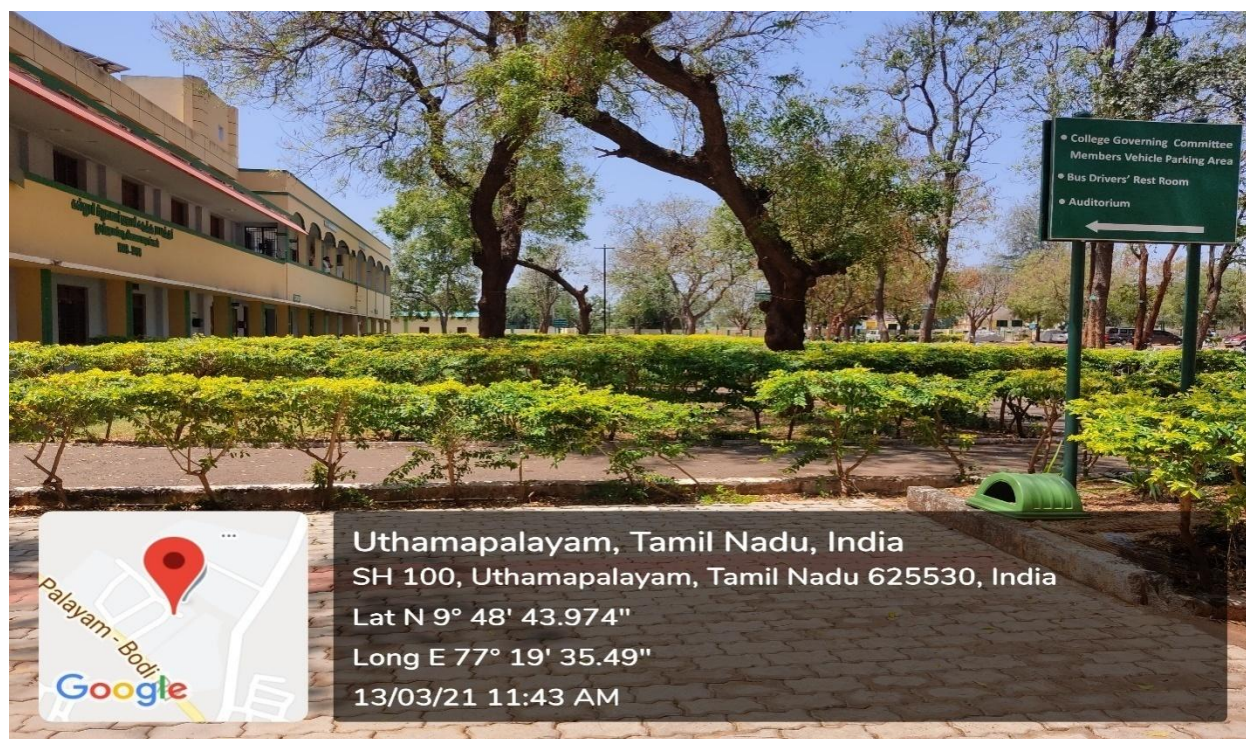
- To set the procedure for disposal of all types of harmful wastes.
- To reduce energy consumption.
- To give preference to the most energy efficient and environmentally sound appliances.
- To minimize the consumption of water and monitor its quality.
- To identify the risks of hazards and implement the policies for safety of stakeholders.
- To facilitate the stakeholders with different aspects of disaster management.
- To train all stakeholders of the organization and empower them to contribute and participate in the environmental protection.

To achieve the mentioned objectives, following stages are implemented. It includes three stages viz. pre-audit stage, audit stage and post-audit stage. Each of these stages comprises a number of clearly defined objectives, with each objective to be achieved through specific actions and these actions yielding results in the form of outputs at the end of each stage.

<b>3.</b>	<b>INTRODUCTION TO ENVIRONMENTAL/GREEN AUDIT</b>
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The various activities carried out in the academic institutions affects the environment in which it is situated. To address the issues, the institutions can successfully use auditing strategies to monitor their environmental-energy related activities. An "environmental audit" is a "systematic, documented, periodic and objective review to meet environmental requirements". Although environmental audits may be performed in many ways for different purposes, the reasons for performing an audit and the goals to be achieved will determine the type of environmental audit to be performed. Green audit is the tool of management system used methodologically for protection and conservation of the environment. It is also used for the sustenance of the environment. The audit suggests different standard parameters, methods and projects for environmental protection. The green audit is useful to detect and monitor sources of environment pollution and it emphasizes on management of all types of wastes, monitoring of energy consumption, monitoring of quality and quantity of water, monitoring of hazards, safety of stakeholders and even the management of disasters.

Hajee Karutha Rowther Howdia College, the first higher educational institution in Cumbum valley is an outcome of founder's passion towards the upliftment of the agricultural families of his native area. The strength of the students and staffs are 2578 and 215, respectively. Taking the green related concepts into consideration the college is committed to protect and to promote greenery in its campus. To maintain its green aim active, the college implements the traditional and scientific methods besides enforcing the legislations lay down by the government. Green Awareness programmes are conducted periodically in the campus for the staffs and students to keep the campus green forever thereby enhancing the beauty of Cumbum valley. Hajee Karutha Rowther Howdia College is making continuous efforts to protect, raise awareness and improve the environment on and off its campus. The inclusion of the Environmental Studies as a compulsory subject in the curriculum reflects the concern of the college for the protection and development of the environment. Government and legal procedures related to this are implemented periodically. The college is moving towards complete purity. The level of CO<sub>2</sub> can be reduced by growing more trees. A total of 388 matured trees are found inside the campus.



**Fig.1: Green campus**



### 3.1 WATER MANAGEMENT

The six bore-wells inside the campus cater the total requirement of the college through water tanks of different capacities. The College has a RO plant of 6000 litres capacity which generates 12,000 litres of waste (grey) water and reused for gardening purposes. Recharging of ground water and rainwater harvesting are implemented by the college thereby conserving the water from its inception and practice vigorously. These technologies, where surface runoff is effectively collected during yielding rain periods. It has been very helpful to augment the ground water. The college does not depend upon or buy public water supply from outside the campus. The overflow of water from the tank is directed to the garden area. Students and faculty members of the institution are oriented by different programmes about water conservation. 5 number of pumps (1 no. of 7.5 HP, 1 no. of 5 HP, 3 nos. of 15 HP ) are used for pumping water in the college and hostel . The total running hours of the pump is approximately 10 hours.

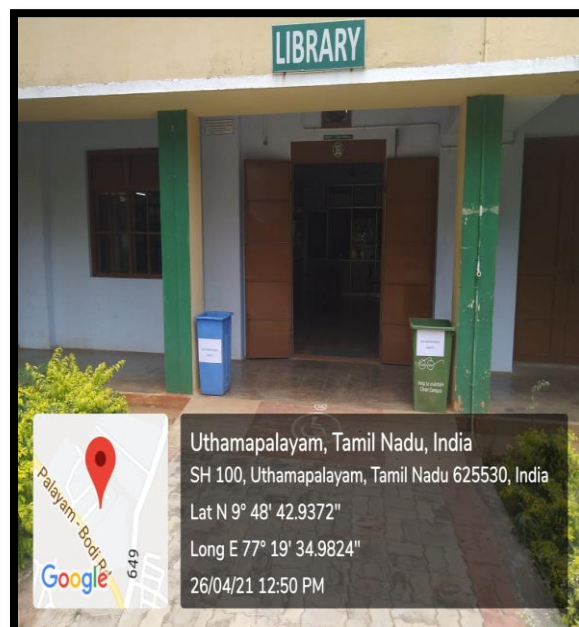


**Fig.2: Reverse Osmosis (RO) Plant**

### 3.2 SOLID WASTE MANAGEMENT

The campus is cleaned on daily basis. Waste bins are placed in corridors, office and staff rooms. The waste generated in the campus includes wrappers, glass, metals, paper, etc. Old newspapers, used papers and journal files, workshop scrap etc. are given for recycling to external agencies. Glass, metals and other non-biodegradable wastes are given to external agencies where they are

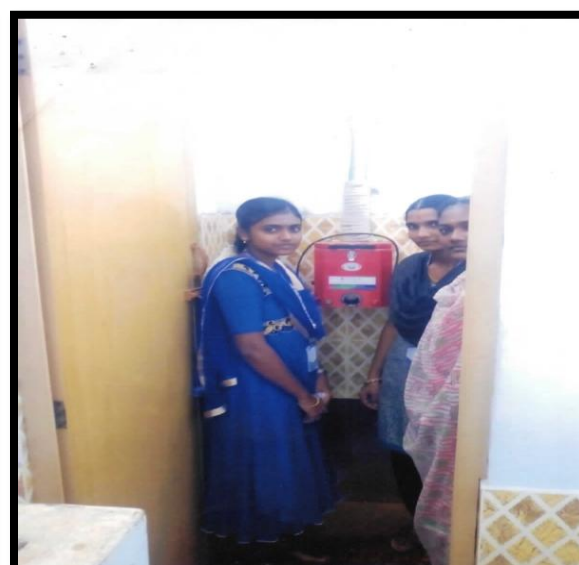
segregated and disposed/ recycled according to the nature of the waste. Non-biodegradable and plastic wastes are disposed by municipal collection centre. Leaf litter is allowed to decompose systematically over a period of time and used as manure for the gardens in the institute. Sanitary Napkin Incinerators have been installed in the girls' hostels to facilitate disposal of sanitary napkins in an environment-friendly way. A 1m<sup>3</sup> biogas plant is functioning in the campus for producing biogas using the food waste.



**Fig.3: Green and blue colour wastebins to segregate degradable and non-biodegradable wastes**



**Fig.4: Garbage pit**



**Fig.5: Sanitary Napkin Incinerator**





**Fig.6: Floating type Biogas plant**

### **3.3 LIQUID WASTE MANAGEMENT**

Sewage, Laboratory, hostel and canteen effluent waste are the major liquid waste. Effective drainage system is found in all buildings for managing sewages. The laboratory waste water does not contain hazardous chemicals and periodical monitoring is done by the maintenance team. The college will be strict on the source reduction of chemical waste. Laboratories are purchasing smallest quantities of chemicals for particular purposes and share surplus chemicals with other laboratories inside the campus. Laboratories have shifted the experiments from macro-scale to micro-scale in order to reduce the chemical waste.

### **3.4 E WASTE MANAGEMENT**

Electronic goods are put to optimum use; the minor repairs are set right by the Laboratory assistants and teaching staff; and the major repairs are handled by the Technical Assistant and are reused. The College has entered into MoU with **Tritech Systems, Porur, Chennai**, which buys the damaged computers and other non-reparable e-waste and issues a Recycling certificate. UPS Batteries are recharged / repaired / exchanged by the suppliers. The waste compact discs and other disposable non-hazardous items are used by students for decoration during college fests as a creative means of showcasing the waste management practice that has been induced in the minds of the students.

<b>4.</b>	<b>INDOOR AIRQUALITY</b>
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Indoor air quality (IAQ) refers to the quality of the air inside buildings as represented by concentrations of pollutants and thermal (temperature and relative humidity) conditions that affect the health and performance of occupants. It has become one of the most important issues of environment and health worldwide considering the principle of human rights to health that everyone has the right to breathe healthy indoor air. With the help of Indoor Air Quality meter (Extech EA80), CO<sub>2</sub> level, relative humidity, dry bulb and wet bulb temperatures can be measured. The measurements are carried out based on the protocol given by Central Pollution Control Board, Ministry of Environment and Forests, Govt. of India and the norms are discussed briefly in the subsequent sections. Indoor air quality test was carried out at different locations of the institution. Carbondioxide levels are within the ASHRAE 55-1992 limit in the outdoor and indoor.

The wind speed was measured at three locations as mentioned below.

S.No	Location	Anemometer Reading (m/s)
1	SF Block- Computer lab (M.Com)	6.9
2	SF Block- Computer lab (IT)	3.3
3	Main Block- Photocopy room	2.8

The instrument used in the present audit was Extech Make EA80 Model of Indoor air quality meter. The range of the instrument is given below

- CO<sub>2</sub> range : 0 to 6,000ppm
- Temperature range : -4 to 140°F (-20 to 60°C)
- Humidity range : 10 to 95%RH



**Fig.7: Indoor air quality meter**

#### **4.1 AIR QUALITY MEASUREMENTS**

<b>Standard Level of CO<sub>2</sub></b>	<b>ASHRAE and OSHA standards: 1000 ppm</b>
<b>Standard Level of Relative Humidity</b>	<b>30 – 60 % (ASHRAE)</b>
<b>Standard Level of Temperature</b>	<b>26 - 30°C <math>\pm</math>3°C (ASHRAE)</b>

S.No	Location	CO <sub>2</sub> (ppm)	Relative Humidity (%)	Temperature (°C)		Comments & Recommendation
				Wet	Dry	
Main Block						
1.	IQAC Block	540	44.9	22.6	30.4	Within the limits
2.	Veranda	520	57.9	23.5	30.4	Within the limits
3.	Office	534	50.3	23.7	31.7	Within the limits
4.	Book Depot	496	52	23.2	30.7	Within the limits
5.	Photocopy room	705	42.2	19.4	27.9	Within the limits
1 <sup>st</sup> Floor						
6.	I floor- Veranda	517	52.5	23.1	30.5	Within the limits
7.	Physics Dept-Staff	487	53.5	22.7	30.0	Within the limits

	room					
8.	Tamil Dept-Staff room	459	53.2	22.8	30.0	Within the limits
9.	Class room	555	53.5	22.9	29.9	Within the limits
2 <sup>nd</sup> Floor						
10.	II Floor- Veranda	640	54.6	23.4	30.4	Within the limits
11.	English Dept-Staff room	704	53.9	23.4	30.4	Within the limits
12.	English Language lab	635	61.4	24.6	30.3	Within the limits
13.	Library	552	52.8	22.8	30.1	Within the limits
14.	Class room – Maths	514	54.0	22.8	29.8	Within the limits
Science Block – Ground Floor						
15.	Botany Lab-UG	509	53.8	23.1	30.2	Within the limits
16.	Chemistry Dept Staff room	592	55.9	22.9	29.5	Within the limits
17.	Chemistry Lab	496	55.9	22.8	29.3	Within the limits
18.	Research lab- Chemistry	498	56.4	22.9	29.2	Within the limits
19.	Veranda	486	55.2	23.8	30.6	Within the limits
Science Block – 1 <sup>st</sup> Floor						
20.	Veranda	694	54.5	23.2	30	Within the limits
21.	Physics lab-UG	645	54.9	23.2	30	Within the limits
22.	Physics lab-PG	594	55.1	23.2	30	Within the limits
23.	Research lab	560	54.3	22.8	29.8	Within the limits
Science Block – 2 <sup>nd</sup> Floor						
24.	Computer science –	483	54.4	22.7	29.5	Within the limits

	Staff room					
25.	CS-Class room	497	54.3	22.8	29.7	Within the limits
26.	Zoology Dept- Staff room	476	54.9	23	29.8	Within the limits
27.	Zoology lab	609	53.5	23.3	30.4	Within the limits
28.	I B.Sc. Class room	576	53.8	23.4	30.6	Within the limits
29.	II B.Sc. Class room	490	52.9	23.1	30.4	Within the limits
SF Block- Ground Floor						
30	Entrance	555	49.7	24.6	32.7	Within the limits
31	Biochemistry Lab	476	51.1	24.2	31.8	Within the limits
32	Seminar hall 2	468	52.2	23.3	30.8	Within the limits
33	II M Com- Class room	586	52.4	23.5	30.8	Within the limits
SF Block- 1 <sup>st</sup> Floor						
34	M.Com- Staff room	496	52.3	23	30.3	Within the limits
35	Class room	496	52.1	23	30.3	Within the limits
36	Veranda	495	51.4	23.1	31	Within the limits
SF Block- 2 <sup>nd</sup> Floor						
37	Veranda	470	52.6	24.1	31.5	Within the limits
38	Commerce Dept. Staff room	580	40.3	20.2	29.9	Within the limits
39	IT Lab	840	47	19.1	26.7	Within the limits
40	I M.Sc. Class room	530	52.6	23.7	30.4	Within the limits
Golden Jubilee Block- Ground Floor						
41	Veranda	484	48.4	23.5	32.1	Within the limits
42	Class room- 1 <sup>st</sup>	478	49.6	24	32.2	Within the limits



	History					
43	History Dept. Staff room	459	50.6	23	30.7	Within the limits
Golden Jubilee Block- 1 <sup>st</sup> Floor						
44	Veranda	498	51.9	23.1	30.2	Within the limits
45	Arabic Dept. Staff room	452	52.4	23.2	30.5	Within the limits
46	CA-Dept. Staff room	430	52.8	23.3	30.7	Within the limits
Golden Jubilee Block- 2 <sup>nd</sup> Floor						
47	Banking Dept. Staff room	470	53.5	23.3	30.4	Within the limits
48	Class room- Banking	466	54.1	23.3	30.4	Within the limits
49	BBA Dept. Staff room	431	52.5	23.4	30.7	Within the limits
PG Building- Ground Floor						
50	Veranda	531	51.8	23.6	31.2	Within the limits
51	Class room	468	52.5	23.5	30.9	Within the limits
52	Microbiology- Staff room	540	53.1	23.2	30.3	Within the limits
PG Building- 1 <sup>st</sup> Floor						
53	Biochemistry- Staff room	484	52.7	24	31.6	Within the limits
54	Biochemistry- Class room	453	51.2	23.6	31.3	Within the limits
55	CERD Tailoring	416	52.2	23.8	31.5	Within the limits
Indoor Stadium						
56	Ground floor	534	49.6	23.2	31.1	Within the limits
57	Indoor stadium	575	50.6	23.1	30.9	Within the limits

MP Building						
58	Medical Centre	534	49.1	24.1	32.4	Within the limits
59	E-Service centre	520	49.4	23.7	32.1	Within the limits
60	Library- Entrance	443	51.6	23.7	31.5	Within the limits
61	Library- Digital section	468	53.5	24.2	31.6	Within the limits
62	Library-Stack room	457	51.8	23.6	31.3	Within the limits
63	CoE Office	840	53.6	24.5	31.7	Within the limits

## 4.2 OCCUPANT DISCOMFORTNESS

Discomfort can be caused to the occupants due to

- Inadequate ventilation
- High temperature and humidity levels
- High levels of CO<sub>2</sub>

Ventilation should be distributed effectively in spaces, and stagnant air zones should be avoided. ASHRAE recommends relative humidity levels between 30 and 60 percent for optimum comfort. Higher humidity may result in microbial growth. A consistently implemented good-housekeeping plan is essential to eliminate or reduce the microbial growth in the building.

Damp indoor environments have been associated with many serious health effects, including asthma, hypersensitivity, and sinusitis. Moisture incursion leading to dampness can result from water leaks and/or by condensation due to high humidity. Common sources of moisture in buildings include: plumbing; roof and window leaks; flooding; condensation on cold surfaces, e.g., pipe sweating; poorly-maintained drain pans; and wet foundations due to landscaping or gutters that direct water into or under the building. Water vapor from unvented or poorly-vented kitchens, showers, combustion appliances, or steam pipes can also create conditions that promote microbial growth. Well-designed, well-constructed and well-maintained building envelopes are critical to the prevention and control of excess moisture and microbial growth by avoiding thermal bridges and preventing intrusion by liquid or

vapor-phase water. Management of moisture requires proper control of temperatures and ventilation to avoid high humidity, condensation on surfaces, and excess moisture in materials.

CO<sub>2</sub> is a colourless, odourless, and tasteless gas. It is a product of completed carbon combustion and the by-product of biological respiration. ASHRAE states that CO<sub>2</sub> concentrations in acceptable outdoor air typically range from 300-500 ppm. Adverse health effects from CO<sub>2</sub> may occur since it is an asphyxiate gas. The CO<sub>2</sub> levels can be used as a rough indicator of the effectiveness of ventilation, and excessive population density in a structure. CO<sub>2</sub> increases in buildings with higher occupant densities, and is diluted and removed from buildings based on outdoor air ventilation rates. Therefore, examining levels of CO<sub>2</sub> in indoor air can reveal information regarding occupant densities and outdoor air ventilation rates. High CO<sub>2</sub> levels may indicate a problem with overcrowding or inadequate outdoor air ventilation rates. CO<sub>2</sub>, a by-product of normal cell function, is removed from the body via the lungs in the exhaled air. Exposure to high levels of CO<sub>2</sub> can increase the amount of this gas in the blood, which is referred to as *hypercapnia* or *hypercarbia*. As the severity of hypercapnia increases, more symptoms ranging from headache to unconsciousness appear, and it can also lead to death.

The traditional means of dealing with IAQ is through ventilation with outdoor air, but this approach assumes that the outdoor air is cleaner than the indoor air. In many locations and for many contaminants, this is not the case, and insufficiently treated ventilation air can actually make IAQ worse. Poor outdoor air quality includes regionally elevated outdoor contaminant levels, as well as local sources such as motor vehicle exhaust from nearby roadways and contaminants generated by activities in adjacent buildings. Some green building programs recommend across-the-board increases in ventilation rates, but such recommendations may be counterproductive in areas with poor outdoor air quality unless accompanied by appropriate and effective increases in filtration and air cleaning.

### **4.3 INFERENCE**

- Carbon-di-oxide levels are within the ASHRAE 55-1992 limit in the outdoor and indoor. For indoor condition, CO<sub>2</sub> level should be less than 1000 ppm. CO<sub>2</sub> levels are well within the limits in all places.

- In Computer Centres, the temperature settings of the air conditioners may be adjusted according to the student's occupancy. This will bring better comfort inside the room.
- ASHRAE recommends relative humidity levels between 30 and 60 percent for optimum comfort. The humidity is within the limit in most of the places. The buildings are well planned and natural circulation of air is felt in all places. Even classrooms filled with 60 students have good range of humidity.
- During the occupancy, the windows may be kept open and natural circulation of air may bring the humidity level below 70%.
- The average ambient temperature in the campus is found to be 30°C.
- Tree plantation is highly promoted and it is evidenced through maintenance activities like display of scientific and vernacular names of trees.
- Awareness programmes on environmental consciousness are organized and it is evidenced through the activities of Eco Club.

## **5.**

### **INTRODUCTION TO ENERGY AUDIT**

An energy audit is an examination of the total energy used in a particular building or industry. The analysis is designed to provide a relatively quick and simple method of determining not only how much energy is being consumed but where and when. The energy audit will identify deficiencies in operating procedures and in physical facilities. Once these deficiencies have been identified, it will be apparent where to concentrate efforts in order to save energy. The energy audit is the beginning of and the basis for an effective energy-management programme. Human settlements encompass a variety of buildings. Regardless of the building involved, the audit procedure is basically the same. No two buildings are identical regarding energy usage. This is due to the possible variables affecting the buildings, e.g., occupancy rates, the building's size and orientation, its geographic location, the type of heating and cooling systems, the amount and types of equipment in use, the type of construction, the level of insulation and so on. Because each building is unique, it is difficult to generalize about energy-consumption patterns, and so it is necessary to conduct an energy audit for each building. Most buildings were probably designed, built and equipped when cheap energy was readily available. Little attention was paid

to energy efficiency. Consequently, there is a great potential for improving operating costs of existing buildings.

## **6. LIQUID AND GASEOUS FUEL CONSUMPTION**

LPG cylinders are used in the laboratories, girls' hostel and canteen. Diesel and Petrol are being used for vehicles and generator. The number of bikes and cars used per day are 250 and 20 respectively. There are 11 number of college buses. The annual usage of LPG is approximately 3064 kg (6005 lit).

S.No	Purpose	Fuel	Usage in Nos.	Capacity/Specification	Usage period
1.	Laboratories	LPG	7	14.2kg	1 year
2.	Girls Hostel	LPG	3	19 kg	1 month
3.	Canteen	LPG	10	19 kg	1 month
4.	Generator	Diesel	35 lit for 9 hrs	30K – 4KFWN105, Kirloskar	1 month
5.	College Vehicles	Petrol and diesel	20000 lit		1 year

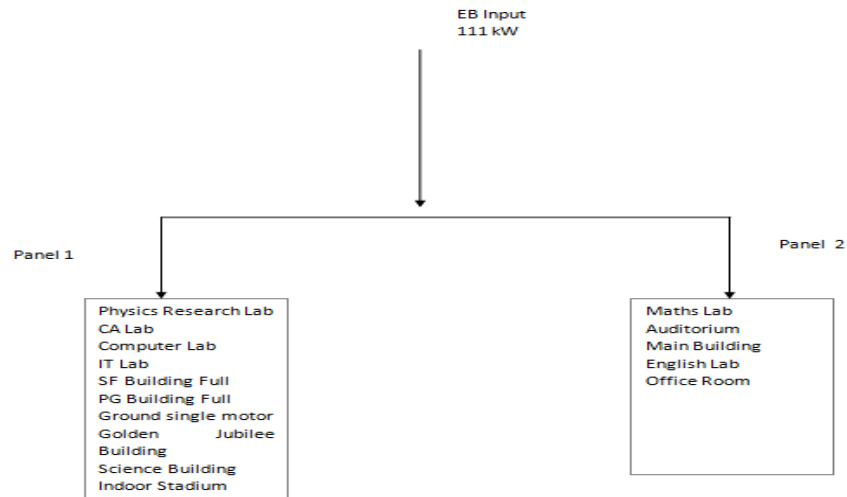
## **7. ACTUAL MEASUREMENTS IN ELECTRICAL SYSTEM**

The electrical energy consumption was verified using electricity bills. The consumption was 6117kwhfor the last assessment period. The measurements of electrical parameters were undertaken using Fluke 435Power Quality Analyzer at the plant PCC. The following relevant electrical parameters were recorded by the above instrument with the set recording sample time of 30sec interval. In addition, additional measurements were undertaken at the downstream feeders having significant Power Quality issues. The parameters monitored are:

<ul style="list-style-type: none"> <li>➤ 3 phase average line or phase voltages</li> <li>➤ 3 phase average line currents</li> <li>➤ 3 phase average fundamental line or phase voltages</li> <li>➤ 3 phase average fundamental line currents</li> <li>➤ Frequency</li> <li>➤ Total 3- phase active power in kW - in case of four wire output, the total three phase power alone is monitored</li> </ul>	<ul style="list-style-type: none"> <li>➤ Total 3 phase reactive power in kVAR - in case of four wire output, the total three phase power alone is monitored</li> <li>➤ Total 3 phase apparent power in kVA - in case of four wire output, the total three phase power alone is monitored</li> <li>➤ Total average Power factor</li> <li>➤ Percentage 3 phase voltage THD</li> <li>➤ Percentage 3 phase current THD</li> </ul>
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The summary details of the above measurements are provided in appendix. The college has sanctioned demand of 111kW. The college having the diesel operated gen-set with capacity of 30kVA (24kW) for providing power supply in case of power failure. The college has renewable energy-based power generation plant in their premises. The installed Capacity of Solar Power Plant is 17 kW. The solar panel on grid solar capacity is 12 kW and the solar capacity with UPS is 5 kW. The typical power distribution diagram is shown below.



**Fig.8: Power Distribution Diagram**



**Fig.9: Solar Power Plant**

Apart for Solar PV, the college also has 2 wind turbines of 2.5 kW each. The wind power generated will be stored into battery. The battery rating used to store the power is 20 numbers with 12V, 100Ah battery.



**Fig.10: Battery System**



**Fig.11: Lattice tower Horizontal axis Wind turbine**

<b>8.</b>	<b>ANNUAL ENERGY CONSUMPTION AND CO<sub>2</sub> EMISSION</b>
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S.No.	Description	Type of fuel and their conversion process		
		Electrical energy consumed	Diesel	LPG
1	Annual Energy Consumption	52302 kWh	20420 lit	6005 lit
2	CO <sub>2</sub> Emission (tonne/Annum)	49.6	54.7	9.06
	CO <sub>2</sub> Emission standards	0.95 kg/kWh	2.68 kg/lit	1.51 kg/lit
3	Total CO <sub>2</sub> emission	113 t		
4	Total No. of students and staff	2793		
5	Per capita CO <sub>2</sub> emission	0.040 t (+)		
6	Energy from solar PV(51 kWh/day for PV and 1 kWh/day for wind for 300 days)	15600kWh		
7	CO <sub>2</sub> neutralised due to Renewables	14.82 t (-)		
8	No. of Matured Trees (1 tree absorbs 22 kg CO <sub>2</sub> /year)	388		
9	CO <sub>2</sub> neutralised due to trees	8.5 t (-)		
10	Per Capita CO <sub>2</sub> Emission to be Neutralized	0.032 t		

<b>9.</b>	<b>BEST PRACTICES</b>
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- The College has given importance to carbon neutralization by installing two wind turbines and solar PV for generating power.
- The energy is also conserved by using natural light in the classrooms. Fixation of sensor lights in the campus is under processing.
- LED bulbs and CFLs are being used in all possible locations as an energy conservation measure.
- Green transport is often practiced as an active transport system which encourages students to walk or cycle in the campus. The College has made arrangements for the parking of the vehicles of the students and staff near the entrance. With this active

transport practice, the use of private vehicles on campus is reduced and thus can be a strategy to reduce traffic congestion and pollution in campus.

- Training programmes conducted on Energy Conservation, Environment Impacts and Fuel Savings for i) Students, Staffs and Faculty Members (for the specified period) by any external agencies
- The college has been maintaining seventeen rain water recharging pits. Buildings in the college are linked to a rain water storage grid with varying capacities. These rainwater recharging systems help to recharge the ground water and thus the campus gets ample increase in the amount of ground water.
- The college herbal garden was setup in an area of 4000 square feet of land where medicinal and nourishment plants are cultivated. The college has four lawns and several hedges, as well as a variety of vegetation, which adds beauty and aesthetics to the campus. A gardener is assigned to guide irrigation, weeding, and manure application.
- Drip irrigation is used as an attempt to keep the hedges and landscaping in excellent condition. In order to maintain gardens and lawns 30 sprinklers have been installed. All of them have been in working conditions.

<b>10.</b>	<b>RECOMMENDATIONS FOR ENERGY SAVINGS AND SUSTAINABILITY</b>
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1. All Class Rooms and labs to have Display Messages regarding optimum use of electrical appliances in the room like, lights, fans, computers and projectors.
2. All computers to have power saving settings to turn off monitors and hard discs, say after 10minutes/30 minutes.
3. The comfort air conditioning temperature to be set between 24°C to 26°C.
4. Lights in toilet area may be kept OFF during day time.
5. Energy and water saving slogans, awareness stickers may be pasted in appropriate places.
6. Policies and procedures for handling, storage and disposal of chemicals and all types of wastes may be formulated and the same can be circulated throughout the college after getting approval from the management committee.

7. Forming of small committees to track and monitor the work of different processes relevant to energy and environment.
8. Periodic maintenance should be done for all electrical related equipment/systems.
9. The power room has to be maintained neatly. For safety purpose, insulation mats have to be placed in power room.



**Fig.12: Power room**

10. The college has APFC with installed capacity of 63 kVAR with different ratings. From the measurements, it has been observed that the power factor is nearly 0.98.
11. The periodic maintenance of solar panel has to be carried out. The maintenance will increase the power production capability.



**Fig.13:Solar PV**

12. For electrical maintenance department, a separate technician with electrical background can be preferred.
13. EB readings, Solar power, Wind power production or consumption has to be entered in separate register and maintained properly and have to be reviewed by some faculty in-charge.
14. The periodic maintenance may be carried out on UPS batteries and it may be recorded in maintenance chart.

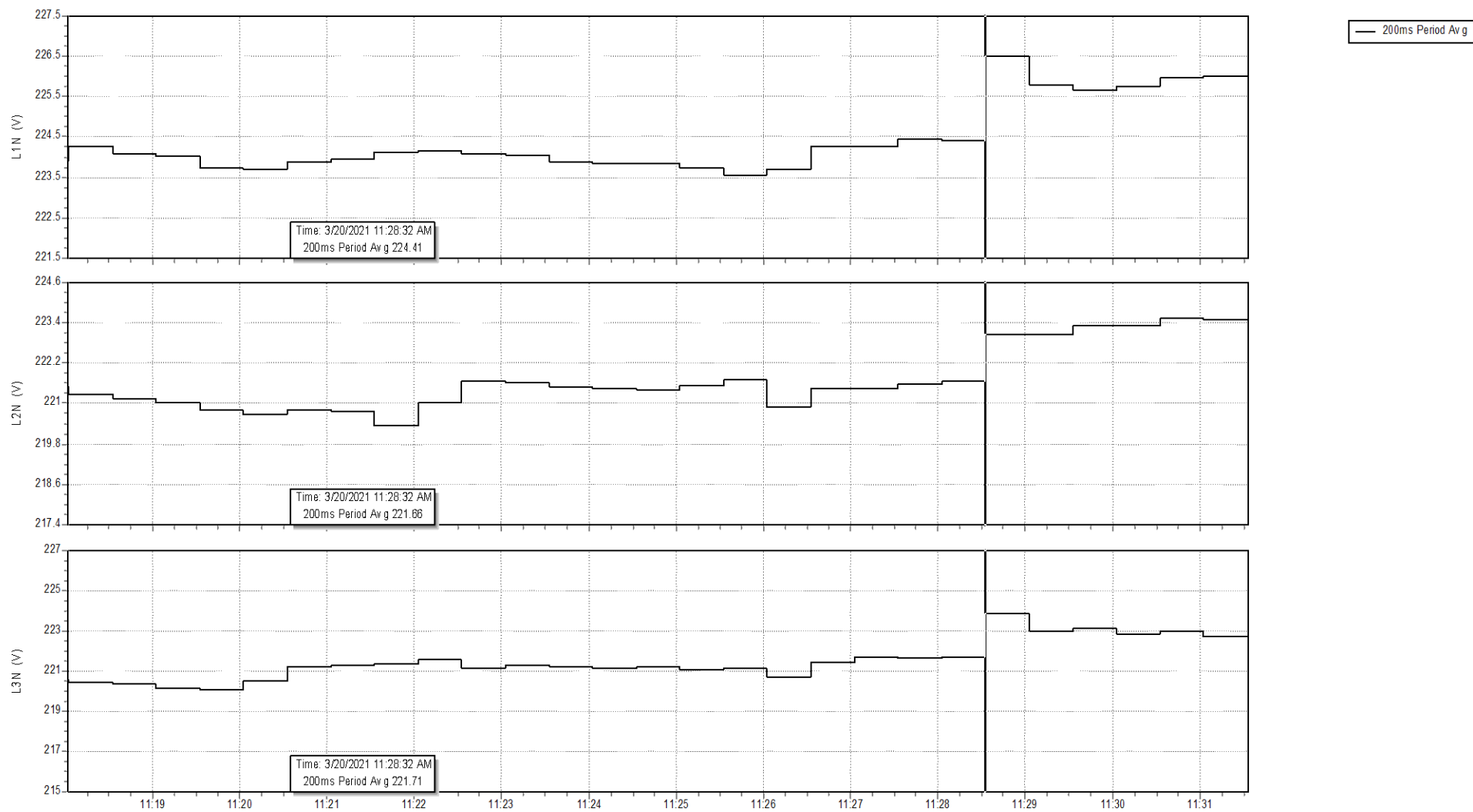


## APPENDIX A-SUMMARY SHEET OF EB INPUT

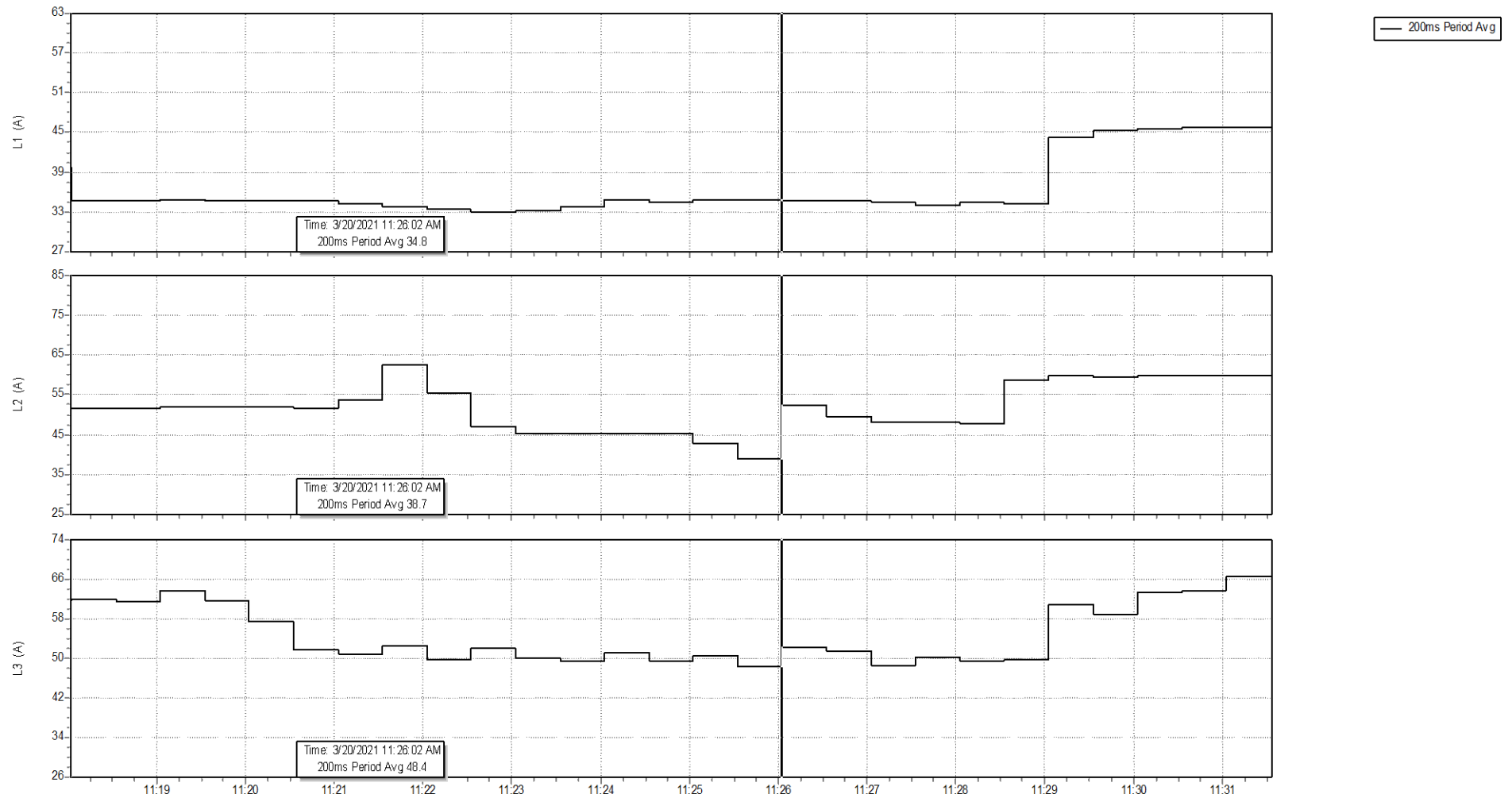
### BASIC ELECTRICAL PARAMETERS

Phase Voltage (L1,L2,L3) Avg V	Line Current (L1,L2,L3) Avg A	Phase Voltage (L1,L2,L3) Fundamental Avg V	Line Current (L1,L2,L3) Fundamental Avg A	%-age Voltage Unbalance	%-age Current Unbalance	Frequency In Hz	Active Power Total Avg in kW	Reactive Power Total Avg in kVAR	Apparent Power Total Avg in kVA	DPF	TPF	THD V Avg % age	THD A Avg % age
221.98	51.10	221.93	50.67	0.46	15.32	49.96	33.19	4.72	33.59	0.99	0.98	1.59	12.93
222.00	49.43	221.97	48.93	0.53	18.97	49.95	32.16	4.43	32.53	0.99	0.98	1.58	13.26
221.86	49.27	221.83	48.80	0.52	18.87	49.95	32.03	4.41	32.40	0.99	0.98	1.58	13.15
221.73	50.20	221.70	49.73	0.52	19.44	49.93	32.64	4.40	33.01	0.99	0.98	1.60	13.25
221.53	49.43	221.50	48.93	0.51	18.97	49.92	32.11	4.36	32.48	0.99	0.98	1.58	13.18
221.64	48.00	221.57	47.53	0.49	17.31	49.92	31.19	3.92	31.48	0.99	0.98	1.61	13.52
221.96	46.00	221.97	45.53	0.48	15.34	49.94	29.96	3.57	30.23	0.99	0.98	1.61	14.09
222.00	46.33	221.93	45.80	0.50	16.47	49.94	30.16	3.63	30.43	0.99	0.98	1.60	14.05
221.95	49.73	221.93	49.33	0.60	21.02	49.95	32.44	3.84	32.72	0.99	0.98	1.61	13.26
222.25	46.13	222.20	45.67	0.51	18.03	49.95	29.95	3.41	30.19	0.99	0.98	1.55	12.96
222.30	44.00	222.30	43.33	0.45	15.82	49.96	28.36	4.11	28.79	0.99	0.97	1.64	15.60
222.32	42.80	222.30	42.20	0.42	13.68	49.97	27.83	3.69	28.12	0.99	0.98	1.62	15.41
222.21	42.83	222.17	42.20	0.40	12.86	49.98	27.83	3.63	28.11	0.99	0.98	1.63	15.70
222.14	43.77	222.13	43.07	0.40	12.50	49.97	28.43	3.63	28.71	0.99	0.98	1.66	16.32
222.15	43.10	222.13	42.47	0.41	12.67	49.97	27.97	3.68	28.27	0.99	0.98	1.64	16.29
222.12	42.70	222.07	42.20	0.36	11.44	49.97	27.81	3.03	28.03	0.99	0.98	1.62	15.32
222.13	40.63	222.10	40.27	0.34	9.21	49.98	26.73	2.08	26.81	1.00	0.99	1.50	12.68
221.78	46.37	221.73	45.33	0.53	18.39	49.99	29.39	5.21	30.08	0.98	0.96	1.75	18.51
222.39	45.13	222.33	44.40	0.47	15.43	49.99	29.16	4.40	29.59	0.99	0.97	1.73	17.59
222.47	43.70	222.43	43.13	0.45	13.89	49.99	28.40	3.81	28.72	0.99	0.97	1.66	16.13
222.54	44.07	222.50	43.47	0.45	14.11	49.99	28.68	3.81	28.99	0.99	0.98	1.67	16.10
222.59	43.87	222.50	43.27	0.44	13.67	50.00	28.52	3.73	28.83	0.99	0.98	1.66	16.08
224.48	47.53	224.40	46.87	0.54	18.88	50.00	31.17	4.29	31.53	0.99	0.98	1.67	15.33
223.95	54.97	223.93	54.47	0.48	12.97	49.99	36.01	5.56	36.49	0.99	0.98	1.64	13.18
224.04	54.60	224.00	54.00	0.46	11.70	49.96	35.79	5.72	36.29	0.99	0.98	1.61	13.04
223.98	56.23	223.93	55.67	0.49	12.31	49.97	36.89	5.84	37.39	0.99	0.98	1.64	12.92

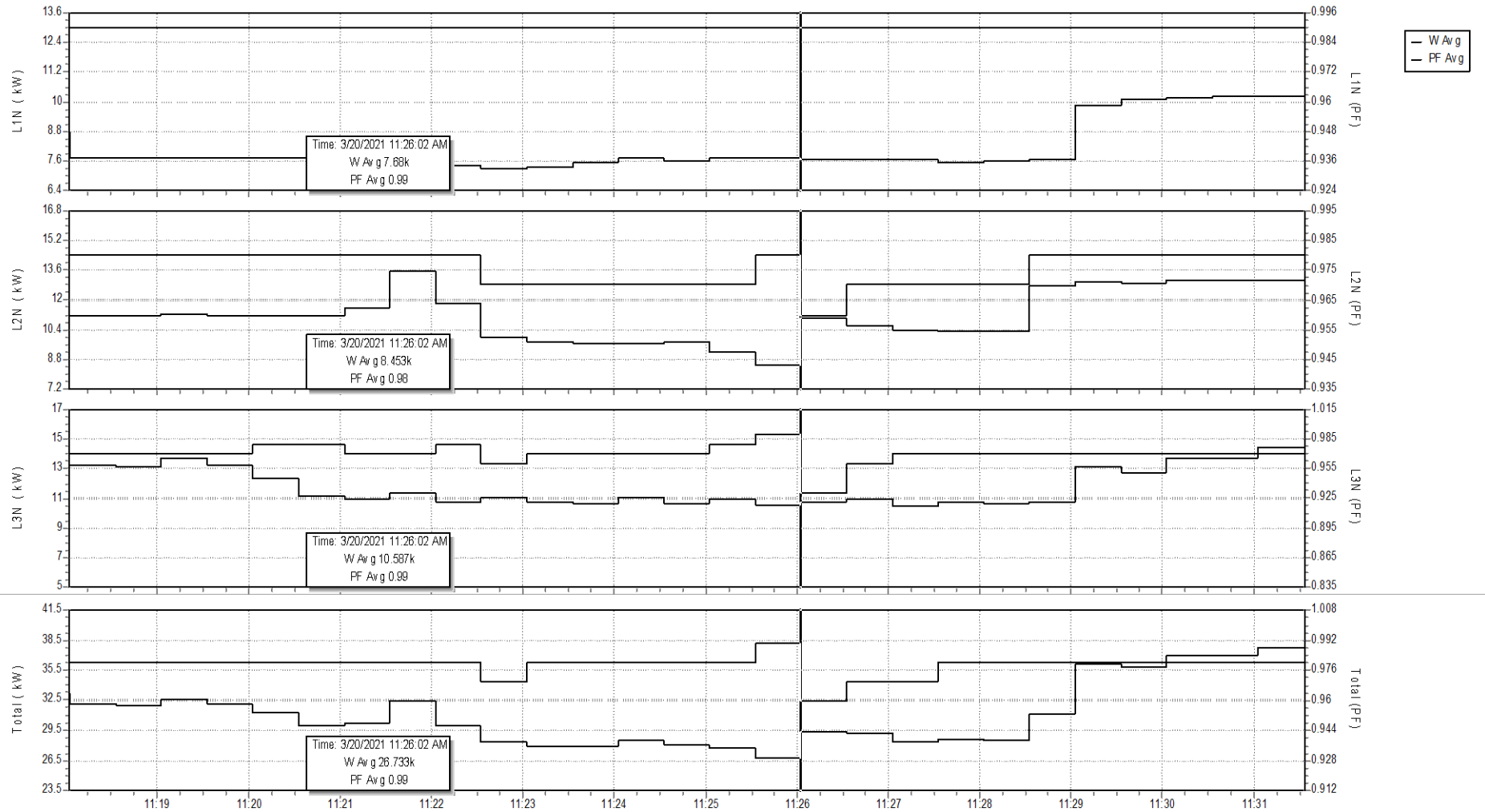
## APPENDIX B-TREND CURVES FOR VARIOUS PARAMETERS ( VOLTAGE CURVE )



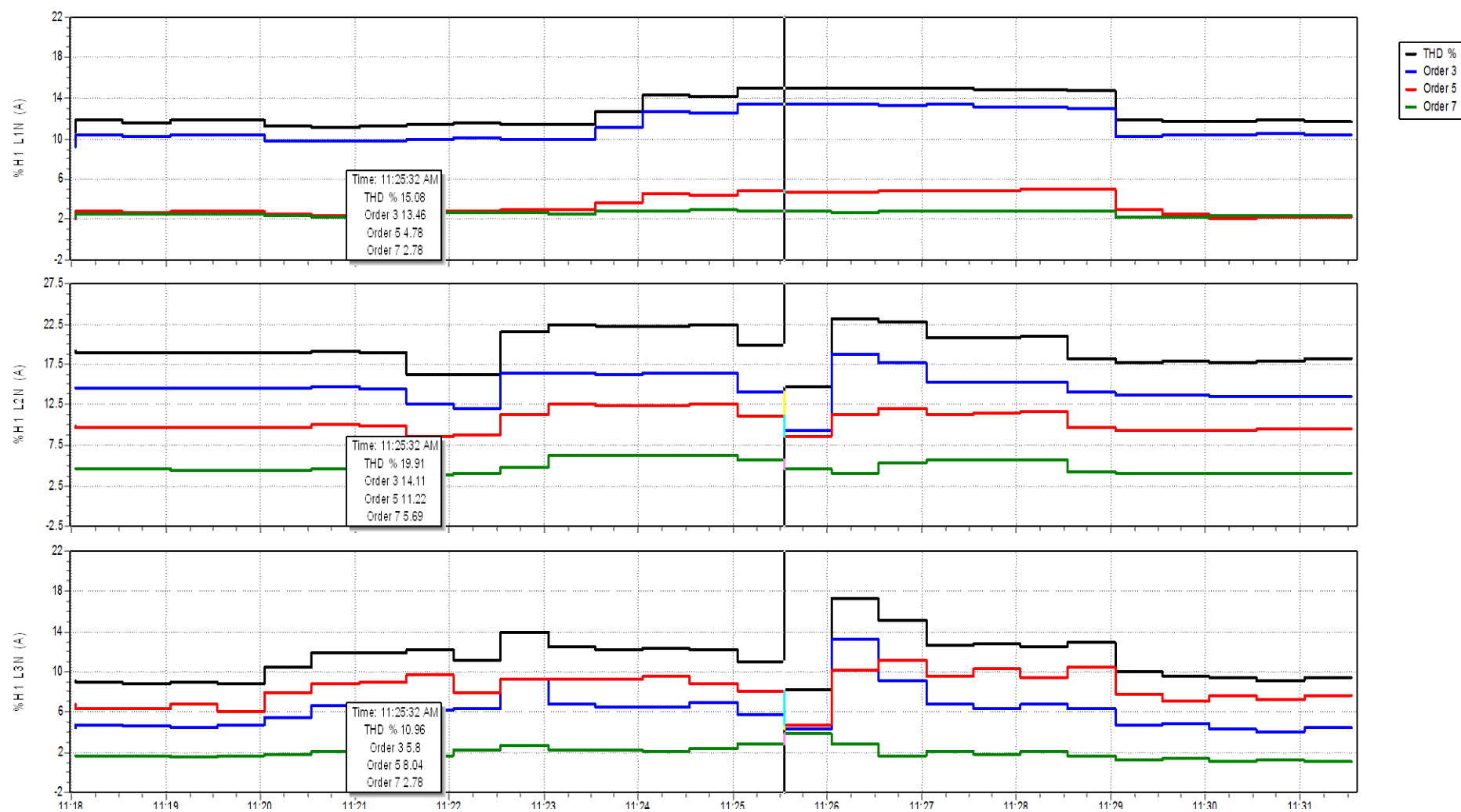
## APPENDIX C-CURRENT CURVE



## APPENDIX D -POWER AND POWER FACTOR



## APPENDIX E - CURRENT HARMONICS CURVE



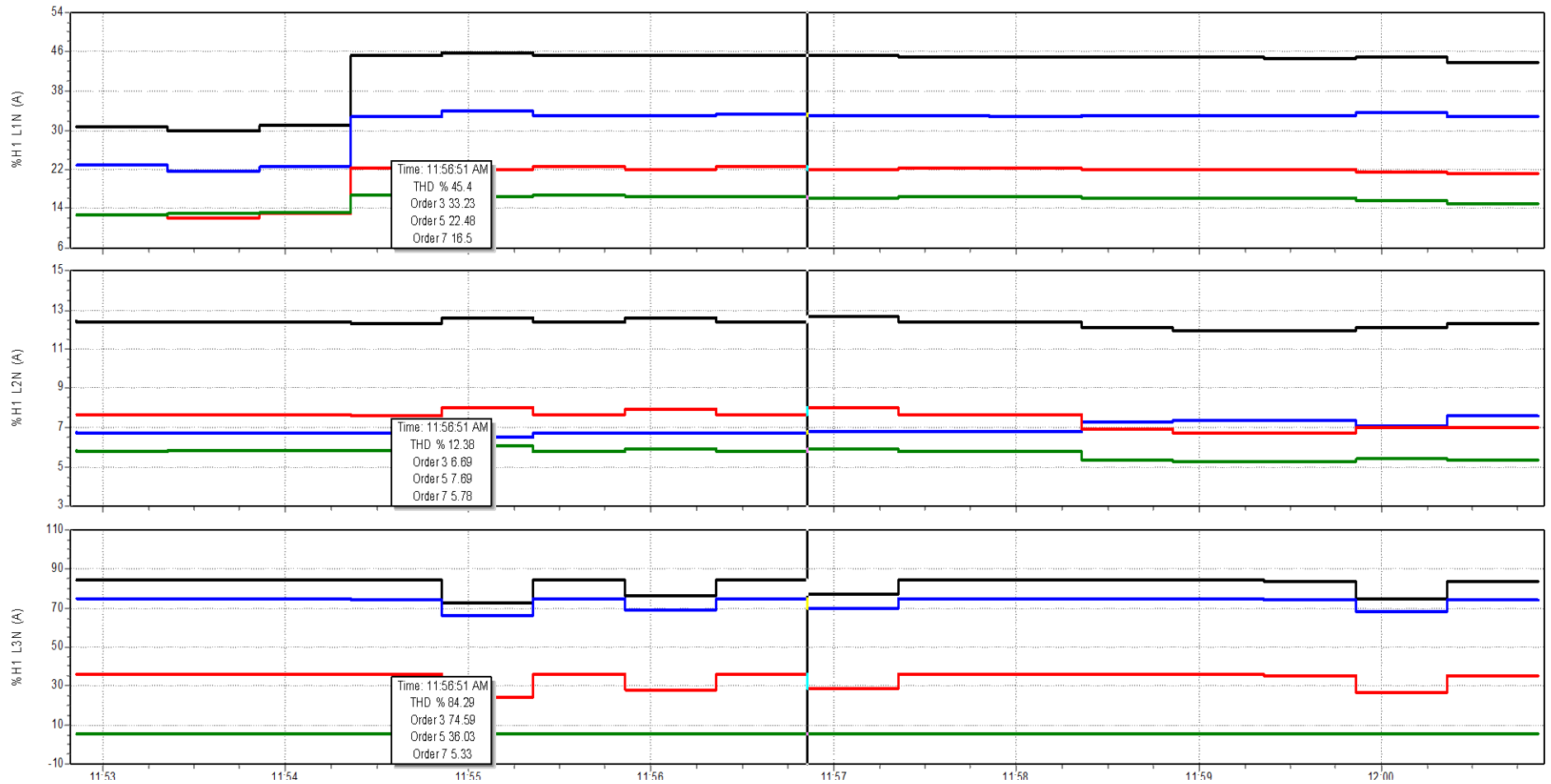


## APPENDIX F -SUMMARY SHEET OF BASIC ELECTRICAL PARAMETERS IN AUDITORIUM

Phase Voltage (L1,L2,L3) Avg V	Line Current (L1,L2,L3) Avg A	Phase Voltage (L1,L2,L3) Fundamental Avg V	Line Current (L1,L2,L3) Fundamental Avg A	%-age Voltage Un balance	%-age Current Un balance	Frequency In Hz	Active Power Total Avg in kW	Reactive Power Total Avg in kVAR	Apparent Power Total Avg in kVA	DPF	TPF	THD V Avg % age	THD A Avg % age
222.30	8.73	222.30	7.93	0.67	91.43	49.95	4.61	0.89	5.21	0.89	0.79	1.75	42.57
222.16	8.73	222.13	7.87	0.68	91.43	49.96	4.60	0.88	5.20	0.88	0.79	1.75	42.57
221.97	8.73	221.93	7.93	0.57	91.59	49.96	4.60	0.89	5.20	0.88	0.79	1.75	42.22
222.04	8.70	222.00	7.80	0.58	91.97	49.96	4.59	0.89	5.19	0.88	0.79	1.73	42.65
221.99	8.90	221.97	8.07	0.59	93.52	49.97	4.59	0.99	5.20	0.88	0.78	1.73	47.20
221.89	10.10	221.87	9.13	0.60	92.10	49.99	4.99	1.44	5.80	0.86	0.77	1.72	43.65
222.00	8.67	221.97	7.73	0.58	93.72	49.99	4.51	0.93	5.11	0.88	0.78	1.72	47.38
222.01	9.80	222.00	8.87	0.61	92.49	50.01	4.88	1.31	5.63	0.87	0.77	1.73	44.75
222.12	8.60	222.07	7.73	0.65	93.69	50.02	4.48	0.93	5.08	0.88	0.78	1.74	47.36
222.01	9.63	222.00	8.67	0.72	92.71	50.01	4.80	1.27	5.53	0.87	0.77	1.75	44.90
222.04	8.63	222.00	7.67	0.71	93.80	49.99	4.48	0.93	5.08	0.88	0.78	1.74	47.29
222.21	8.63	222.17	7.67	0.70	93.86	50.02	4.48	0.93	5.08	0.88	0.78	1.74	47.27
222.26	8.70	222.23	7.73	0.71	93.92	50.02	4.52	0.93	5.12	0.88	0.78	1.75	47.21
222.55	8.70	222.50	7.80	0.71	93.97	50.02	4.53	0.93	5.13	0.88	0.78	1.75	47.13
222.53	8.77	222.50	7.80	0.71	93.98	50.05	4.56	0.96	5.17	0.88	0.78	1.78	46.89
222.19	10.17	222.20	9.20	0.71	92.44	50.08	5.03	1.40	5.81	0.87	0.77	1.76	43.99

## APPENDIX G -TREND CURVES FOR VARIOUS PARAMETERS

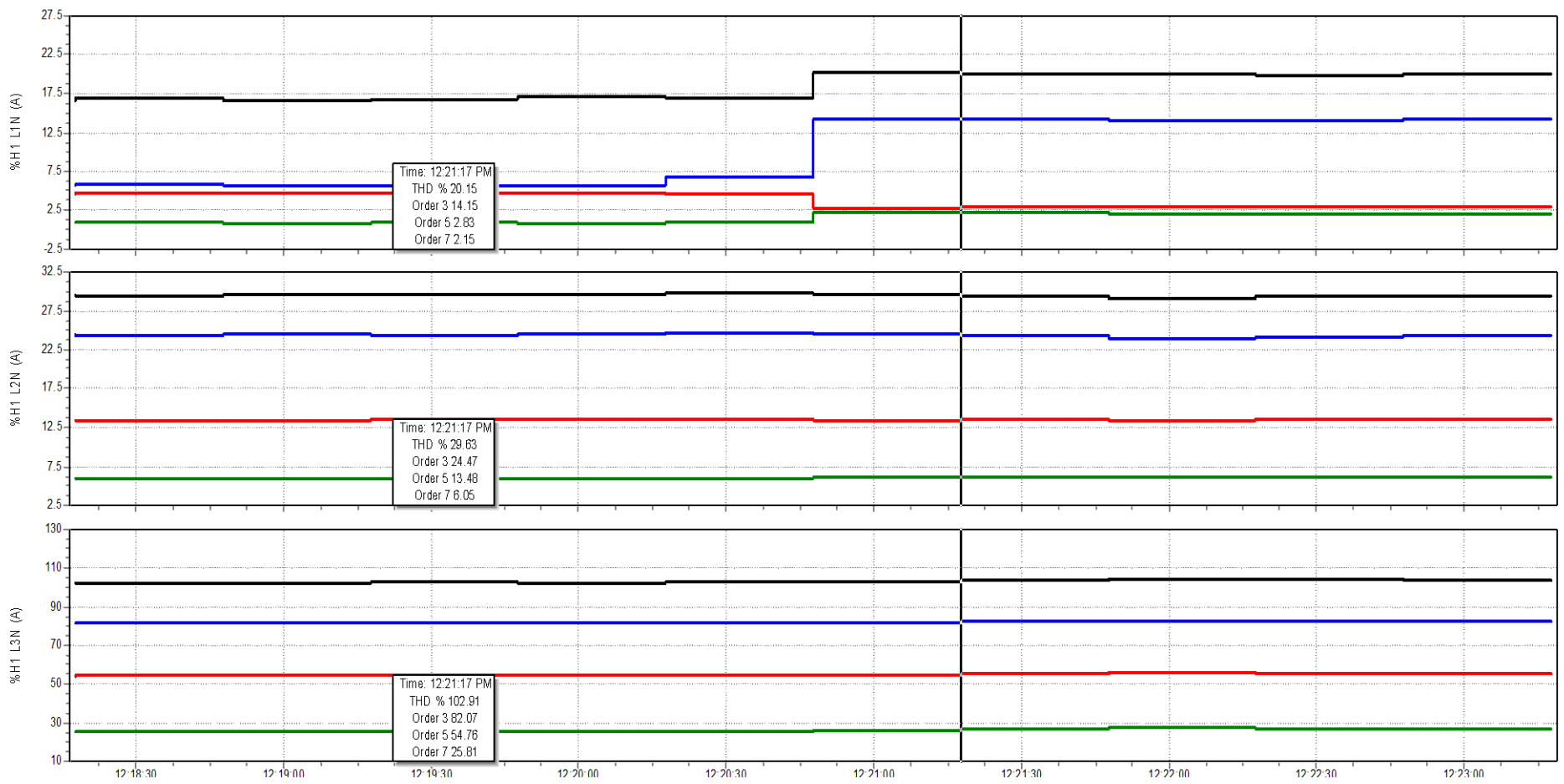
### CURRENT HARMONICS CURVE



## APPENDIX H -SUMMARY SHEET OF BASIC ELECTRICAL PARAMETERS IN IT LAB

Phase Voltage (L1,L2,L3) Avg V	Line Current (L1,L2,L3) Avg A	Phase Voltage (L1,L2,L3) Fundamental Avg V	Line Current (L1,L2,L3) Fundamental Avg A	%-age Voltage Un balance	%-age Current Un balance	Frequency In Hz	Active Power Total Avg in kW	Reactive Power Total Avg in kVAR	Apparent Power Total Avg in kVA	DPF	TPF	THD V Avg % age	THD A Avg % age
222.16	15.57	222.10	14.13	0.59	62.71	49.91	7.92	2.84	9.39	0.84	0.76	1.70	49.42
222.41	15.53	222.37	14.13	0.58	63.07	49.91	7.89	2.85	9.36	0.84	0.76	1.69	49.50
222.42	15.50	222.37	14.00	0.59	62.70	49.90	7.91	2.83	9.36	0.84	0.77	1.70	49.46
222.56	15.47	222.53	14.00	0.56	62.66	49.89	7.91	2.83	9.36	0.85	0.77	1.71	49.62
222.45	15.47	222.43	13.93	0.56	62.67	49.90	7.88	2.83	9.33	0.84	0.76	1.70	49.75
222.80	14.80	222.73	13.33	0.59	76.05	49.90	7.16	2.67	8.60	0.83	0.74	1.72	49.78
223.21	12.23	223.17	10.47	0.65	107.97	49.90	5.59	2.27	6.97	0.80	0.69	1.72	50.90
223.51	12.07	223.43	10.33	0.66	107.91	49.90	5.53	2.24	6.89	0.80	0.69	1.71	51.03
223.63	11.97	223.60	10.20	0.64	107.84	49.92	5.51	2.19	6.83	0.81	0.69	1.71	51.22
223.71	12.03	223.67	10.27	0.64	107.88	49.92	5.52	2.23	6.87	0.80	0.69	1.70	51.09

APPENDIX I -CURRENT HARMONICS CURVE



**End of the Report**  
**Thank You**

**To whomsoever it may concern**

This is to certify that, we have conducted an **Energy Audit** in M/s. **Hajee Karutha Rowther Howdia College**, Uthamapalayam, Tamil Nadu on 20 March 2021. The audit team has identified energy saving measures and the summary of Energy Audit Process is given below.

S.No.	Description	Parameters
1	Annual Energy Consumption	52302 kWh + 6005 lit LPG + 20420 lit diesel
2	Present Annual Energy Cost	Rs 23,35,788
3	Annual Energy Savings due to the installation of solar PV and wind	Rs 1,01,400
4	% Energy Savings due to solar PV and	30 % ( 15600 kWh)
4	Proposed % Energy Savings	8 % Electrical + 7 %LPG + 4% diesel
5	Proposed annual Energy Savings	Rs 1,20,000
6	Initial Investment Required	Nil

**Equipment/Systems Audited**

Electrical Network  
Solar PV system  
Inverter, UPS and Battery System  
Lightings, Fans & Air Conditioning System  
LPG Consumption for Cooking Application  
Fuel Consumption

Audited and Accounted for Jan-2020 to Dec-2020

Yours Truly



**Dr. P. NAVANEETHAKRISHNAN**  
BEE Certified Energy Auditor  
Regd. No: EA3643  
5/83, Namakkalpalayam Road,  
Chennimalai - 638 051, Erode Dt.

(Certified Energy Auditor)



**KONGU ENGINEERING COLLEGE**  
**(Autonomous)**  
**PERUNDURAI, ERODE - 638 060, INDIA**



**To whomsoever it may concern**

This is to certify that, we have conducted a **Green Audit** in M/s. **Hajee Karutha Rowther Howdia College**, Uthamapalayam, Tamil Nadu on 20 March 2021. This audit process investigates the following activities;

- I) Coverage of 388 matured trees, herbal garden and rain water harvesting pit
- II) Inspection of Rooftop Solar PV Plant
- III) Inspection of Wind turbines.

Audited and Accounted for Jan-2020 to Dec-2020

Yours Truly

  
**Dr. P. NAVANEETHAKRISHNAN**  
BEE Certified Energy Auditor  
Regd. No: EA3643  
5/83, Namakkalpalayam Road,  
Chennimalai - 638 051, Erode Dt.

(Certified Energy Auditor)



**To whomsoever it may concern**

This is to certify that we have conducted an **Environmental Audit** in M/s. **Hajee Karutha Rowther Howdia College**, Uthamapalayam, Tamil Nadu on 20 March 2021. This audit process highlights the present CO<sub>2</sub> emission and methods adopted to neutralize the same in the college campus.

S.No.	Description	Type of fuel and their conversion process		
		Electrical energy consumed	Diesel	LPG
1	Annual Energy Consumption	52302 kWh	20420 lit	6005 lit
2	CO <sub>2</sub> Emission (tonne/Annum)	49.6	54.7	9.06
	CO <sub>2</sub> Emission standards	0.95 kg/kWh	2.68 kg/lit	1.51 kg/lit
3	Total CO <sub>2</sub> emission	113 t		
4	Total No. of students and staff	2793		
5	Per capita CO <sub>2</sub> emission	0.040 t (+)		
6	Energy from solar PV ( 51 kWh/day for PV and 1 kWh/day for wind for 300 days)	15600 Kwh		
7	CO <sub>2</sub> neutralised due to Renewables	14.82 t (-)		
8	No. of Matured Trees (1 tree absorbs 22 kg CO <sub>2</sub> /year)	388		
9	CO <sub>2</sub> neutralised due to trees	8.5 t (-)		
10	Per Capita CO <sub>2</sub> Emission to be Neutralized	0.032 t		

System Audited	Systems Inspected
Electricity consumption and generation	Solid & E waste handling & Management
Diesel consumption	Usage of chemical, salts & acids
LPG consumption	RO system

Audited and Accounted for Jan-2020 to Dec-2020

Yours Truly

  
**Dr. P. NAVANEETHAKRISHNAN**  
 BEE Certified Energy Auditor  
 Regd. No: EA3643  
 5/83, Namakkalpalayam Road,  
 Chennai - 638 051, Erode Dt.

(Certified Energy Auditor)

**To whomsoever it may concern**

This is to certify that 1 m<sup>3</sup> capacity Biogas plant is in function at M/s. **Hajee Karutha Rowther Howdia College**, Uthamapalayam, Tamil Nadu and it is verified during the **Environmental Audit**.



Yours Truly



**Dr. P. NAVANEETHAKRISHNAN**  
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(Certified Energy Auditor)