Carbon Emissions Audit 2024

Carbon Accounting & Energy Conservation Potential Study

At

Indian Institute of Management Kozhikode

IIMK Campus P. O, Kunnamangalam, Kozhikode - 673570
Kerala, India.

March 2025

Carbon Audit & Savings Achievement Assistance By

Sopanam Energy Aesthetics

24/75F,. Sopanam Office Annex, Near Mini Civil Station, Irinjalakuda, Thrissur, Kerala – 680125, India

email– jishnu@sopanamenergy.com , Website– www.sopanamenergy.com, +91 9995748722

PREFACE

A Carbon Footprint Audit is a systematic evaluation of the greenhouse gas (GHG) emissions produced by an organization, product, or activity. This process aims to quantify both direct and indirect emissions to understand the full environmental impact. Emissions are typically categorized into three scopes: Scope 1 (direct emissions from owned or controlled sources), Scope 2 (indirect emissions from purchased electricity, steam, heating, or cooling), and Scope 3 (other indirect emissions, including those from the supply chain, business travel, and waste management).

By conducting a carbon audit, organizations can identify the major sources of emissions within their operations and supply chain. This information is crucial for creating actionable strategies to reduce their carbon footprint and improve sustainability. A carbon audit is not only beneficial for environmental impact but also plays a key role in regulatory compliance, meeting sustainability goals, and enhancing corporate reputation. Many businesses use audits to demonstrate transparency and social responsibility, building trust with consumers, investors, and stakeholders.

The insights gained from a carbon audit can guide organizations toward energy efficiency, renewable energy adoption, and optimized logistics, all of which contribute to long-term emissions reductions. As the world increasingly focuses on tackling climate change, conducting carbon audits has become an essential practice for organizations aiming to remain competitive and environmentally responsible.

CERTIFICATION

This is to certify that

The data collection has been carried out diligently and truthfully. All data monitoring devices are in proper working condition and have been calibrated or certified by authorized agencies. No tampering of such devices has occurred.

All reasonable professional skill, care, and diligence have been exercised in preparing the audit report, and its contents are a true representation of the facts. Adequate training has been provided for equipment maintenance, implementation of energy efficiency practices, energy conservation measures, offsetting CO_2e emissions, and the adoption of energy management systems.

JISHNU SANATH

Certified Energy Auditor

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ACKNOWLEDGEMENT

We express our sincere gratitude to the authorities of Indian Institute of Management, Kozhikode for entrusting and offering the opportunity to conduct a Carbon Footprint Audit. It is our immense pleasure to present the Carbon Footprint Audit report.

We acknowledge the positive support from the management and the Accreditation and ranking department in undertaking the Carbon Footprint Audit of the Institute and for continuous help and support before and during the Audit.

We are also thankful to all field staff and agencies working with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system/equipment performance and saving potential. We admire the help of all concerned staff for their active participation in completing the official documentation.

02-04-2025
Irinjalakuda

Director
Sopanam Energy Aesthetics

1. EXECUTIVE SUMMARY

A **Carbon Footprint Audit** was conducted at IIM Kozhikode in March 2025 by Sopanam Energy Aesthetics (SEA), Thrissur, Kerala.

The carbon audit provides a comprehensive assessment of the organization's greenhouse gas (GHG) emissions across all relevant scopes: Scope 1 (direct emissions), Scope 2 (indirect emissions from purchased energy), and Scope 3 (indirect emissions across the value chain). It identifies key emission sources, evaluates current practices, and benchmarks performance against industry standards.

The audit also recommends actionable strategies for reducing emissions, improving energy efficiency, and enhancing sustainability efforts. By addressing carbon footprint reduction, the audit helps the organization align with climate goals, comply with regulations, and contribute to environmental responsibility, fostering long-term operational and reputational benefits.

The audit includes an on-site survey and discussions with institution personnel, followed by data collection to determine the total annual carbon dioxide (CO_2e) emissions for the facility for the reporting period from January 2024 to December 2024. A technical evaluation of applicable measures to reduce energy consumption was also conducted as part of the CO_2e emission mitigation strategy. The site visit encompassed an exhaustive study of IIM Kozhikode's utilities, including HVAC, lighting, and kitchen systems. An inception meeting and a site survey exit meeting were held by SEA with all relevant personnel at the site to review the work plan, schedule, and collaborate with the IIM Kozhikode team.

This report presents the greenhouse gas (GHG) emissions profile of the facility for the reporting year 2024, with **Total Absolute emissions** amounting to **10,055.38 tonnes of CO_2 equivalent (tCO_2e)**. The emissions have been classified into Scope 1, Scope 2, and Scope 3 categories in accordance with the GHG Protocol.

- **Scope 1 emissions**, which include direct emissions from on-site fuel combustion, company-owned vehicles, and refrigerant leakage, contributed **559.42 tCO_2e**, representing **5.6%** of the total emissions.

- **Scope 2 emissions**, arising from the consumption of purchased electricity, were the highest contributor at **5,553.29 tCO_2e**, accounting for **50.2%** of the total emissions. This underscores the critical role of energy efficiency and renewable energy adoption in reducing the facility's carbon footprint.

- **Scope 3 emissions**, encompassing indirect emissions from employee commuting, waste disposal, water usage, and supply chain activities, totaled **3942.67 tCO_2e**, or **39.2%** of overall emissions. This highlights the significance of sustainable procurement, mobility solutions, and waste reduction initiatives.

The near-equal share of Scope 2 and Scope 3 emissions reflects the dual need for operational energy optimization and strategic engagement with value chain partners to drive long-term decarbonization. Immediate opportunities for emission reduction lie in energy efficiency upgrades, renewable energy sourcing, and stakeholder collaboration on sustainability practices.

Absolute emissions are the total amount of greenhouse gases, measured in tonnes of Carbon dioxide equivalent (tCO_2e), that an entity emits over a specific time period, regardless of size or efficiency.

Table 1.1.(a) : Executive Summary

Classification	Absolute emissions (t CO_2e)	Percentage Share (%)
Scope 1	559.4	5.6%
Scope 2	5553.3	55.2%
Scope 3	3942.7	39.2%
Total Absolute CO_2e Emission	10055.4	

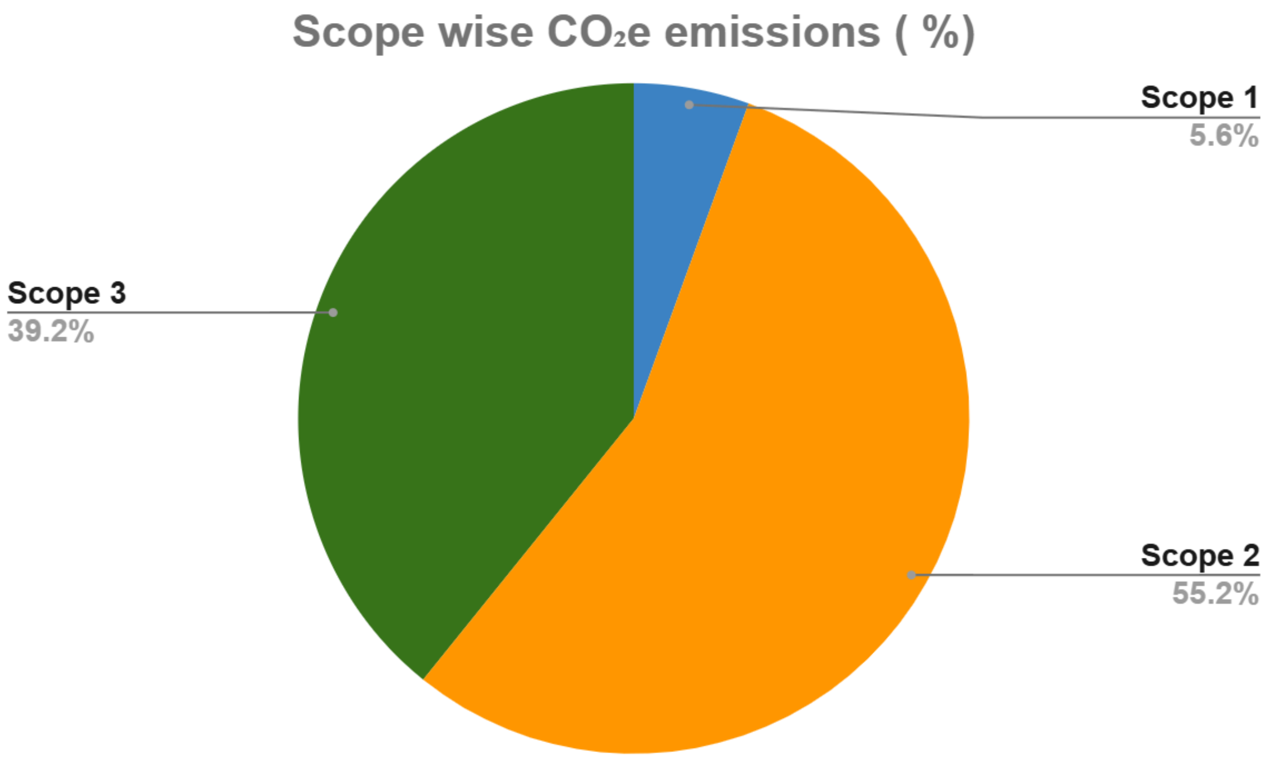


Figure 1.1.(a) : Executive Summary

The individual emission shared by various activities in the institute is tabulated below.

Scope 2 (Purchased Energy) is the **largest contributor**, **half (55.2%)** of total emissions.

Scope 3 (Indirect emissions) is also substantial, especially from:

- **Food consumption** (23.18%)
- **T&D losses** (5.93%)
- **Employee commute** (5.48%)

Scope 1 emissions are the smallest share at 5.6%.

Table 1.1.(b) : Activity wise emission

Classification	Activity	Absolute emissions (t CO_2e)	Percentage Share
Scope 1	Stationary combustion	261.03	2.60%
	Mobile Combustion	76.46	0.76%
	Fugitive emissions	221.92	2.21%
Total Absolute Emission (tCO_2e)		**559.42**	
Scope 2	Purchased Energy	5553.29	55.23%
Total Absolute Emission (tCO_2e)		**5553.29**	
Scope 3	Purchased electricity T & D loss	596.53	5.93%
	Air travel	48.46	0.48%
	Employee commute	551.23	5.48%
	Fertilizer emissions	0.72	0.01%
	Food consumption	2330.57	23.18%
	Water consumption	6.92	0.07%
	Waste management	28.33	0.28%
		1.16	0.01%
	Civil maintenance works	70.87	0.70%
	Civil infrastructure	15.86	0.16%
	Purchased goods and services	292.01	2.90%
Total Absolute Emission (tCO_2e)		**3942.67**	
Grand Total		**10055.38**	

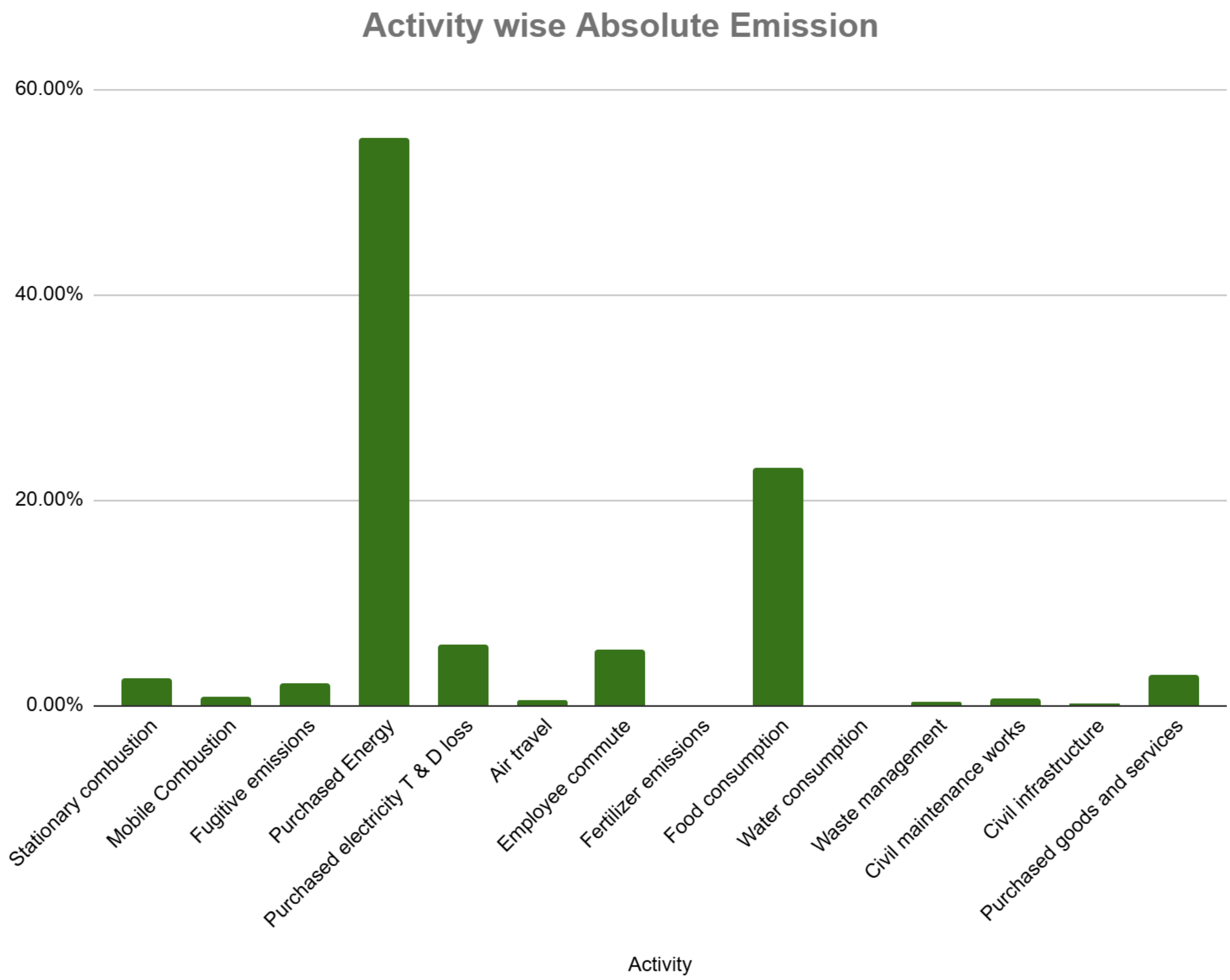


Figure 1.1.(a) : Histogram of activity-wise emissions

Category	Number
Students	1448
Teaching Staff	104
Non teaching staff	102
Contract workers	350
Total	**2004**

The emission intensity (tCO_2e/head) of the institute for the past year is 5 Tonne of CO_2e/head/year.

Emission intensity (tCO_2e/head/year)= *Annual Absolute Emission* (tCO_2e/year) / *Number of people*

2. INTRODUCTION

In today's rapidly changing world, the need to address climate change has become a central focus for individuals, organizations, and governments alike. One of the most effective ways organizations can contribute to environmental sustainability is by reducing their greenhouse gas (GHG) emissions. A **carbon audit** plays a crucial role in this process by providing a detailed evaluation of an organization's carbon footprint. It helps identify the sources of emissions across all relevant scopes—**Scope 1 (direct emissions)**, **Scope 2 (indirect emissions from purchased energy)**, and **Scope 3 (indirect emissions across the value chain)**–and assesses the organization's overall impact on the environment.

Conducting a carbon audit is essential for understanding the extent of GHG emissions produced by an organization, allowing for the creation of targeted strategies to mitigate these emissions. It is especially important for businesses aiming to comply with growing regulations and sustainability standards. As more governments and regulatory bodies introduce policies to reduce carbon emissions, organizations are expected to meet compliance requirements, avoid penalties, and demonstrate accountability for their environmental impact.

Reducing GHG emissions is not only a regulatory requirement but also an opportunity for businesses to improve operational efficiency and reduce costs. By identifying areas for energy savings, waste reduction, and process optimization, organizations can lower their energy consumption, leading to both financial savings and reduced environmental impact. Ultimately, a carbon audit is an essential first step in reducing GHG emissions, enabling organizations to take measurable actions towards their sustainability goals.

Energy assessors from Sopanam Energy Aesthetics conducted a Carbon Footprint Audit as per GHG guidelines at IIM Kozhikode, Kozhikode on 8th March 2025. The goals of this assessment are consistent with the Institute's ongoing commitment to sustainability. They are intended to strengthen their efforts by implementing new ideas and measures via an in-depth look at major equipment and supporting processes.

2.1 Brief Highlights

IIM Kozhikode, located in the scenic foothills of the Western Ghats in Kerala, is renowned for its world-class infrastructure and sustainable Institute. The sprawling Institute covers over 100 acres and offers state-of-the-art facilities, making it one of India's most prestigious business schools. With a focus on academic excellence and holistic development, IIM Kozhikode boasts modern lecture halls, seminar rooms, and a well-equipped library, creating an ideal environment for learning.

The Institute is also committed to sustainability, with green initiatives like rainwater harvesting, waste management systems, and energy-efficient buildings. Its eco-friendly design integrates nature, offering picturesque views and serene surroundings, enhancing the overall student experience. The vibrant Institute life includes a range of extracurricular activities, clubs, and cultural events, encouraging creativity, leadership, and teamwork.

The infrastructure also supports advanced research and development, with specialized labs, conference facilities, and a fully functional IT infrastructure. The Institute houses a variety of accommodation options, sports facilities, and recreational areas to ensure students' well-being. IIM Kozhikode's commitment to innovation, sustainability, and academic rigor makes it a preferred destination for students and faculty from around the world, fostering the next generation of leaders and entrepreneurs.

2.2 Objectives

- Compute Scope 1, Scope 2 and Scope 3 Carbon Footprint for all activities operating from the IIM Kozhikode Institute for the calendar year 2024. Compute the various components in each of the categories.
- Evaluate the impact of the change in the carbon footprint for the various components in each of the scope categories .
- Identify opportunities for Improvement to further enhance IIM-K's performance on their sustainability journey.
- Present a factual status of the overall performance through the assessment year on all the three scopes of emissions with a detailed reflection on the trends of change and the established reasons, to facilitate the leadership team at the university to take internal decisions to drive the overall sustainability program.

2.3 Scope And Reporting Boundary

Physical boundary:

- All activities including academic and non-academic activities within the IIMK Institute located at Kunnamangalam, kozhikode, Kerala – 673570.
- All activities including academic and non-academic activities within the IIMK Kochi Institute located at Athulya IT Complex, Infopark, Kakkanad, kerala-673570.

Operational boundary:

Scope 1 Direct GHG emissions from:

I. Captive power generation activities including the combustion of fossil fuels (HSD) in stationary source of electricity generators, LPG consumption in canteen & kitchen.
II. Combustion of fuels in mobile sources- IIM-K owned & controlled vehicles and the fuel used for the horticulture activities.

III. Fugitive emissions from Refrigeration/air-conditioning equipment installed and operated.

Scope 2 Indirect emissions from:

I. Purchased electricity including renewable and non-renewable power.

Scope 3 Other Indirect GHG emissions from:

I. Commuting of Teaching Staff, Non-Teaching Staff, Students and Sub-contractors.
II. Business Air travel and associated institute stay.
III. Material procurement, consumption and disposal.
IV. Waste management and disposal.
V. Upstream and downstream activities.

Reporting Period:

- ❖ The Carbon footprint analysis is conducted for the reporting period (Jan '24 – Dec '24) .
- ❖ For scope 1 and 2 emissions the carbon footprint is compared with the previous year (Jan '23 – Dec '23) to analyse the trends.

2.4 Audit Team

- Er. Aneesh Rajendran – Certified Lead GHG Verifier/ Validator, BEE Accredited Energy Auditor (AEA – 0339)
- Er. Jishnu Sanath – BEE Certified Energy Auditor (CEA-32889/21)
- Er. Jijoraj A N – BEE Certified Energy Manager(CEM-300984/24)
- Er. Abhishek P – Senior Energy Engineer
- Er. Prince Xavier – Energy Engineer
- Er. Rosh John – Energy Engineer
- Er. Shine Shaji – Energy Engineer

2.5 Instruments Used

- Power Logger – Hioki PW 3360-21
- Digital thermometer – RTek RT 850 N
- Hygrometer – Meco 961-P
- Anemometer – HTC AVM 06
- Manometer – HTC PM 6202
- Clamp on Multimeter – Metravi 307
- Clamp on Multimeter – Ideal 61 -775

3. ANALYSIS OF GHG EMISSIONS

Greenhouse gas (GHG) emissions are gases released into the atmosphere that trap heat, contributing to global warming and climate change. The major GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, generated from human activities like energy production, transportation, and agriculture being the primary sources.

The **Greenhouse Gas (GHG) emission scopes** were implemented by the **Greenhouse Gas Protocol Initiative**, a multi-stakeholder partnership convened by the **World Resources Institute (WRI)** and the **World Business Council for Sustainable Development (WBCSD)**. This initiative provides a standardized framework for measuring and managing greenhouse gas emissions at the corporate level.

The GHG Protocol defines three types of emissions:

- **Scope 1**: Direct emissions from owned or controlled sources.
- **Scope 2**: Indirect emissions from the generation of purchased electricity consumed by the organization.
- **Scope 3**: Indirect emissions from all other activities in the value chain, such as transportation, waste, and the production of purchased goods and services.

These scopes are widely used by organizations globally to measure their carbon footprint and to set targets for emission reductions, contributing to transparency, accountability, and more effective climate action.

Carbon dioxide equivalent (CO_2e) is a standard unit of measurement used to express the impact of different greenhouse gases (GHGs) in terms of the amount of carbon dioxide (CO_2) that would have the same global warming potential (GWP) over a specified time period (usually 100 years). It allows for the comparison of emissions from various gases, such as methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, by converting them into an equivalent amount of CO_2e based on their respective GWPs.

3.1 Scope 1 GHG Emissions

Scope 1 emissions refer to direct greenhouse gas emissions that occur from sources owned or controlled by an organization, such as fuel combustion in company vehicles or facilities. These emissions are produced by activities under the organization's direct operational control.

3.1.1 Stationary Combustion

The Greenhouse Gas (GHG) Protocol defines stationary combustion as the burning of fuels in stationary equipment or devices that do not move. Under the GHG Protocol, emissions from stationary combustion are categorized as Scope 1 emissions, since they are direct emissions from owned or controlled sources. To calculate these emissions, the protocol recommends using fuel consumption data and applying the appropriate emission factors for each type of fuel consumed.

The fuels coming under stationary combustion include Diesel used for Diesel generators and LPG used in kitchens.

Diesel is used in diesel generators at two substations, namely Academic Hill and Residential Hill. The diesel consumption for the diesel generators used by the IIMK Kochi facility is also considered, as the cost is covered by the parent organization, IIM Kozhikode.

The LPG is used in the 2 kitchens namely Sarovar and Prism.
The fuel consumption details and their emissions for the year 2024 are tabulated below.

Table 3.1.1 (a) : Stationary emissions Source details 2024

Month	Activity	Diesel - DG				LPG - Kitchen		
		Academic hill substation Diesel Consumption	Residential hill Substation Diesel consumption	IIMK Kochi Diesel consumption	Total Diesel consumption	LPG Consumption Sarovar	LPG Consumption prism	Total LPG consumption
		Litre	Litre	Litre	Litre	kg	kg	kg
Jan'24	Stationary combustion	2100	195	339.6	2295	1710	3841	5551
Feb'24		418	138		556	1197	3841	5038
Mar'24		1541	408		1949	1178	3841	5019
Apr'24		2350	492		2842	1216	768.2	1984.2
May'24		4185	612		4797	741	768.2	1509.2
Jun'24		2433	306		2739	1463	3841	5304
Jul'24		9984	1450		11434	931	2812	3743
Aug'24		3426	572		3998	988	4180	5168
Sep'24		2495	75		2570	1520	3800	5320
Oct'24		1395	102		1497	703	4085	4788
Nov'24		3817	513		4330	1178	4180	5358
Dec'24		184	165		349	1102	3990	5092
Total					**39695.6**			**53874.4**

Table 3.1.1(b) : Stationary emission data 2024

Activity	Source	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Stationary combustion	Diesel	39695.6	litre	2.64	kg/ litre	104796	104.80
	LPG	53874.4	kg	2.9	kg/ kg	156236	156.24
Total						261032	**261.03**

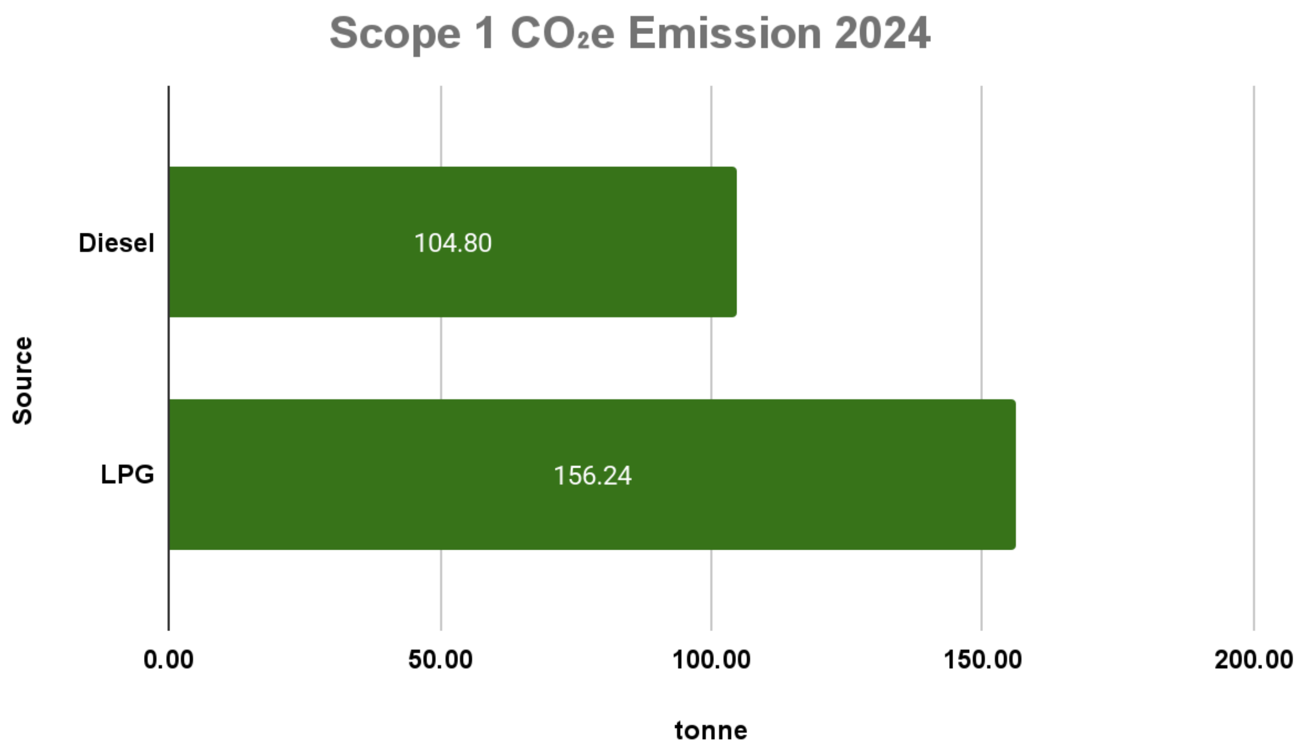


Figure 3.1.1(a) : Stationary emission data 2024

Stationary Emission previous year – 2023

The fuel consumption details and their emissions for the year 2023 are tabulated below.

Table 3.1.1(c) : Stationary emission source details 2023

Period	Activity	Diesel – DG				LPG – Kitchen		
		Academic hill substation Diesel Consumption	Residential hill Substation Diesel consumption	IIMK Kochi Diesel consumption	Total Diesel consumption	LPG Consumption Sarovar	LPG Consumption prism	Total LPG consumption
		Litre	Litre	Litre	Litre	kg	kg	kg
Jan '23 – Dec '23	Stationary combustion	9720	2241	209	12170	10051	28685	38736

Table 3.1.1(d) : Stationary emission data 2023

Activity	Source	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Stationary combustion	Diesel	12170	litre	2.64	kg/ litre	32129	32.13
	LPG	38736	kg	2.9	kg/ kg	112334	112.33
Total						144463	**144.46**

we can see that there is an 80.7% increase in emissions, amounting to **116.5** tCO_2e, from 2023 to 2024.

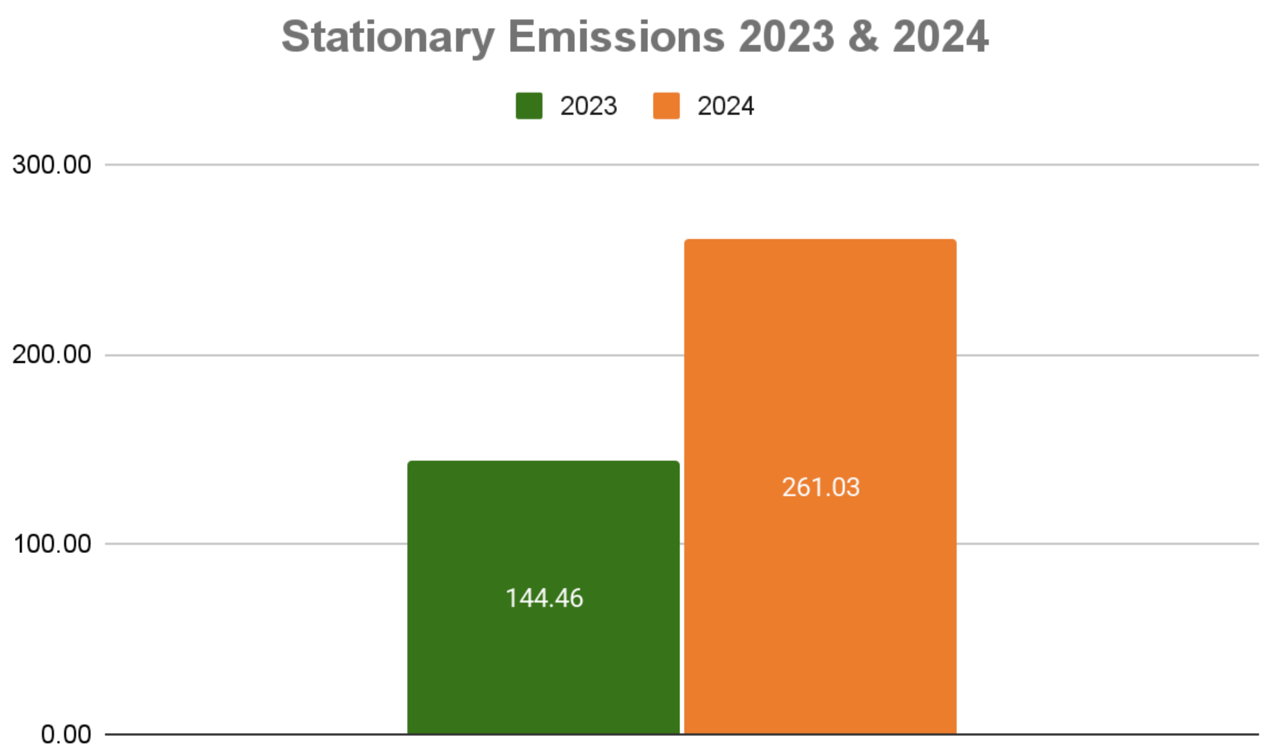


Figure 3.1.1(b) : Stationary emission 2023 & 2024

3.1.2 Mobile Combustion

The **GHG Protocol** defines **mobile combustion** as the burning of fuel in mobile sources that are owned or controlled by an organization.
The mobile sources in IIM-K includes transportation vehicles and horticulture equipment (Lawn mowers, weed cutters, chainsaws etc.)

The fuel consumption details and their emissions for the year 2024 are tabulated below.

Table 3.1.2 (a): Mobile emissions source details 2024

Month	Activity	Diesel	Petrol	Petrol
		Owned Vehicle Fuel Consumption (Litre)	Owned Vehicle Fuel Consumption (Litre)	Total Horticulture tools Petrol Consumption (Litre)
Jan'24	Mobile Combustion	1745	207	140
Feb'24		2616	164	100
Mar'24		2928	100	80
Apr'24		1644	179	60
May'24		1736	172	60
Jun'24		1784	70	200
Jul'24		2069	172	160
Aug'24		1930	332	180
Sep'24		1925	326	180
Oct'24		2449	405	140
Nov'24		2073	150	120
Dec'24		2200	561	160
Average		2092	236	**132**
Total		**25098**	**2837**	**1580**

Table 3.1.2 (b): Mobile emission data 2024

Activity	Source	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Owned vehicle Fuel Consumption	Diesel	25098	litre	2.64	kg/ litre	66259	66.26
	Petrol	2837	litre	2.31	kg/ litre	6552	6.55
Horticulture equipment fuel consumption	Petrol	1580	litre	2.31	kg/ litre	3650	3.65
Total						76462	**76.46**

Mobile Emissions previous year – 2023

The fuel consumption details and their emissions for the year 2023 are tabulated below.

Table 3.1.2 (c): Mobile emission source details 2023

Period	Activity	Diesel	Petrol	Petrol
		Owned Vehicle Fuel Consumption (Litre)	Owned Vehicle Fuel Consumption (Litre)	Total Horticulture tools Petrol Consumption (Litre)
Jan '23 – Dec '23	Mobile Combustion	**22641.5**	**1964.29**	**1260**

Table 3.1.2 (c): Mobile emission data 2023

Activity	Source	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Owned vehicle Fuel Consumption	Diesel	22641.5	litre	2.64	kg/ litre	59774	59.77
	Petrol	1964.29	litre	2.31	kg/ litre	4538	4.54
Horticulture equipment fuel consumption	Petrol	1260	litre	2.31	kg/ litre	2911	2.91
Total						67222	**67.22**

From this table, we can see that there is a **13.7%** increase in emissions, amounting to **9.24** tCO_2e, from 2023 to 2024.

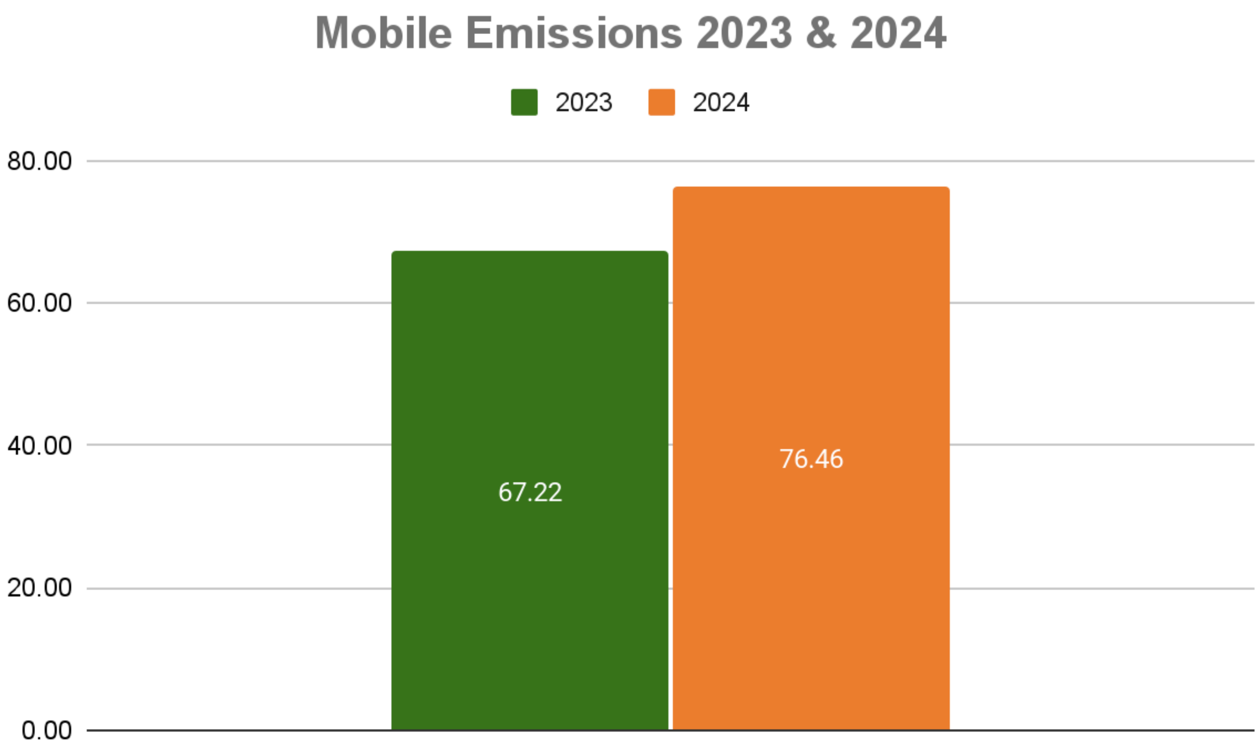


Figure 3.1.2(a) : Mobile emissions 2023 & 2024

3.1.3 Fugitive Emissions

Fugitive emissions under the GHG Protocol refer to greenhouse gas emissions that are not intentionally released through combustion or industrial processes but instead leak or escape from systems due to unintentional releases, such as equipment malfunctions, maintenance activities, or accidental releases.

The primary source of fugitive emissions at IIM-K is the refrigerant used in HVAC equipment. The refrigerant fugitive emissions are quantified based on their top up data. For the year 2024, the refrigerant top-up data and their associated emissions are tabulated below.

The most commonly topped-up refrigerant is R410, which is used in VRFs, chillers, and split AC units. The use of R410 is beneficial because it is a Hydrofluorocarbon (HFC) with zero ozone depletion potential, although it has a higher global warming potential (GWP).

Table 3.1.3 (a): Fugitive emission data 2024

Activity	Type	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Fugitive emissions	Refrigerant(R407)	7	kg	1774	kg/ kg	12418	12.42
	Refrigerant(R32)	7	kg	677	kg/ kg	4739	4.74
	Refrigerant(R22)	7	kg	1810	kg/ kg	12670	12.67
	Refrigerant(R410)	92	kg	2088	kg/ kg	192096	192.10
Total						221923	**221.92**

Fugitive Emissions previous year – 2023

Table 3.1.3 (b): Fugitive emission data 2023

Activity	Type	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Fugitive emissions	Refrigerant(R407)	12	kg	1774	kg/ kg	21288	21.29
	Refrigerant(R32)	6	kg	677	kg/ kg	4062	4.06
	Refrigerant(R22)	6	kg	1810	kg/ kg	10860	10.86
	Refrigerant(R410)	70	kg	2088	kg/ kg	146160	146.16
Total						182370	**182.37**

From this table, we can see that there is a **21.69%** increase in emissions, amounting to **39.55** tCO_2e, from 2023 to 2024.

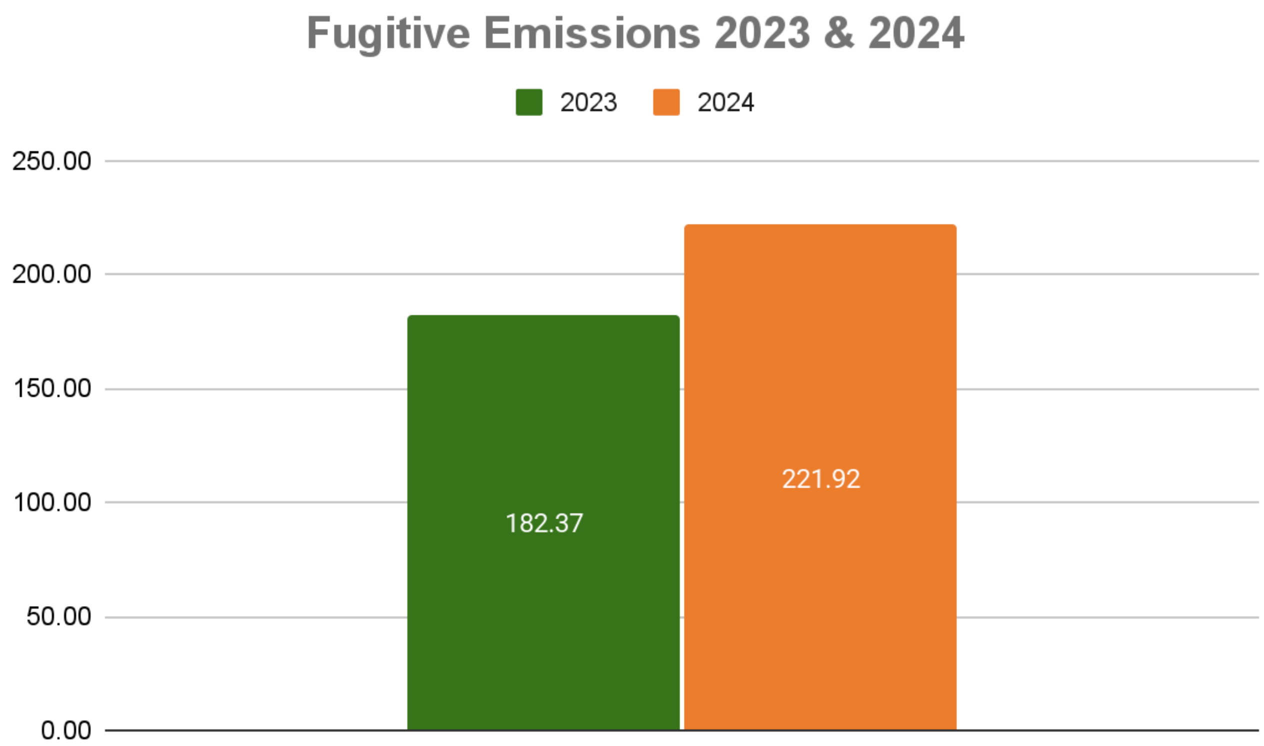


Figure 3.1.3(a) : Fugitive emissions 2023 & 2024

3.1.4 Summary Scope 1 Emissions

The scope 1 emissions includes the Stationary combustion, mobile combustion and fugitive emissions.

For the year 2024 the total scope-1 Absolute emissions was **559.42** tonnes of CO_2e. The major share is from stationary combustion, which accounts for 47% of total emissions, followed by fugitive emissions and mobile combustion which account for 40% and 13%, respectively.

The scope 1 CO_2e emissions for the year 2024 are tabulated below.

Table 3.1.4 (a): Summary Scope 1 Emissions 2024

Classification	Activity	Absolute emissions (t CO_2e)
Scope 1	Stationary combustion	261.03
	Mobile Combustion	76.46
	Fugitive emissions	221.92
Total Absolute Emission		**559.42**

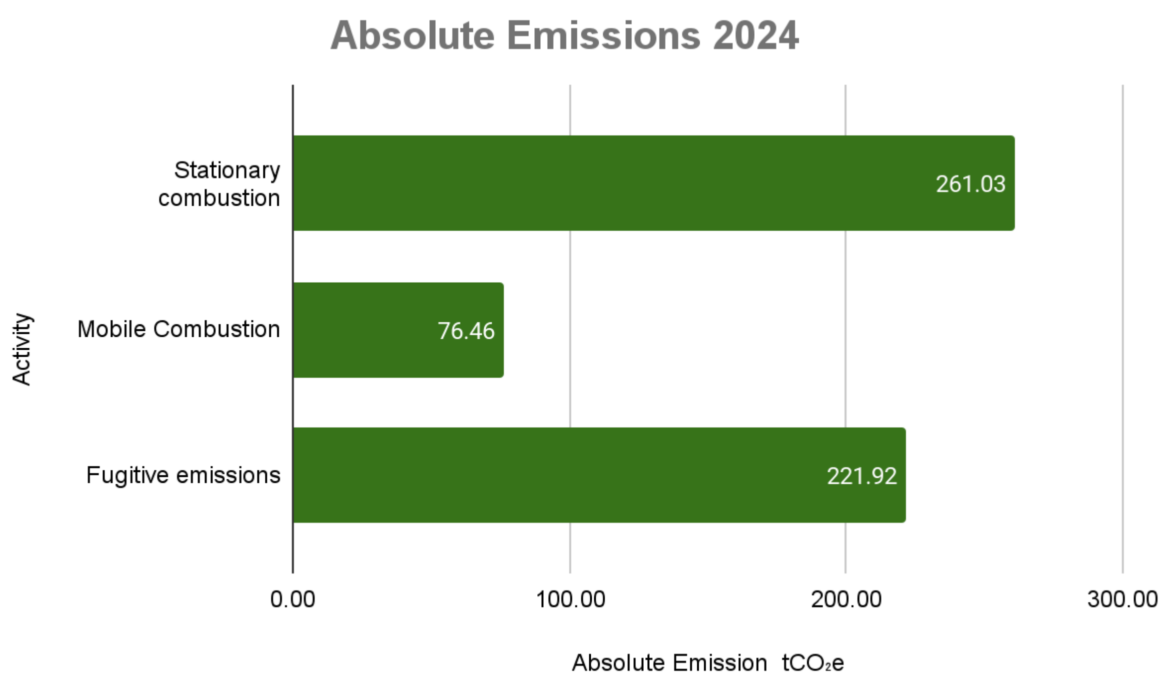


Figure 3.1.4 (a): Summary Scope 1 Emissions 2024

Scope 1 Emissions previous year – 2023

The scope 1 CO_2e emissions for the year 2023 are tabulated below.

Table 3.1.4 (b): Summary Scope 1 Emissions 2023

Classification	Activity	Absolute Emission tCO_2e
Scope 1	Stationary combustion	144.46
	Mobile Combustion	67.22
	Fugitive emissions	182.37
Total Absolute CO_2 Emission		**394.05**

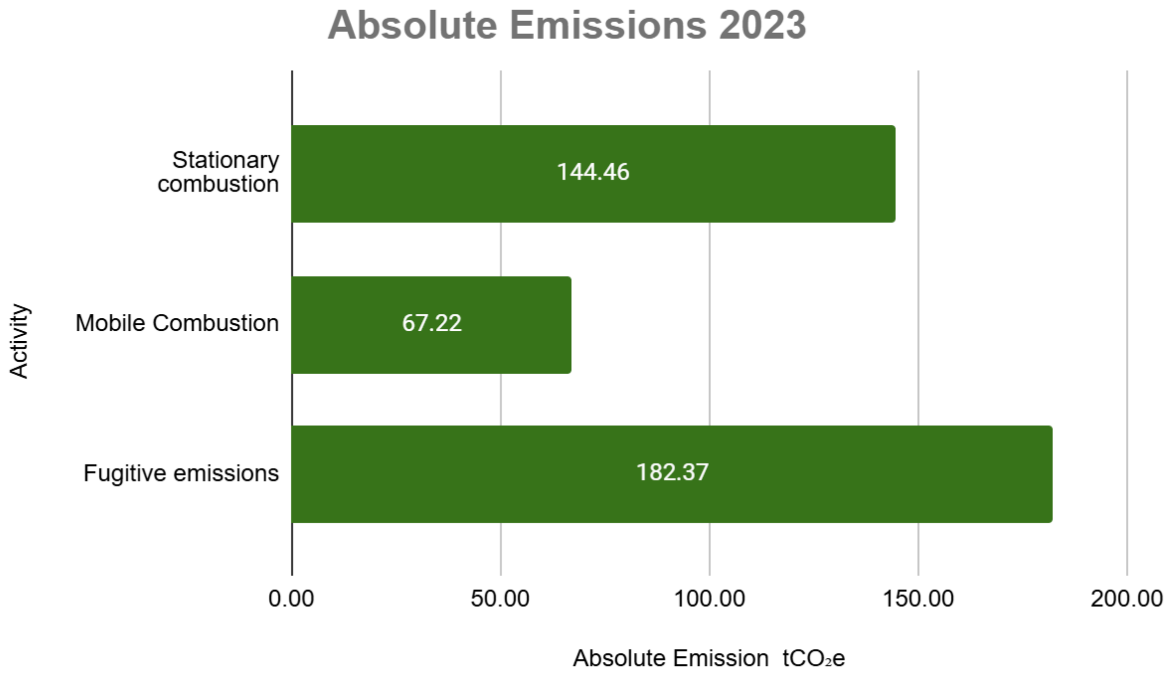


Figure 3.1.4 (b): Summary Scope 1 Emissions 2023

Scope 1 Emissions Comparison (2023 & 2024)

This section presents a comparative analysis of the organization's absolute emissions (measured in tonnes of CO_2 equivalent – tCO_2e) across various operational activities between the years 2023 and 2024. The data reveals a notable increase in overall emissions, with some activities showing substantial year-on-year percentage changes.

1. Stationary Combustion

- Diesel use witnessed a dramatic increase in emissions from 32.13 tCO_2e in 2023 to 104.80 tCO_2e in 2024, representing a 226.18% rise. This suggests either a significant increase in diesel-powered operations or reduced efficiency in fuel use.

- LPG consumption also increased by 39.08%, indicating growing dependency or usage within stationary operations. This growth may stem from heating or process-related demand.

2. Owned Vehicle Fuel Consumption

- Emissions from diesel-fueled vehicles rose modestly by 10.85%, while petrol-fueled vehicles saw a larger increase of 44.41%, potentially reflecting expanded fleet usage or longer travel distances.

- These increases could highlight the need for reviewing fleet operations, encouraging fuel-efficient driving practices, or transitioning to lower-emission vehicles.

3. Horticulture Equipment Fuel Consumption

- Emissions related to petrol-powered horticultural equipment grew by 25.40%, possibly due to extended usage periods or expanded landscaping activities.

4. Fugitive Emissions from Refrigerants

- Notably, emissions from Refrigerant R407 significantly decreased by 41.67%, a positive shift that may reflect improved maintenance, reduced leakage, or changes in refrigerant usage.

- On the contrary, emissions from Refrigerants R32, R22, and R410 all increased, with R410 emissions rising by 31.43%, the highest among these three. These increases could point to growing refrigeration demands or aging equipment prone to leakage.

Key Observations

- The sharp rise in diesel combustion and fugitive emissions from R410 refrigerants are the most significant contributors to the overall increase in emissions.

- While one refrigerant (R407) showed marked improvement, most other sources demonstrated increased emissions, suggesting a need for more aggressive energy and refrigerant management strategies.

Recommendations

- Implement energy efficiency measures for stationary combustion activities, including optimizing fuel mix and exploring cleaner energy alternatives.
- Upgrade vehicle fleet to hybrid or electric models and implement telematics to reduce fuel consumption.
- Regular maintenance and phased replacement of older HVAC/refrigeration systems to minimize refrigerant leakage.
- Monitor and manage emissions trends through improved data tracking and reporting to identify specific sources of inefficiency.

Table 3.1.4 (c): Comparison Scope 1 Emissions 2023 & 2024

Activity	Source	Absolute Emission tCO_2e 2023	Absolute Emission tCO_2e 2024	Percentage increase/decrease in emissions from 2023
Stationary combustion	Diesel	32.13	104.80	226.18%
Stationary combustion	LPG	112.33	156.24	39.08%
Owned vehicle Fuel Consumption	Diesel	59.77	66.26	10.85%
Owned vehicle Fuel Consumption	Petrol	4.54	6.55	44.41%
Horticulture equipment fuel consumption	Petrol	2.91	3.65	25.40%
Fugitive	Refrigerant(R	21.29	12.42	-41.67%

Activity	Source	Absolute Emission tCO_2e 2023	Absolute Emission tCO_2e 2024	Percentage increase/decrease in emissions from 2023
emissions	407)			
Fugitive emissions	Refrigerant(R 32)	4.06	4.74	16.67%
Fugitive emissions	Refrigerant(R 22)	10.86	12.67	16.67%
Fugitive emissions	Refrigerant(R 410)	146.16	192.10	31.43%
Total		**394.05**	**559.42**	

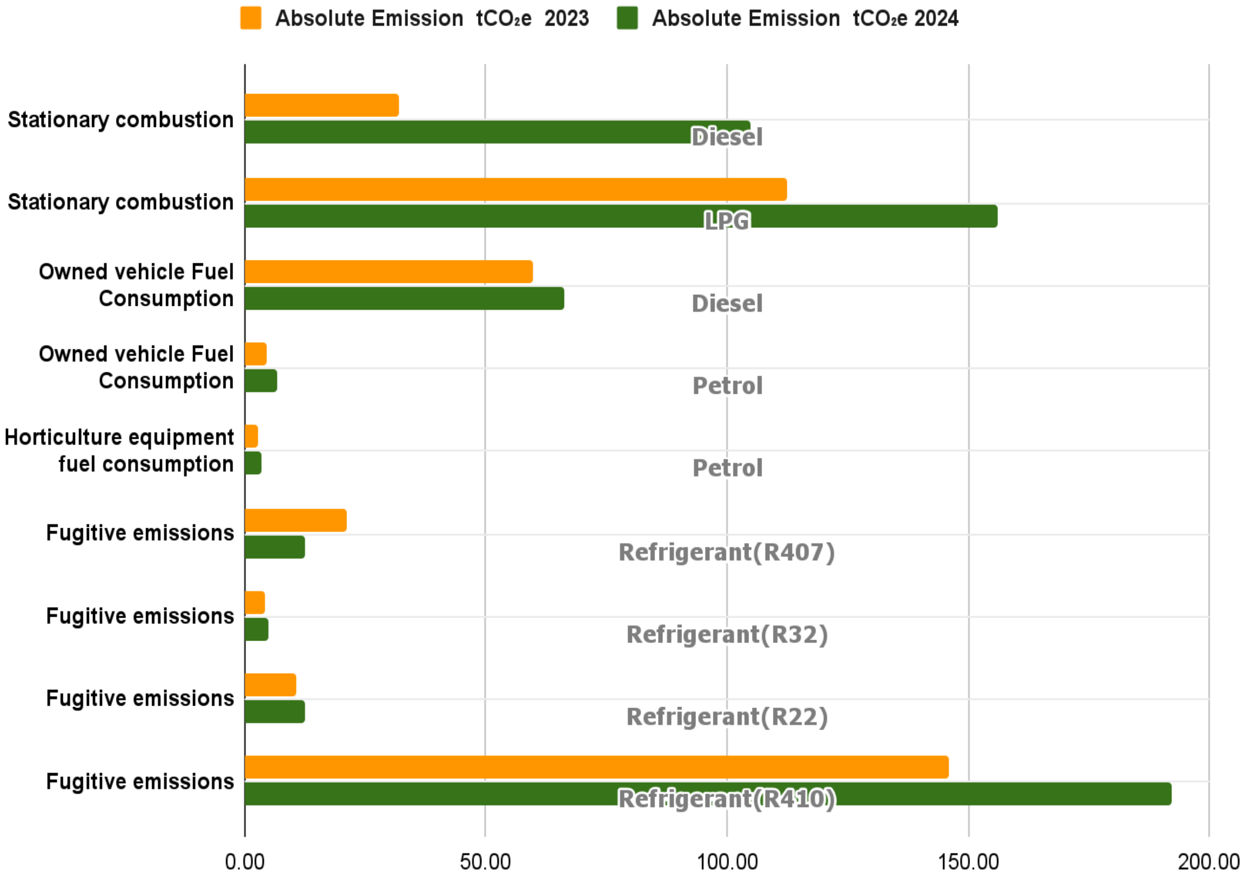


Figure 3.1.4 (b): Comparison – Scope 1 Emissions 2023 & 2024

3.2 Scope 2 GHG Emissions

Scope 2 GHG emissions refer to indirect emissions from the consumption of purchased electricity, steam, heating, and cooling. These emissions occur at the power generation source, but the organization is responsible for them due to its demand for the energy.

3.2.1 Emissions From Purchased Energy (Electricity)

The only energy purchased in IIM Kozhikode is electricity. Under the **GHG Protocol**, **Scope 2 emissions** from electricity refer to indirect greenhouse gas emissions associated with the generation of purchased electricity consumed by an organization. These emissions occur at the power plants where electricity is produced but are attributed to the organization based on its consumption of the electricity.

The electricity is purchased from Kerala State Electricity Board (KSEB). The supply at 11kV is distributed at 433 V by two substations namely Academic hill and Residential hill.

The electricity consumption detail and the CO_2e emissions for the year 2024 is tabulated below.

Table 3.2.1 (a): Annual electricity consumption at IIMK (2024)

Month	Activity	Electricity – Residential	Electricity – Academic	Electricity – Total
		Consumption (kWh)	Consumption (kWh)	Consumption (kWh)
Jan'24	Purchased Energy	59436	553890	613326
Feb'24		57060	563820	620880
Mar'24		65277	612915	678192
Apr'24		59325	508290	567615
May'24		48435	338520	386955
Jun'24		53829	447135	500964
Jul'24		54747	463380	518127
Aug'24		58755	491445	550200
Sep'24		57222	514890	572112
Oct'24		58968	508200	567168
Nov'24		58749	546975	605724
Dec'24		57576	533470	591046
Average				564359

Month	Activity	Electricity – Residential	Electricity – Academic	Electricity – Total
		Consumption (kWh)	Consumption (kWh)	Consumption (kWh)
Total				**6772309**

Table 3.2.2 (b): Scope 2 Emissions (Electrical) 2024

Activity	Source	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Purchased Energy	Electricity	6772309	kWh	0.82	kg/ kWh	5553293	**5553.29**

SCOPE 2 Emission– Previous year (2023)

The electricity consumption details and the CO_2e emissions for the year 2023 are tabulated below.

Table 3.2.1 (c): Annual electricity consumption at IIMK (2023)

Period	Activity	Electricity – Residential	Electricity – Academic	Electricity – Total
		Consumption (kWh)	Consumption (kWh)	Consumption (kWh)
Jan '23 – Dec '23	Purchased Energy	5516463	523500	6039963

Table 3.2.1 (d): Scope 2 Emissions (Electrical) 2023

Activity	Source	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute Emission CO_2e	Absolute Emission CO_2e
						kg	tonne
Purchased Energy	Electricity	6039963	kWh	0.82	kg/ kWh	4952770	**4952.77**

From this table we can see that there is a **12.1%** increase in emissions, amounting to 600.5 tCO_2e, from 2023 to 2024.

3.2.2 Summary of Scope 2 Emissions

The scope 2 emissions includes the emissions due to energy purchase. The only energy purchase in IIMK is electricity.

For the year 2024 the total scope 2 Absolute emissions was **5553.29** tonnes which is **12.1%** higher than previous year.

Scope 2 emissions (electricity) can be mitigated by using renewable energy sources such as solar plants and by purchasing renewable energy from suppliers through power purchase agreements.

The scope 2 Absolute emissions for the year 2024 and 2023 are tabulated below.

Table 3.2.2 (a): Scope 2 Emissions Summary

Classification	Activity	Absolute Emission tCO_2e
Jan '23 – Dec '23	Purchased Energy	**4952.77**
Jan '24 – Dec '24	Purchased Energy	**5553.29**

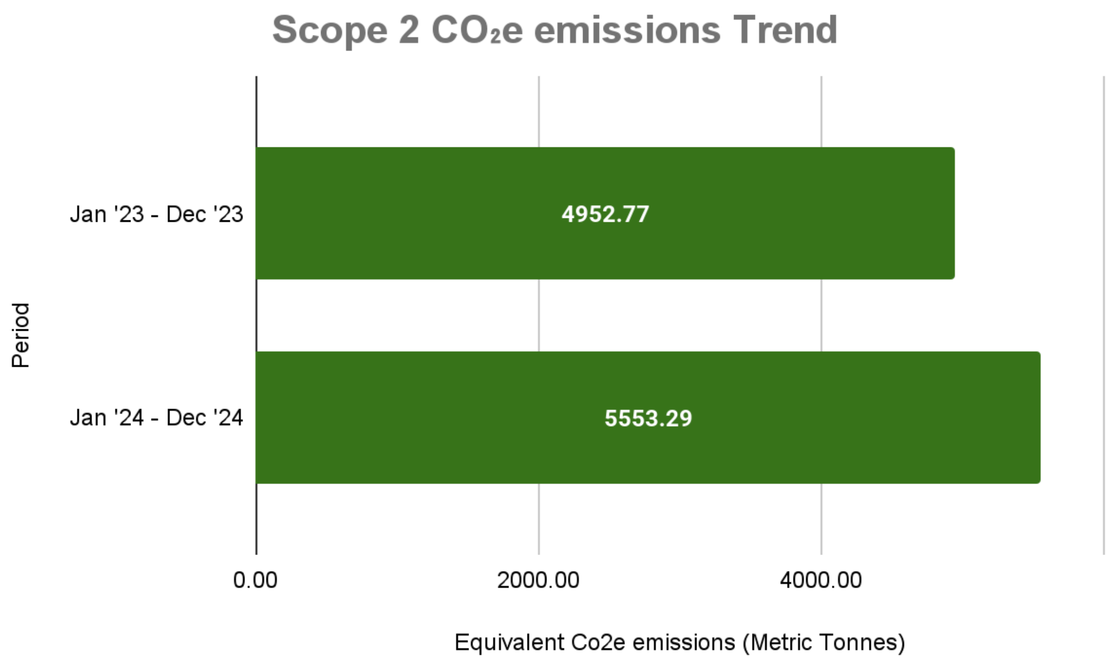


Figure 3.2.2 : Scope 2 Emissions Trend

3.3 Scope 3 GHG Emissions

Scope 3 GHG emissions refer to indirect emissions that occur in the value chain of an organization, both upstream and downstream. These emissions can result from activities such as purchased goods and services, capital goods, business travels, employee commute, waste disposal, etc. Unlike Scope 1 and Scope 2 emissions, Scope 3 emissions are not directly controlled by the organization, making them more challenging to measure and manage.

The scope 3 emissions in IIM-K is calculated based on Average-data method :- It estimates emissions for goods and services by collecting data on the mass (e.g., kilograms), or other relevant units of goods or services purchased and multiplying by the relevant secondary (e.g., industry average) emission factors (e.g., average emissions per unit of good or service).

Secondary data (e.g., from published databases, government statistics, literature studies, and industry associations), is used to arrive at the emission factors. Care has been taken to understand the boundaries covered by the data to minimize the potential for double counting errors overlapping across the value chain.

The summary of scope 3 emissions is tabulated below:

Table 3.3(a): Summary of Scope 3 Emissions at IIMK (2024)

Classification	Activity	Particulars	Quantity	Unit of Quantity	Emission Factor	Unit of emission factor	Absolute emissions	Absolute emissions
							kg	Tonne
Scope 3	Purchased electricity	Electricity T & D loss	727479	kWh	0.82	kg CO_2e / kWh	596533	596.53
	Air travel	Distance travelled	381600	pax km	0.127	kg CO_2e / pax km	48463.2	48.46
	Employee commute	-	-	-	-	-	551230	551.23
	Fertilizer emissions	-	-	-	-	-	716	0.72
	Food consumption		615,636	kg	-	kg CO_2e /kg	2330574	2330.57
	Water consump	Transportation of	4244	kL	-	kg CO_2e /kL	6919	6.92

Classification	Activity	Particulars	Quantity	Unit of Quantity	Emission Factor	Unit of emission factor	Absolute emissions kg	Absolute emissions Tonne
	tion	tanker water						
	Waste management	Wastewater	153118	kL	0.185	kg CO_2e /kL	28327	28.33
		Food waste	132000	kg	0.0088	kg CO_2e /kg	1162	1.16
	Civil maintenance works	-	-	-	-	-	70870	70.87
	Civil infrastructure	Sports complex	-	-	-	-	15864	15.86
	Purchased goods and services	-	-	-	-	-	292013	292.01
	Total						**3942671.2**	**3942.67**

The following is the list of scope 3 emissions identified at IIM-K.

Business Travels

Business travels encompasses travelling in a job-related context by staff members of IIM-K. The majority of business travels were domestic flights. A total of 3,81,600 passenger-kms were recorded during the reporting period. The emissions from hotel stay and auxiliary transport services have been excluded for the want of supporting data.

Carbon emission = Distance travelled (pax km) x EF (kg CO_2e / pax km)

Purchased electricity T&D loss

The facility purchases electricity from the state grid. It is reported that there is transmission and distribution loss of 9.7% from the generation side to the user end as per the Kerala State Electricity Regulatory Commission report FY '24.

Carbon emission = Electricity T&D loss (kWh) x EF (kg CO_2e / kWh)

Employee commute

In evaluating the carbon footprint of our organization, we have identified employee commuting as a significant factor, primarily due to our reliance on fossil fuel-powered transportation. We collected important data on the modes of transportation used by employees, including the average distance traveled per trip, commuting frequency, and the specific emission factors associated with each type of transport. Through our calculations, we quantified the overall carbon emissions by multiplying the total kilometers traveled by the relevant emission factors, measured in kilograms of CO_2 per kilometer. Notably, teaching staff members using private vehicles are responsible for annual emissions of **31.45 tonnes of CO_2e**. In contrast, non-teaching staff, who primarily commute in their own vehicles, contribute an estimated **85.43 tonnes of CO_2e**.

Additionally, contract workers and others commuting from Calicut City by diesel buses are also accounted for.The emissions from these are estimated to be **434.35 tonnes of CO_2e** each year.

In total, the commuting emissions amount to **551.23 tonnes of CO_2e** annually. With a workforce comprising 104 teaching staff, 102 non-teaching staff, 350 contract workers and other commuters, the organization must explore more sustainable transportation alternatives to reduce its environmental impact.

Food consumption

As part of the carbon audit conducted at IIM Kozhikode, we analyzed the food consumption patterns and their associated carbon emissions over a one-year period. The data covered a wide range of food products, including groceries, vegetables, fruits, non-vegetarian items, bakery products, dairy, and other consumables.

Carbon emission = Food consumption (kg) x EF (kg CO_2e / kg)

Key Metrics:

- Total Food Consumption: **6,15,636 kg** of various food products were consumed during the audit period.
- Total Carbon Emissions: The calculated carbon emissions from these food products amounts to **2,330.6 tonnes of CO_2e** annually.

These figures provide critical insights into the environmental impact of food consumption at IIM Kozhikode. The data highlights the need for targeted strategies to reduce carbon footprints, such as promoting locally sourced and sustainable products, optimizing supply chains, and encouraging eco-friendly consumption habits.

Table 3.3(b): Food Consumption - Scope 3 Emissions at IIMK (2024)

Period	ITEMS	TOTAL CONSUMPTION (KG)	Emission Factor (Kg CO_2e/kg)	Kg CO_2e	Tonne CO_2e
Jan-24 to Dec-24	GROCERY	108,562	2.33	252950	253
	VEGETABLES	116,503	0.37	43106	43
	FRUITS	21,497	0.503	10813	11
	NON VEG	253,488	6.889	1746280	1746
	BAKERY	404	2.45	990	1
	DIARY	115,181	2.4	276434	276
TOTAL		**615,636**	3.79	2330574	**2331**

Transportation of tanker water

The facility on an average consumes about 650 kL of water per day. The main source of freshwater is 3 ponds spread across the Institute. However, during peak summers additional water is made available from tanker supplies. A total of 4244 kL of tanker water was purchased during the reporting period. 12 kL and 5 kL capacity tankers are used to transport water.

Table 3.3(c): Water Transportation - Scope 3 Emissions at IIMK (2024)

Description	Unit	12 kL capacity Tanker	5 kL capacity Tanker
Water consumption	kL/annum	2122	2122
Tanker capacity	kL	12	5
Number of tanker services required	Nos.	177	425
Distance traversed in each service	km	20	20
Average mileage of tanker	kms/litre	3.6	5.2
Total diesel consumed for transportation	Litres/annum	986.1	1634.6
Total emissions	kgCO2e/annum	2603	4315
	tCO2e/annum	2.60	4.32
	tCO2e/annum	6.92	

Civil maintenance works

A total of 28 major civil maintenance works were carried out in the facility during the reporting period. The total work order value of the respective activities were provided by IIM-K. The Absolute CO_2 emissions was calculated by estimating the quantity of construction goods from the total cost and multiplying it by the industry average emission factor for the major items used for construction. The total embodied carbon emissions are then divided by the estimated lifespan of the maintenance work (estimated to be 3 years) to arrive at the annual CO_2e emission.

Carbon emission = Quantity x EF (kg CO₂CO2e /qty) / lifespan

The calculations are provided in annexure II.

Civil infrastructure

A sports complex comprising of football ground, swimming pool, tennis court, changing room and a washroom block was built in the institute in 2024. The area of the structures was provided by IIM. The amount of different types of materials used for construction was estimated from the area given and the total emission is calculated using the emission factors of the respective construction materials. The total embodied carbon emissions is then divided by the estimated lifespan of the construction work to arrive at the annual CO_2e emission.

Carbon emission = Quantity x EF (kg CO_2e /qty) / lifespan

Table 3.3(d): Scope 3 Emissions - Civil Infrastructure (2024)

Sports complex			
Particulars	Total embodied carbon emission (tCO_2e)	Estimated lifespan of structure (years)	Annual carbon emission (tCO_2e/ year)
Football field	41.6	15	2.77
Tennis court	63.9	10	6.39
Swimming pool	87.2	20	4.36
Washroom block	17.3	30	0.58
Changing room	53.0	30	1.77
Total Tonne	**263.0**	**-**	**15.9**

Waste management

The facility generates a variety of wastes – from food and human waste to paper, plastics, metal and electronics. IIM-K has a comprehensive system in place to manage waste in an environmentally responsible manner.

The daily food waste generation is estimated to be around 400 kg. The food waste is decomposed in 3 organic waste converter (OWC) machines operated in the facility. The emission factor considered for the gas emissions from the decomposing waste excludes the electricity used for operating the OWC machines to eliminate double counting errors.

The facility has one 350 kL/day and another 140 kL/day capacity STP plants for the treatment of wastewater. The recycled water from the STP is used for gardening purposes thereby reducing the consumption of freshwater.

The emissions from food and wastewater only are calculated as the data for other forms of waste is not readily available.

Carbon emission = Quantity x EF (kg CO_2e /qty)

Paper and plastic wastes are segregated at the facility itself. The wastes are then collected by 'Niravu' – a waste management consultancy based in Kozhikode.

Metal is given as scrap by floating tender.

e-waste management – IIM-K has a buyback policy with the electronics manufacturers. In buy-back policy, a part of Extended Producer Responsibility (EPR), involves producers to take back the used electronic equipment from consumers, ensuring proper collection, transportation, and disposal through authorized recyclers. Sanitary wastes are disposed off in incinerators. Since IIM-K has a no-burning policy in the Institute, electric incinerators are used instead of conventional fuel based ones.

Fertilizer Use

Fertilizer usage results in CO_2e emissions primarily through the release of nitrous oxide (N_2O) during soil application, which has a significantly higher global warming potential than CO_2. Additionally, the production, transportation, and application of fertilizers contribute to CO_2e emissions, particularly from the use of fossil fuels in these processes. The total CO_2e emissions from fertilizer usage depend on factors such as the type and quantity of fertilizer applied, soil conditions, and agricultural practices.

Carbon emission = Quantity (kg) x EF (kg CO_2e / kg)

The details of usage and Absolute CO_2 emission by fertilizers are tabulated below.

Table 3.3(e): Scope 3 Emissions - Fertilizer usage (Jan 2024 - Dec 2024)

Type	Consumption	Unit	Emission Factor	Unit of emission factor	Absolute CO_2e Emissions	
					kg/annum	tonne/annum
Urea	100	kg	0.3127	kgCO_2e/ kg	31	0.03
17-17 Compound	100	kg	0.5	kgCO_2e/ kg	50	0.05
MOP	150	kg	0.05	kgCO_2e/ kg	8	0.01
Cow Dung Dry	12500	kg	0.045	kgCO_2e/ kg	563	0.56
Cow Dung Wet	1050	kg	0.024	kgCO_2e/ kg	25	0.03

Groundnut Cake	150	kg	0.2	$kgCO_2e/kg$	30	0.03
Limestone powder	50	kg	0.2	$kgCO_2e/kg$	10	0.01
Total					**716**	**0.72**

Purchased goods and services

The college procures a wide range of goods each year to support its academic, administrative, and residential functions. These include paper products, plastic products, Computers & IT equipment, Electronics & appliances, Furniture, Office supplies, Hostel stationery & student supplies.

A comprehensive list of procurements made and during the reporting period was provided by the facility. The co_2e for the goods was calculated by multiplying the quantity and their respective emission factor.

The associated upstream transportation emissions were also calculated by estimating the distance from the source to the institute.

$$\text{Carbon emission(Products)} = \text{Quantity (kg)} \times \text{EF (kg } CO_2e / kg)$$

$$\text{Carbon emission(Transportation)} = \text{Distance(km)} \times \text{EF (kg } CO_2e / km)$$

The calculated carbon emissions from purchased goods and services along with their transportation related emissions amounts to **292 tonnes of CO_2e** annually.

Table 3.3(f): Scope 3 Emissions - General Purchase (Jan 2024 - Dec 2024)

Category	Emission from Purchased products (tCO_2e)	Emission from Purchase related transportation (tCO_2e)	Total emission (tCO_2e)
Purchase through tenders (GEM Portal)	100.970	140.382	241.352
Direct Purchases	37.09	13.5678912	50.66
			292

4. CARBON SEQUESTRATION

Carbon sequestration by trees refers to the process where trees absorb carbon dioxide (CO_2) from the atmosphere during photosynthesis and store it in their biomass (trunks, branches, leaves, and roots) and in the soil.Trees take in CO_2 from the air, use sunlight to convert it into oxygen and glucose through photosynthesis, and store the carbon in their tissues.

Types of Carbon Stored in Trees:

- Aboveground Biomass: Trunk, branches, leaves, and fruits.
- Belowground Biomass: Roots.
- Soil Carbon: Carbon that is transferred to the soil through leaf litter and root decay.

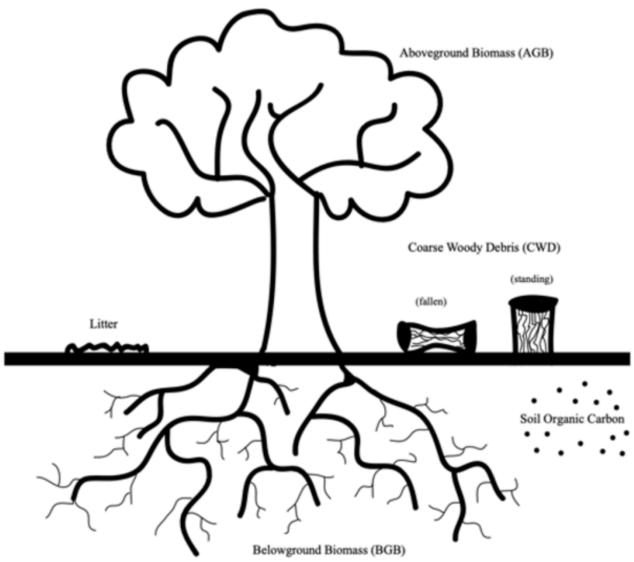


Figure 4.1.: Carbon Stored in Trees

Carbon sequestration rates in plantations vary significantly based on tree species, climate, soil conditions, and forest management practices. Below are general estimates for carbon sequestration per hectare per year for various plantation types:

Table 4.2.: Average Carbon Sequestration Based on Plantation

Type of Plantation	Average Carbon Sequestration (tCO_2/ha/year)
Tropical Forest	5–10 tCO_2/ha/year
Temperate Forest	2–5 tCO_2/ha/year
Boreal Forest	1–3 tCO_2/ha/year
Mangroves	4–6 tCO_2/ha/year
Reforestation Projects	2–8 tCO_2/ha/year (depends on tree species)
Agroforestry Systems	1–4 tCO_2/ha/year

Indian Institute of Management Kozhikode (IIM Kozhikode) is situated on a sprawling 112.5 acre campus. Out of this, 71.32 acres are dedicated to plantation activities, while the remaining area is utilized for buildings, grounds, parking spaces, gymnasiums, and other infrastructure. The college is surrounded by lush greenery, with well-manicured lawns, towering trees, and vibrant gardens that create a serene and refreshing campus atmosphere. The Institute is rich in biodiversity, featuring a diverse range of tree species and vegetation, which significantly contributes to the institution's environmental sustainability goals.

The plantation comprises a variety of native and ornamental tree species, including:Kumil, Batham, Vatta, Kunni, Veetti, Sandal, Mullu Venga, Teak, Mahogany, and Bamboo.

The carbon sequestration calculation requires an extensive study of assessing the sequestration of individual trees and plants based on their dimension and type. Thus an assumption based on the total green cover at the facility has been arrived at to evaluate the carbon sequestration on an average level.

The Carbon Sequestration in the Facility is 202.02 tCO_2e/year.

Based on general sequestration rates for similar species:

- Bamboo: 6–13 tCO_2/ha/year
- Teak & Mahogany: 7–12 tCO_2/ha/year
- Sandal & Other Hardwood Species: 4–8 tCO_2/ha/year

Figure 4.2.: Common Trees in the facility

Table 4.2.: Estimated Total Area

Common Area	Area in Acre
Total Available Land Area	112.5
Total Built Up Area	10.63
Area used for Transportation	14.45
Area used for Gym,Sports,Parking and land not in use	8.33
Total pond Area	7.77
Total Occupied Area	41.18
Estimated Total Area under green cover	71.32

Table 4.3.: Estimated Total Carbon Sequestration

Total Area in Acres	Total Area in Hectare	Average Emission Factor (tCO_2/ha/year)	Total Carbon Sequestration (tCO_2e/year)
71.32	28.86	7	202.02

5. OVERALL INFERENCE AND CONCLUSION

This inaugural carbon audit has provided valuable insights into IIM Kozhikode's carbon footprint, identifying key emission sources across various operations. The audit indicates that the primary contributors to emissions are energy consumption in building operations, particularly through HVAC systems, and transportation activities, which account for a significant portion of Scope 1 and Scope 2 emissions. The use of refrigerants in cooling systems has been identified as a notable source of fugitive emissions.

The audit results show that energy consumption, particularly from electricity, is the largest emission contributor, highlighting an opportunity for improvement through the adoption of renewable energy sources. Additionally, transportation-related emissions, including employee travel and fleet operations, represent another area where emissions reduction strategies could have a significant impact.

Since this is the first audit conducted, there are no previous benchmarks for direct comparison. However, the data provides a baseline for future audits, allowing for better tracking of emission reduction efforts over time. To reduce overall emissions, recommendations include transitioning to energy-efficient and renewable energy systems, improving fleet efficiency, and addressing refrigerant leakage through better maintenance and alternative technologies. These actions, along with regular monitoring, will be essential in achieving sustainability goals and meeting future emission reduction targets.

In the assessment year (2024), the institute reported total greenhouse gas emissions(**Absolute Emissions**) of **10,055.38 tCO_2e**. The scope wise emission data is tabulated below.

Table 5.: Summary of CO_2e emissions 2024

Classification	Absolute emissions (t CO_2e)	Percentage Share (%)
Scope 1	559.4	5.6%
Scope 2	5553.3	55.2%
Scope 3	3942.7	39.2%
Total Absolute CO_2e Emission	10055.4	

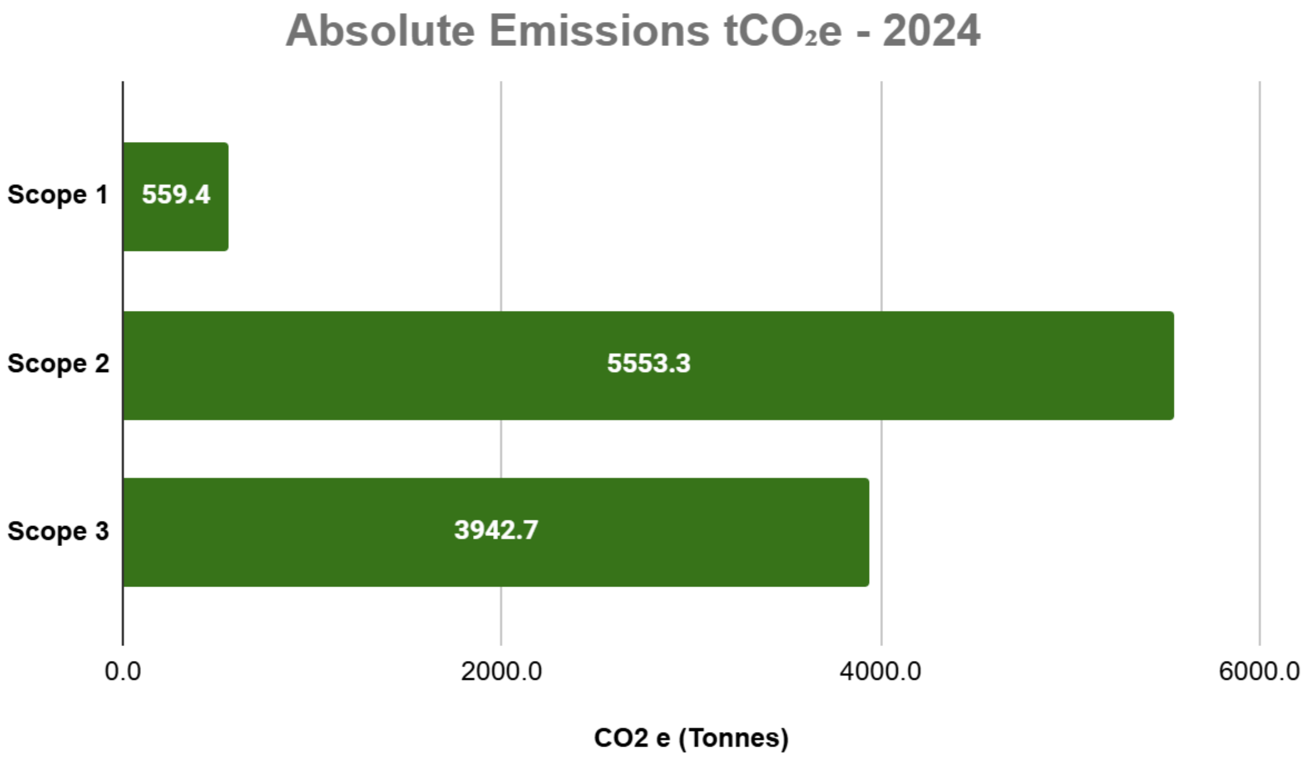


Figure 5.: Summary of CO_2e emissions 2024

5.1 Carbon Neutrality

Achieving carbon neutrality involves balancing the amount of greenhouse gases (GHGs) emitted with an Absolute amount removed or offset. The process begins with measuring an organization's or individual's carbon footprint through a comprehensive carbon audit. This audit identifies major emission sources such as energy consumption, transportation, and waste management.

Once emissions are measured, the focus shifts to reduction – implementing energy-efficient technologies, transitioning to renewable energy, and adopting sustainable operational practices. After emissions have been minimized, the remaining unavoidable emissions can be offset through verified methods such as afforestation, investments in renewable energy projects, or the purchase of certified carbon credits. Continuous monitoring, transparent reporting, and regular audits are essential to ensure accountability and sustained progress.

Aligning these efforts with internationally recognized standards such as the Greenhouse Gas Protocol and ISO 14064 ensures credibility and standardization. Achieving carbon neutrality not only contributes to global climate change mitigation but also enhances institutional reputation, attracts environmentally conscious stakeholders, and supports long-term sustainability goals. It represents a critical step toward a greener, more resilient future.

Current Emission Status of IIMK

- **Annual CO_2e Emissions (2024):** 10,055.4 tonnes
- **Estimated Annual Carbon Sequestration (via trees):** 202.02 tonnes
- **Estimated Annual Carbon Savings by implementing Energy Conservation Measures and Renewable Energy Integration:** 3,676 tonnes

The recommendation and suggestions include implementation of a 2.3 MWp solar power plant, utilization of electric vehicles for transportation, use of biogas for kitchen usage, adoption of sustainable procurement practices etc. These measures are projected to result in a **GHG emissions reduction of 35% by 2030**, accounting for the time required to implement the proposed strategies.

Pathway to Carbon Neutrality

Post-implementation, several measures can be adopted to further progress toward carbon neutrality:

- Conversion of fossil fuel–dependent transportation to **biofuels and electricity**
- Sourcing **100% renewable electricity** through power purchase agreements and the expansion of the on-site **solar power plant**
- Utilization of **biogas** in kitchen facilities to reduce emissions.
- Adoption of **sustainable procurement practices** and engagement with suppliers who have achieved carbon neutrality in their services to reduce emissions across the supply chain
- Optimization of **product and service design** to minimize life-cycle carbon impacts
- Promotion of **green logistics**, reduction of **business travel**, and encouragement of **sustainable employee commuting**
- Conservation and expansion of existing flora on the campus to offset carbon emissions.
- Utilization of **Carbon Credit Trading.** It involves the exchange of carbon credits under both compliance and voluntary markets to reduce greenhouse gas emissions. **ESCerts (Energy Saving Certificates)** are tradable instruments under the PAT(Performance, Achieve and Trade) scheme, awarded to industries that exceed energy efficiency targets, allowing them to sell excess savings to underperforming units.

Target

Based on the outlined strategies and projections, **IIMK is expected to achieve carbon neutrality by the year 2040.**

Target 2030 – 35 % reduction in net CO2e emissions

Target 2035 – 70% reduction in net CO2e emissions

Target 2040 – 100% reduction in net CO2e emissions

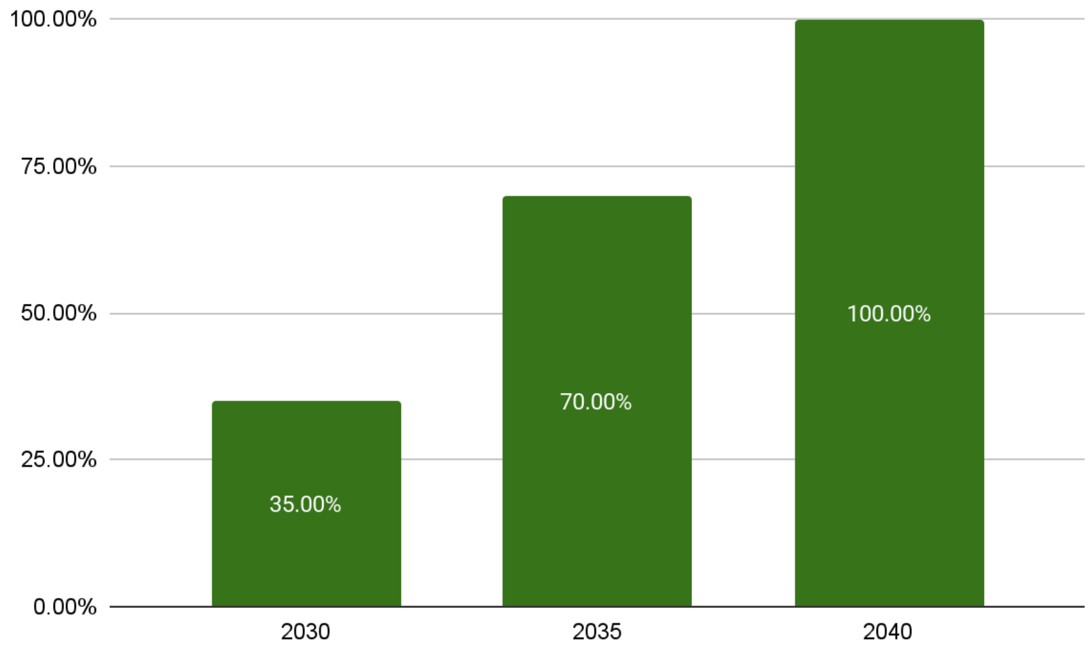


Figure 5.1: Carbon Neutrality Target

5.2 Challenges & Limitations

The presented calculation is the first time an emissions inventory has been created for IIM-K. Every assessment process has been done from the scratch and was developed along the way.

Travelling and commuting are emission categories often cited as being subject to complications in acquiring reliable data sources, and we faced similar limitations.
Limitation in availability of India centric GHG emission factors in the scope 3, the values are either taken from a global database and further computed to India centric operational practices or else computed using published global methodologies.
Limitations were observed in calculating carbon sequestration as the data regarding amount of trees, shrubs and grass cover – their height, girth and age is not available. An average value of carbon sequestration is reached based on the amount of land under green cover.

The experience acquired during the assessment of this case study suggests that the development and improvement of strategies for collecting data should be considered a special point of focus. In addition, developing reliable structures for the collection of data might prove beneficial, especially for institutions with future commitments towards carbon neutrality or mitigation measures, as following up on those goals requires a regular update of the emissions inventory.

5.3 Data to be maintained for Recurring Carbon Audit

Carbon Emission Audit methodology is a completely data driven process and hence requires an extensive compilation of various parameters at periodic intervals. Scope3 emission audit especially emphasizes on actual quantity of goods and services procured ,logistics,manpower commute etc.A record of the following data can be maintained by the institution in order to make the future audit process accurate and easier.

1. Energy consumption and cost (All Sources)
2. Business travel history
3. Mode of transportation of employees
4. Employee commute
   - Distance travelled
   - Type of vehicle owned (Fuel type)
5. Quantity of refrigerant top up
6. Quantity and type of waste disposed
7. Maintenance activity register
8. Purchased goods & services
9. Long term physical assets like buildings, machinery or vehicles
10. Data of transportation and distribution of purchased goods
11. Leased assets by the facility
12. Investment made by the facility
13. Student commute data
14. Air travel data
15. Food consumption data
16. Water consumption data

6. CO_2e MITIGATION MEASURES

Carbon mitigation involves reducing or preventing the release of carbon dioxide (CO_2) and other greenhouse gases to combat climate change. It's essential because rising emissions contribute to global warming, leading to extreme weather, rising sea levels, and ecological damage. Mitigation strategies include shifting to renewable energy, improving energy efficiency, reforestation, and using carbon capture technologies. Urgent action is needed to avoid irreversible environmental impacts and to meet global climate goals. By mitigating emissions, we can protect ecosystems, improve public health, create green jobs, and ensure a sustainable future for future generations.

1. Reduction of dependency of fossil fuels

Reducing dependence on fossil fuels is crucial to mitigate climate change, as their combustion releases harmful greenhouse gases that contribute to global warming. Transitioning to cleaner, renewable energy sources will help reduce environmental damage, improve air quality, and promote long-term sustainability.

2. Hazard of Refrigerants

Refrigerants, particularly those that are hydrochlorofluorocarbons (HCFCs) and hydrofluorocarbons (HFCs), contribute to global warming and ozone layer depletion when released into the atmosphere. These chemicals have a high global warming potential, which accelerates climate change and harms the environment.

3. Importance of renewable energy integration.

Integrating renewable energy sources like wind, solar, and hydropower is crucial for reducing CO_2 emissions, as they produce little to no greenhouse gases during energy generation. Transitioning to renewables helps reduce reliance on fossil fuels, which are the primary contributors to CO_2 emissions and global warming. By increasing the share of renewable energy in the global energy mix, we can significantly mitigate climate change and move towards a more sustainable, low-carbon future.

4. Energy efficiency

Energy efficiency is vital for CO_2 mitigation because it reduces the overall demand for energy, directly lowering the amount of fossil fuels burned and subsequent CO_2 emissions. By optimizing energy use in buildings, transportation, and industries, we can decrease waste and enhance productivity without increasing environmental impact. Improving energy efficiency is one of the most cost-effective strategies to combat climate change while promoting sustainable development and reducing energy consumption. Please refer to chapter 8 for detailed recommendations and suggestions.

5. Recycling of solid waste and water

Recycling waste helps reduce CO_2 emissions by minimizing the need for raw material extraction and processing, which are energy-intensive activities that release greenhouse gases. Recycling also diverts organic waste from landfills, where it would decompose anaerobically, producing methane, a potent greenhouse gas. Efficient water use and recycling decrease the energy required for water treatment and distribution, further lowering CO_2 emissions and promoting a more sustainable use of resources.

7. ENERGY ANALYSIS

7.1 Energy Consumption & Cost Data

Electricity, LPG, Diesel and Petrol are the major sources of energy consumed in the institute. While electricity is used all around the facility by motors and appliances, LPG is used in the kitchen, diesel is used for DG sets and petrol is used for transportation and others. Energy consumption pattern varies according to the ambient temperature & humidity, events conducted and number of rooms occupied at the institute .

For carrying out various cost savings calculations we are considering the latest annual energy data which corresponds to the year Dec 24 to Jan 24. The per unit cost of fuels used in the facility is arrived at by taking the average per unit fuel cost for the past 12 months.

Table 7.1 : Energy consumption and Cost Breakup at IIM Kozhikode Kozhikode

Month	Electricity		LPG		Diesel		Petrol	
	Total Units Consumed	Electricity Cost	Total Consumption	LPG Cost	Total diesel consumption	Diesel Cost	Total petrol consumption	Petrol Cost
	kWh	Rs		Rs	Litre	Rs	Litre	Rs
Jan-24	613326	4851432	5551	548647	4040	390814	347	37500
Feb-24	620880	4934207	5038	480858	3172	307328	264	28478
Mar-24	678192	5331490	5019	485786	4877	464523	180	19267
Apr-24	567615	4635789	1984	188760	4486	421909	239	25333
May-24	386955	3038587	1509	142024	6533	613415	232	24541
Jun-24	500964	4037848	5304	480474	4523	428816	270	28548
Jul-24	518127	4129854	3743	332339	13503	1279995	332	35095
Aug-24	550200	4341723	5168	460747	5928	560451	512	54188
Sep-24	572112	4594200	5320	484708	4495	424978	506	53517
Oct-24	567168	4484043	4788	449064	3946	372604	545	57609
Nov-24	605724	4759143	5358	518061	6403	605933	270	28556
Dec-24	591046	4716259	5092	498480	2549	241517	721	76279
Total	6772309	53854576	53874	5069948	64454	6112283	4417	468911
Average	564359	4487881	4490	422496	5371	509357	368	39076
Total cost In Lacs		**538.55**		**50.70**		**61.12**		**4.69**
Per Unit cost		**7.95**		**94.11**		**94.83**		**106.17**

7.1.1 Energy Description

The energy share is calculated based on Metric Tonne of oil equivalent. **Metric tonne of oil Equivalent**, also known as **Mtoe,** is a standardized unit used to express energy consumption, production, or reserves in terms of the equivalent energy contained in one metric tonne (1,000 kilograms) of crude oil. The metric tonne is a commonly used unit of mass in most countries that follow the metric system, and it has some specific advantages in the global energy context.

The major energy used in the facility is electricity which accounts for 80.74% of total energy followed by LPG which accounts for 8.92% of the total energy, Diesel which accounts for 0.69% and Petrol which accounts for 9.65%.

Table 7.1.1(a) : MTOE distribution at IIM Kozhikode Kozhikode

Particulars	Unit	Quantity	GCV(Kcal)	Metric tonnes of Oil Equivalent (Mtoe)	MTOE % Distribution
Electricity(Grid)	kWh	6772309	860	582.42	80.74%
LPG	kg	53874	11950	64.38	8.92%
Petrol	Litre	4417	11200	4.95	0.69%
Diesel	Litre	64454	10800	69.61	9.65%
Total				**721.36**	**100.00%**

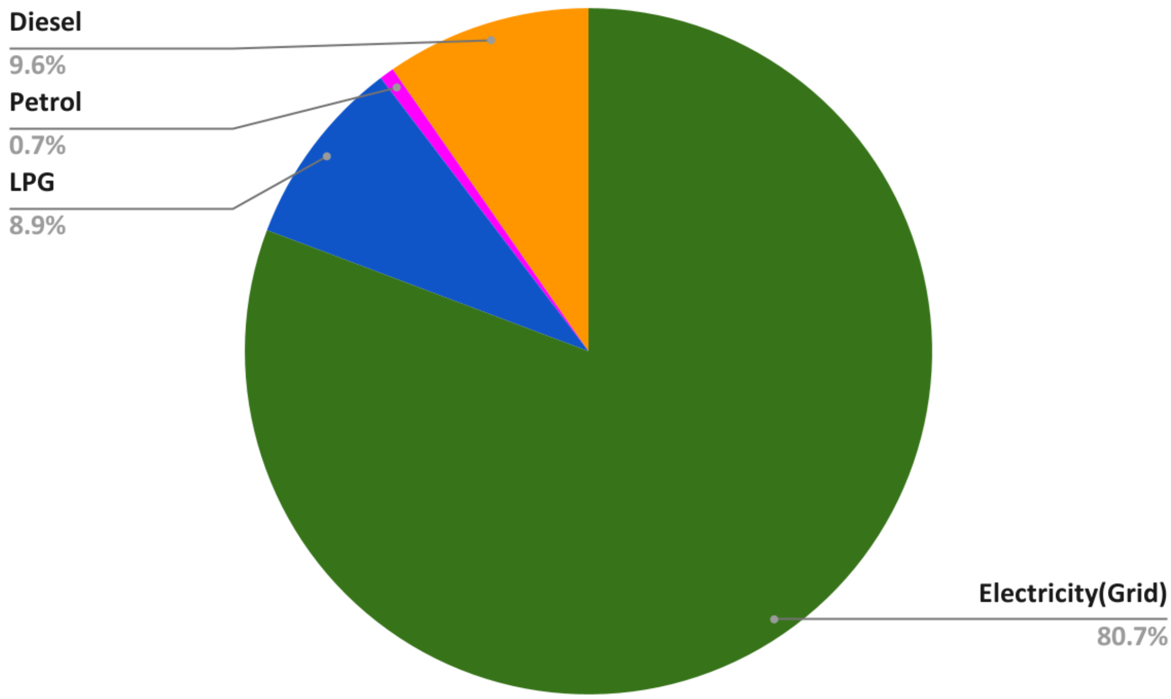


Figure 7.1 .1(a): Annual MTOE Percentage distribution

7.2 Energy Cost Share

IIM Kozhikode requires electricity for providing air-conditioning, lighting, and thermal energy. Energy is the main cost center for any building next to the employee payroll. The major electricity-consuming areas are the HVAC and heating systems. Major electricity-consuming equipment in HVAC systems are chillers and chiller auxiliaries such as chiller water pumps, condenser water pumps, and cooling towers. Centrifugal fans used for AHU and ventilation are also one of the major electricity consumers in HVAC systems.

Electricity, LPG, Diesel and Petrol account for 82.21 %, 7.74 % , 9.93 %, 0.72 % of the total energy costs respectively. Please refer to figure 7.2 (a) and table 7.2 (a) below for energy cost breakup.

Table 7.2 (a) : Energy Cost Breakup at IIM Kozhikode Kozhikode

Description	Annual Energy Consumption	Cost	Unit Cost	Percentage
		Rs. Lakhs	Rs/Qty	
Electricity (kWh)	6772309	538.5	7.95	82.21%
LPG for kitchen (kg)	53874	50.7	94.11	7.74%
Diesel (litre)	64454	61.1	94.83	9.33%
Petrol (litre)	4417	4.7	106.17	0.72%
Total Energy Cost Rs. Lakhs		**655.1**	**-**	**100%**

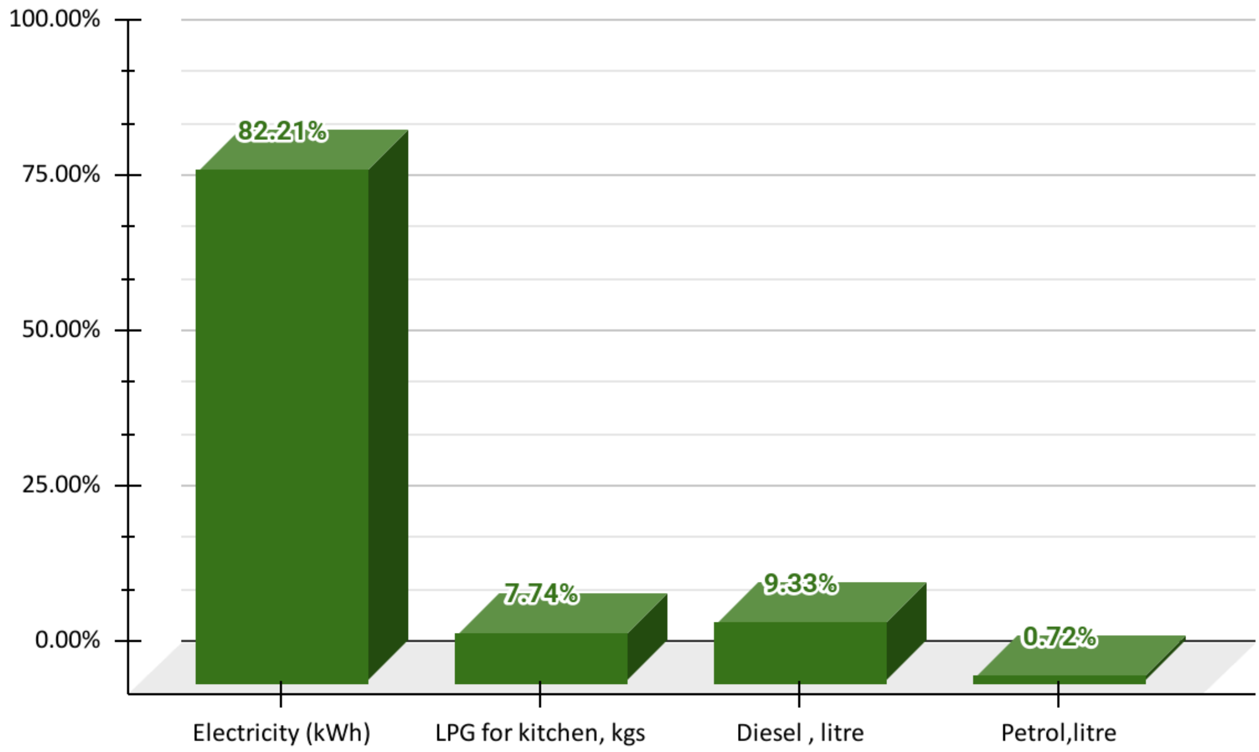


Figure 7.2 (a): Energy Cost Breakup at IIM Kozhikode Kozhikode

7.3 Electricity Bill Analysis Of Residential Hill

The electricity is purchased from Kerala State Electricity Board (KSEB). The supply at 11kV is distributed at 433 V by two substations namely Academic hill and Residential hill.

The energy bills from January 2024 – December 2024 for the residential hill were analyzed. The annual usage was 689,379 kWh. The average power factor was maintained at 0.987. The contract demand is 200 kVA and the connected load is 1228 kW.

The annual electricity cost during this period was 5,432,600 Rs.

Table 7.3(a): Electricity bill analysis Residential Hill

Supplier	KSEB										
Contract Demand (kVA)	200										
Connected load (kW)	1228										
Month	Energy (kWh)				Energy (kVAh)	Power Factor	Recorded Maximum Demand	Demand charge	Energy Charge	PF Incentive	Bill Amount
	Normal	Peak	Offpeak	Total	kVAh		kVA	Rs.	Rs.	Rs.	Rs.
Jan-24	27936	12426	19074	59436	60372	0.980	135.0	66000	368327	5524.9	477107
Feb-24	26028	11661	19371	57060	57918	0.990	134.0	66000	351189	7023.7	456244
Mar-24	29796	12729	22752	65277	66048	0.990	142.5	66000	399019	7980.3	509738
Apr-24	25281	11565	22479	59325	59931	0.990	148.3	71720	359901	7198	473588
May- 24	21252	9696	17487	48435	48435	0.980	121.2	66000	295913	4438.7	291474.3
Jun- 24	25497	11136	17196	53829	54537	0.990	138.6	66000	333343	6666.9	436645
Jul- 24	26538	10725	17484	54747	55947	0.980	127.0	66000	337218	5058.2	443344
Aug-24	28434	11553	18768	58755	59670	0.980	139.0	66000	362029	5430.4	470461
Sep- 24	27573	11208	18441	57222	58011	0.990	142.4	66000	352205	7044.1	457428
Oct-24	27813	12357	18798	58968	59667	0.990	157.1	59080	358390	7314.0	476764
Nov-24	27033	12711	19005	58749	59505	0.990	142.9	66000	365253	7305.1	472092
Dec-24	27969	11631	17976	57576	58350	0.990	143.0	67306	360167	6945.8	467714
Average	**26,763**	**11,617**	**19,069**	**57,448**	**58,199**	**0.987**	**139**	**66,009**	**353,579**	**6,494**	**452,717**
Sum	**321,150**	**139,398**	**228,831**	**689,379**	**698,391**	**-**	**1,671**	**792,106**	**4,242,953**	**77,930**	**5,432,600**

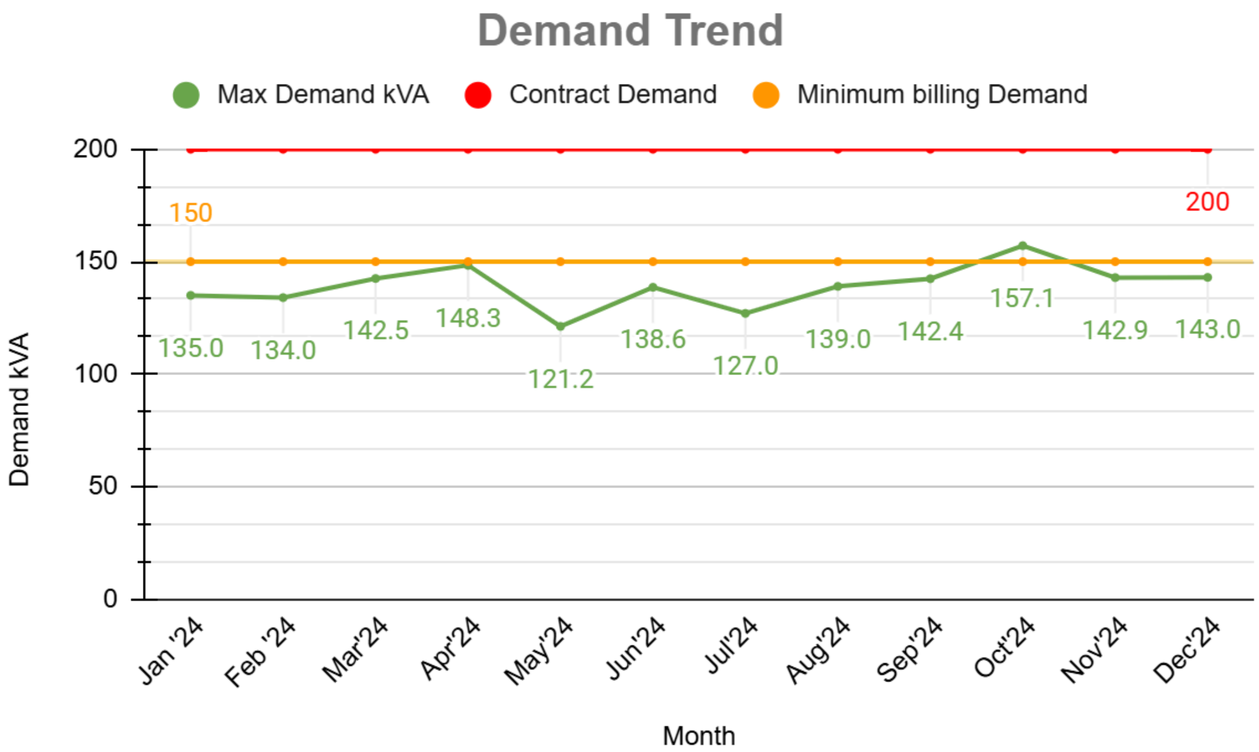


Fig 7.3 (a): Monthly Demand Trend Residential hill

- The sanctioned Contract Demand (CD) for the facility was 200 kVA.
- The average billing demand recorded around the year was 139 kVA which is within the contract demand.
- The minimum and maximum billing demand recorded during this period were 121.2 kVA and 157.1 kVA respectively.

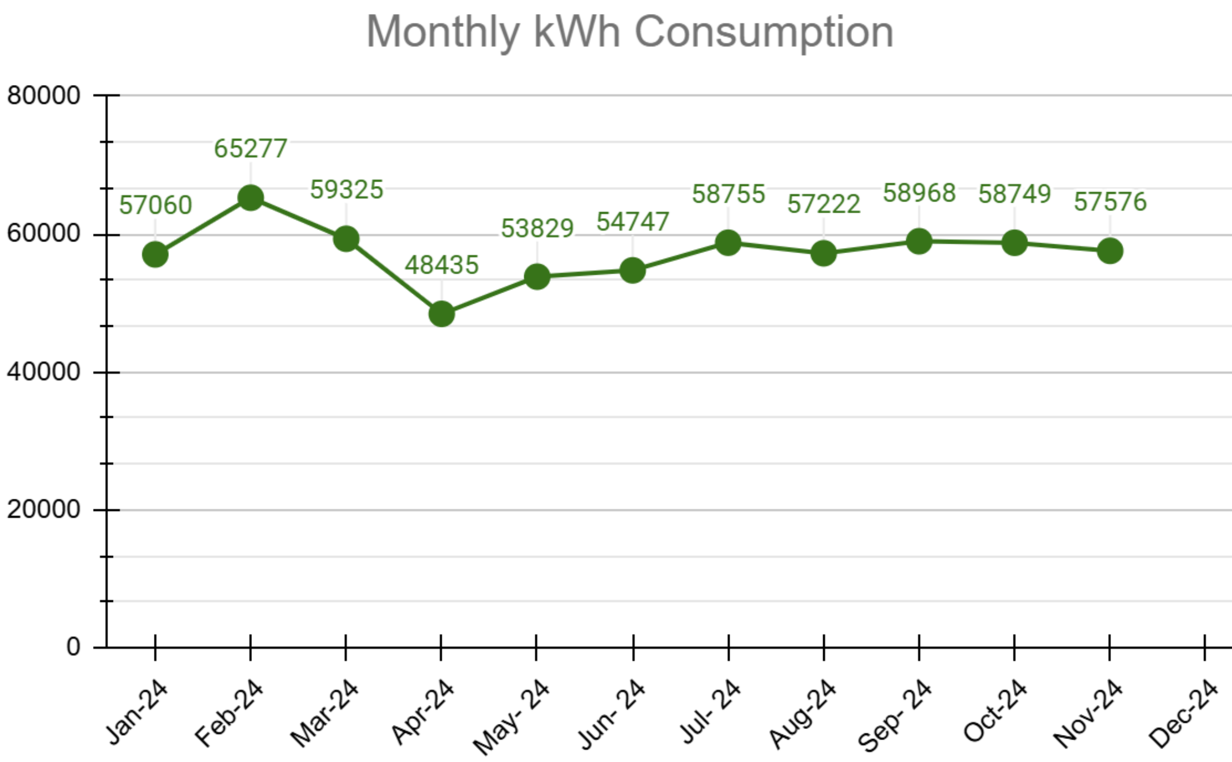


Fig 7.3(b) : Monthly Energy consumption Trend – Residential hill

- The average monthly electricity consumption during Jan 2024 – Dec 2024 is 57,448 kWh and the bill amount is Rs. 452,717.
- The minimum monthly consumption in this period was 48435 kWh in the month of May 2024.
- The maximum monthly consumption in this period was 65,277 kWh in the month of Mar 2024.
- A total of 689,379 kWh units were consumed between January 2024 and December 2024.

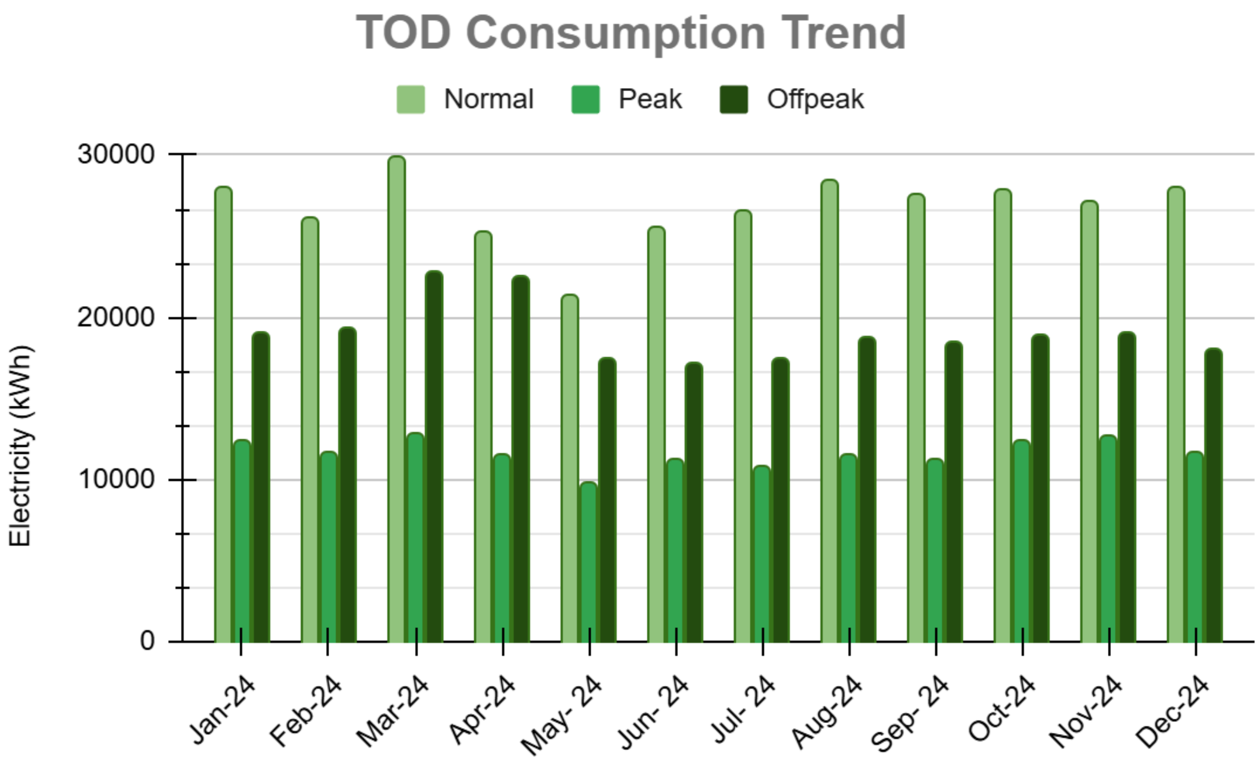


Fig 7.3 (c): Monthly Time zone wise energy consumption – Residential hill

- The above graph shows the energy consumed in the normal (6am-6pm), peak (6pm-10pm) and off peak (10pm-6am) zones in each month.
- Most electricity consumption is during the normal and off-peak hours which is a good practice.
- The minimum and maximum energy consumed during the normal zone were 21,252 kWh in May 2024 and 29,796 kWh in March 2024 respectively.
- The minimum and maximum energy consumed during the peak zone were 9696 kWh in May 2024 and 12729 kWh in March 2024 respectively.
- The minimum and maximum energy consumed during the off-peak zone were 17196 kWh in July 2024 and 22752 kWh in March 2024 respectively.
- Tariff rates for the normal, peak and offpeak are 6.25 Rs., 9.375 Rs, 4.6875 Rs. respectively.
- The peak hour tariff rates are high for Kerala State Electricity Board. Hence it is highly recommended to switch off/ shift the operation of irrelevant loads during this time zone.

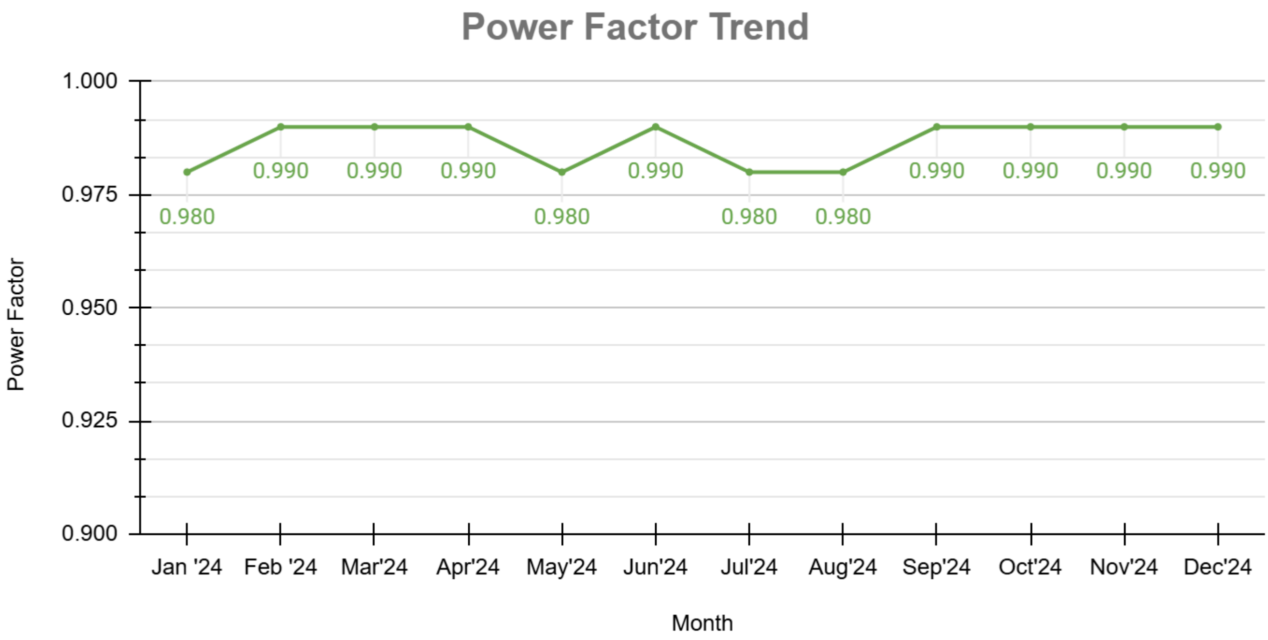


Fig 7.3 (d) : Monthly Power factor Trend – Residential hill

- The above graph shows the power factor of the last 12 months (Jan 24 – Dec 24).
- The average power factor during this period is 0.987.
- Presently the power factor is within the safe limits of 0.95–1, this results in avoiding penalty and receiving power factor incentives from Kerala State Electricity Board.
- Kerala State Electricity Board imposes a penalty for power factor below 0.95 and provides incentives above 0.95.
- For the year Jan 2024– Dec 2024 the facility fetched a power factor incentive of 77930 Rs.

7.4 Electricity Bill Analysis Of Academic Hill

The electricity is purchased from Kerala State Electricity Board (KSEB). The supply at 11kV is distributed at 433 V by two substations namely Academic hill and Residential hill.

The energy bills from January 2024 – December 2024 for the Academic hill were analyzed. The annual usage was 6,082,930 kWh. The average power factor was maintained at 0.990. The contract demand is 1250 kVA and the connected load is 6866 kW.

The annual electricity cost during this period was 48,421,994 Rs.

Table 7.4(a): Electricity bill analysis Academic Hill

Month	Energy (kWh)				Energy (kVAh)	Power Factor	Recorded Maximum Demand	Demand charge	Excess Demand charge	Energy Charge	PF Incentiv e	Bill Amount
	Normal	Peak	Offpeak	Total	kVAh		kVA	Rs.	Rs	Rs.	Rs.	Rs.
Jan-24	307095	99990	146805	553890	558765	0.990	1248.3	549120	0	3431461	68629.2	4374325
Feb-24	311025	99510	153285	563820	568965	0.990	1340.8	590040	20020	3480285	69605.7	4477963
Mar-24	342615	104700	165600	612915	618975	0.990	1364.7	600600	25300	3698896	75488	4821752
Apr-24	293460	85695	129135	508290	513180	0.990	1418.4	623920	36960	3139065	62781.3	4162201
May- 24	193470	60345	84705	338520	341715	0.990	923.6	412720	0	2102473	42049.3	2747113
Jun- 24	249615	80520	117000	447135	450255	0.990	1177.3	517880	0	2771777	55435.5	3601203
Jul- 24	251235	82035	130110	463380	466560	0.990	1148.5	505560	0	2854814	57096.3	3686510
Aug-24	268920	87990	134535	491445	494880	0.990	1124.7	495000	3035928	3035928	60718.5	3871262
Sep- 24	288825	91365	134700	514890	518865	0.990	1314.5	578600	14300	3187730	63754.6	4136772
Oct-24	281220	90375	136605	508200	511305	0.990	1147.1	504680	0	3141379	62827.5	4007297
Nov-24	310905	92175	143895	546975	550545	0.990	1223.4	538120	0	3370387	67407.7	4287051
Dec-24	316995	82660	133815	533470	536895	0.990	1260.0	554530	1960	3323198.9	66464	4248545.3
Average	**284,615**	**88,113**	**134,183**	**506,911**	**510,909**	**0.990**	**1,224**	**539,231**	**261,206**	**3,128,116**	**62,688**	**4,035,166**
Sum	**3,415,380**	**1,057,360**	**1,610,190**	**6,082,930**	**6,130,905**	-	**14,691**	**6,470,770**	**3,134,467**	**37,537,393**	**752,257**	**48,421,994**

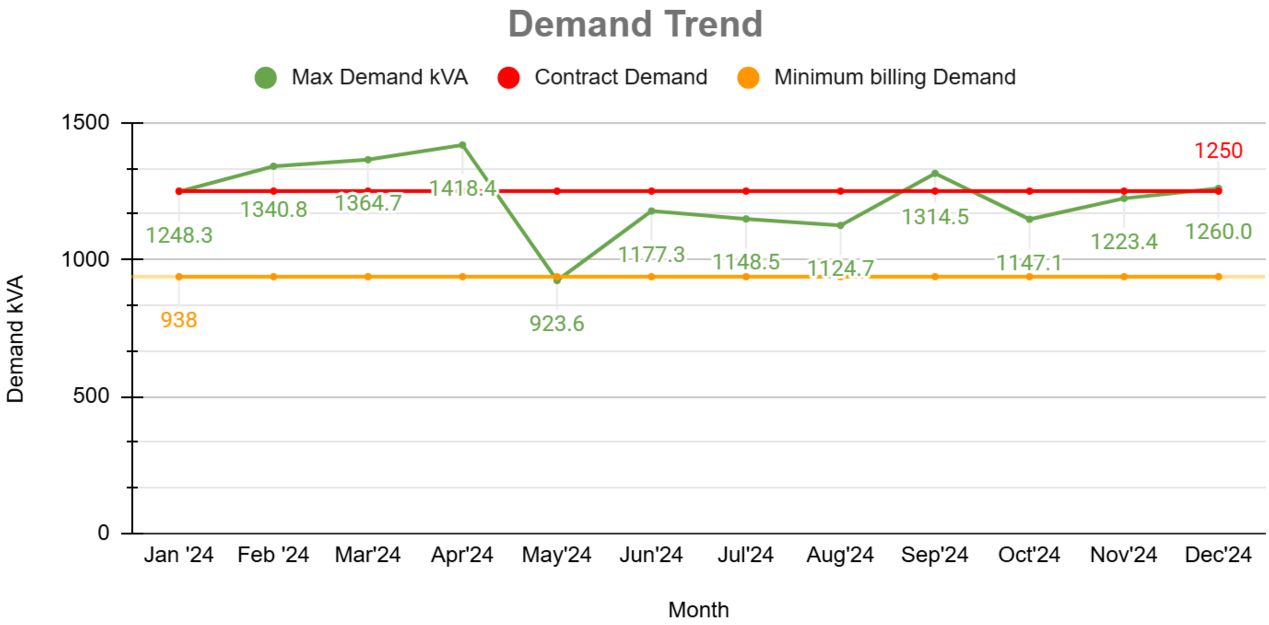


Fig 7.4 (a): Monthly Demand Trend Academic hill

- The sanctioned Contract Demand (CD) for the facility was 1250 kVA.
- The average billing demand recorded around the year was 1224 kVA which is within the contract demand.
- The minimum and maximum billing demand recorded during this period were 923.6 kVA and 1418.4 kVA respectively.

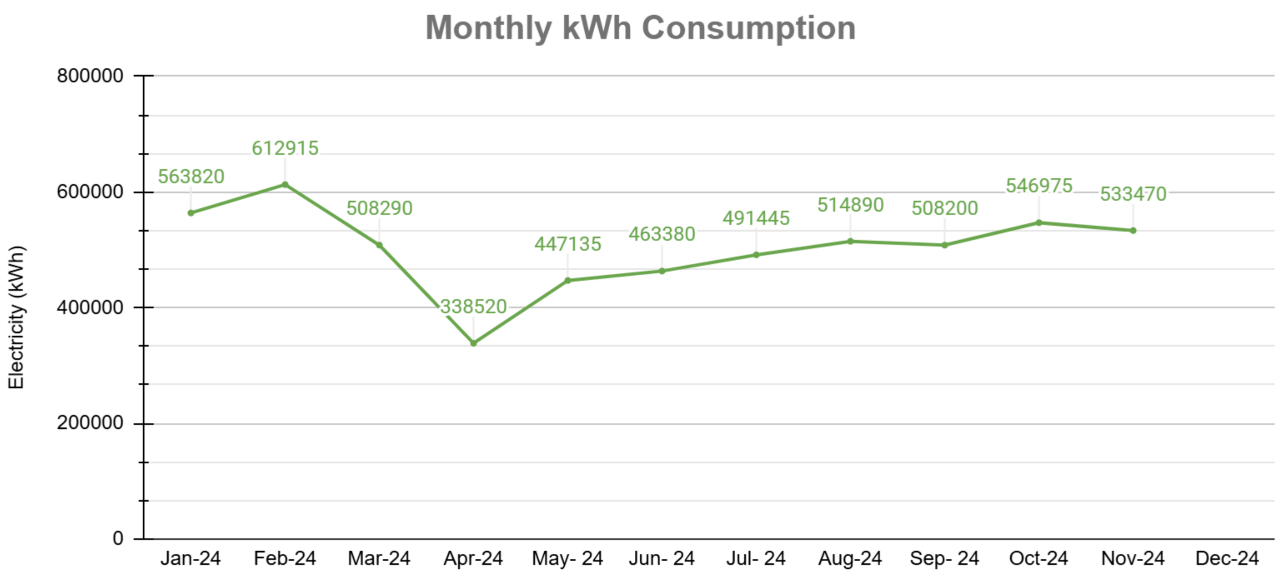


Fig 7.4(b) : Monthly Energy consumption Trend – Academic hill

- The average monthly electricity consumption during Jan 2024 - Dec 2024 is 506911 kWh and the bill amount is Rs. 4035166.
- The minimum monthly consumption in this period was 338520 kWh in the month of May 2024.
- The maximum monthly consumption in this period was 612915 kWh in the month of Mar 2024.
- A total of 6082930 kWh units were consumed between January 2024 and December 2024.

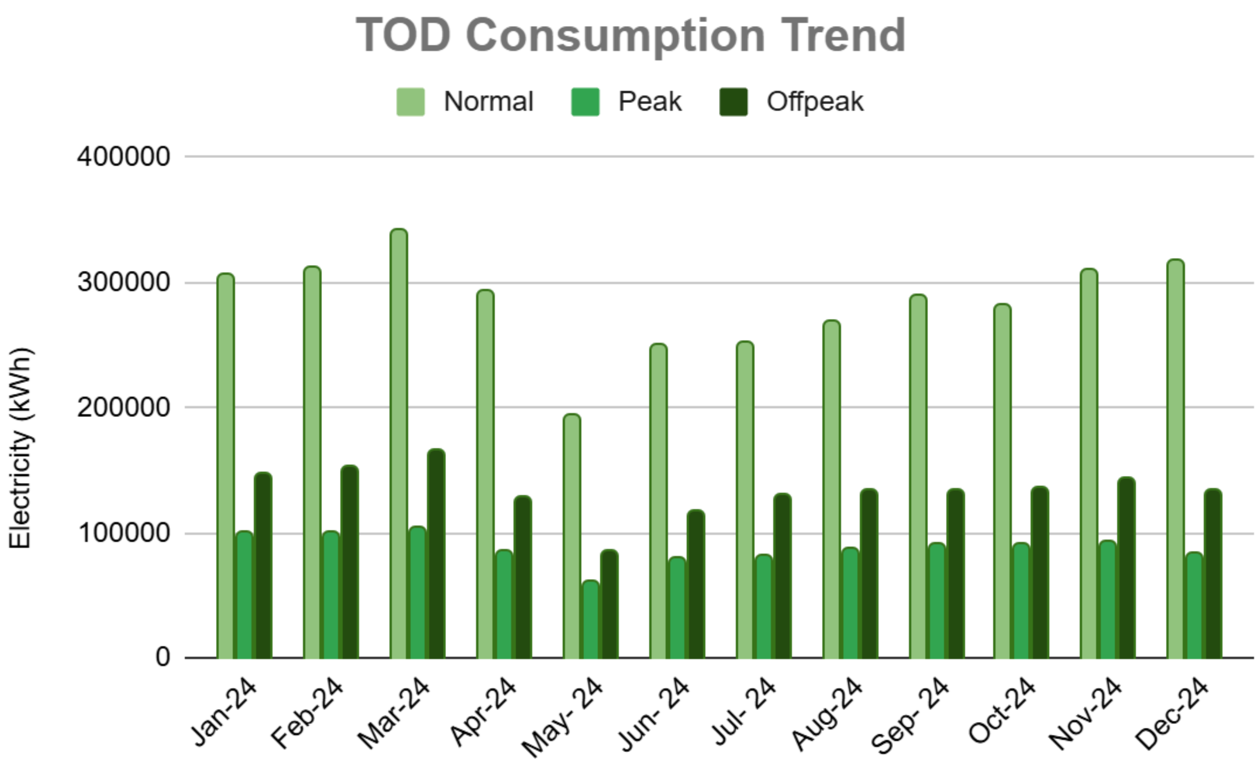


Fig 7.4 (c): Monthly Time zone wise energy consumption - Academic hill

- The above graph shows the energy consumed in the normal (6am-6pm), peak (6pm-10pm) and off peak (10pm-6am) zones in each month.
- Most electricity consumption is during the normal and off-peak hours which is a good practice.
- The minimum and maximum energy consumed during the normal zone were 193470 kWh in May 2024 and 342615 kWh in March 2024 respectively.
- The minimum and maximum energy consumed during the peak zone were 60345 kWh in May 2024 and 104700 kWh in March 2024 respectively.
- The minimum and maximum energy consumed during the off-peak zone were 84705 kWh in May 2024 and 165600 kWh in March 2024 respectively.
- Tariff rates for the normal, peak and offpeak are 6.15 Rs., 9.225 Rs, 4.6125 Rs. respectively.

- The peak hour tariff rates are high for Kerala State Electricity Board. Hence it is highly recommended to switch off/ shift the operation of irrelevant loads during this time zone.

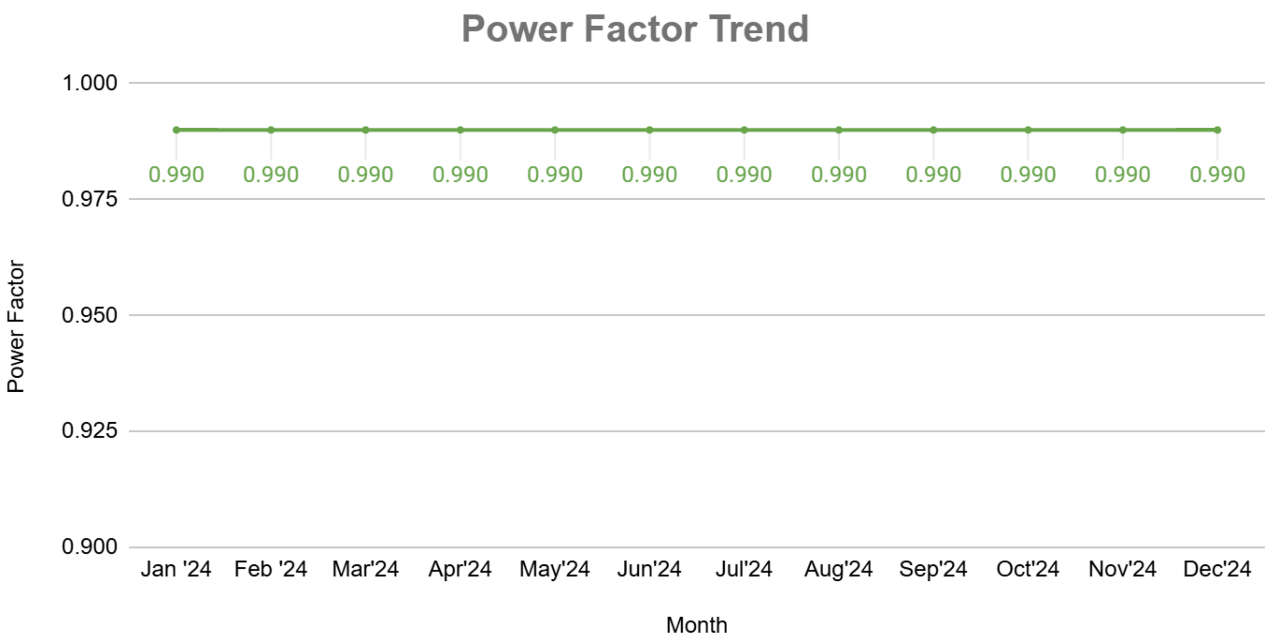


Fig 7.4 (d) : Monthly Power factor Trend – Academic hill

- The above graph shows the power factor of the last 12 months (Jan 24 – Dec 24).
- The average power factor during this period is 0.990.
- Presently the power factor is within the safe limits of 0.95-1, this results in avoiding penalty and receiving power factor incentives from Kerala State Electricity Board.
- Kerala State Electricity Board imposes a penalty for power factor below 0.95 and provides incentives above 0.95.
- For the year Jan 2024– Dec 2024 the facility fetched a power factor incentive of 752257 Rs.

7.5 Power Quality Study

- During the Carbon Audit a power quality study was conducted at 2 of the major feeders in the facility namely Academic Hill substation and 1250 kVA compact substation.
- A **power quality study** involves analyzing the electrical power supplied to a facility to ensure it meets the required standards for voltage, frequency, and waveform. The study identifies issues such as voltage fluctuations, harmonics, and imbalances that could impact equipment performance or cause energy inefficiencies.
- By diagnosing power quality issues, the study helps implement solutions to improve system reliability, reduce equipment damage, and enhance overall operational efficiency.

7.5.1 Data Logging At Academic Hill Substation

During the Carbon audit, Data logging of the LT side of the substation was carried out for 24 hours (from 11:17:28 am on 27-03-2025 to 10:32:28 am on 28-03-2025). The measured electrical parameters are tabulated below.

Table 7.5.1(a): Measured Power parameters at IIM Kozhikode

Transformer												
	Average		Three Phase				Voltage			Current		
	V	A	PF	Hz	kW	kVA	R	Y	B	R	Y	B
Max	249.9	972.8	-0.99	50.11	669.9	674.4	248.7	249	252	1089.5	957.3	871.5
Min	229.2	519.6	-0.78	49.8	289.3	369.8	227.8	228.2	231.5	611.5	461.9	485.4
Avg	241.4	710.6	-0.91	49.9	474.4	513.8	240.3	240.4	243.6	802.7	676.4	652.8

Table 7.5.1(b):Voltage and current unbalance at IIM Kozhikode

Incomer-2 Voltage and Current Unbalance			
Average Voltage Unbalance %	0.911	**Average Current Unbalance %**	12.96
Acceptable Range for (LV & MV) %	3	**Acceptable Range for (LV & MV) %**	5

Table 7.5.1(c):Power quality analysis IIM Kozhikode

POWER QUALITY ANALYSIS – THD				
SI No	Harmonic Analysis	Phase	THD (%)	Inference
Minimum load (07:12 PM – 28/03/2025)				
1	As per IEEE 519 – 2022 the allowable voltage THD 8%	R	2.08	Under permissible limit at minimum load in all phases during load study
		Y	1.76	
		B	2.07	
2	As per IEEE 519 – 2022 the allowable current THD 8%	R	7.06	Above permissible limit at minimum load in all phases during load study
		Y	6.52	
		B	10.71	
Maximum load (13:12 PM – 27/03/2025)				
3	As per IEEE 519 – 2022 the allowable voltage THD 8%	R	2.44	Under permissible limit at maximum load in all phases during load study
		Y	2.24	
		B	2.23	
4	As per IEEE 519 – 2022 the allowable current THD 8%	R	7.51	Above permissible limit at minimum load in all phases during load study
		Y	6.83	
		B	8.71	

The Total harmonic distortion for current THD (I)% is 10.71% above the permissible limit (8%) as per IEEE 519 standards due to harmonics generating loads like UPS and LED lights at minimum loading time.

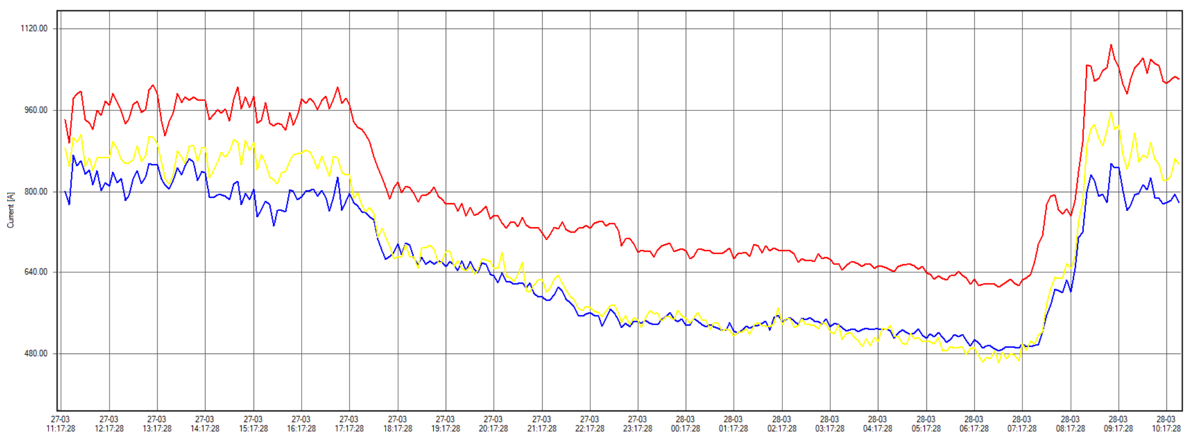


Figure 7.5.1(a) : Time vs Current graph at IIM Kozhikode

- During the data logging period each phase current consumption was measured.
- The maximum current in the R phase is 1089.5 A and on average it consumes 802.7 A.

- The maximum current in the Y phase is 957.3 A and on average it consumes 676.4 A.
- The maximum current in the B phase is 871.5 A and on average it consumes 652.8 A.
- At the IIM Kozhikode Kozhikode the measured average voltage unbalance is under the limit. But the current unbalance (12.96%) is above the limit (5%). It is recommended to balance the load. Please refer to table 7.5.1 (a), (b), (c) and (d) above and figure 7.5.1 (a) and 7.5.1 (b) below.

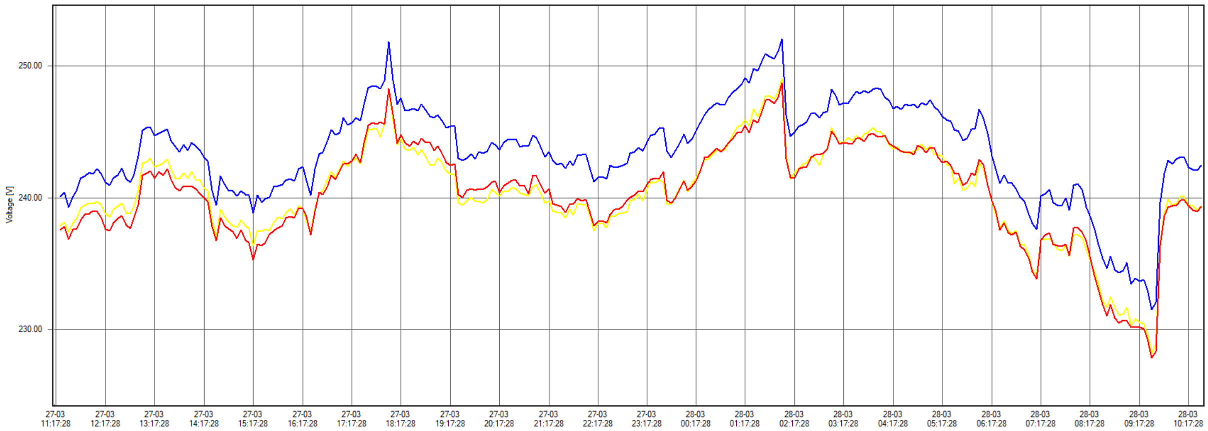


Figure 7.5.1(b) : Time vs Voltage graph at IIM Kozhikode

- During the data logging period each phase voltage was measured
- The maximum voltage in the R – Y phase is 248.7 V and on average it consumes 240.3 V
- The maximum voltage in the Y – B phase is 249 V and on average it consumes 240.4 V
- The maximum voltage in the B – R phase is 252 V and on average it consumes 243.6 V.

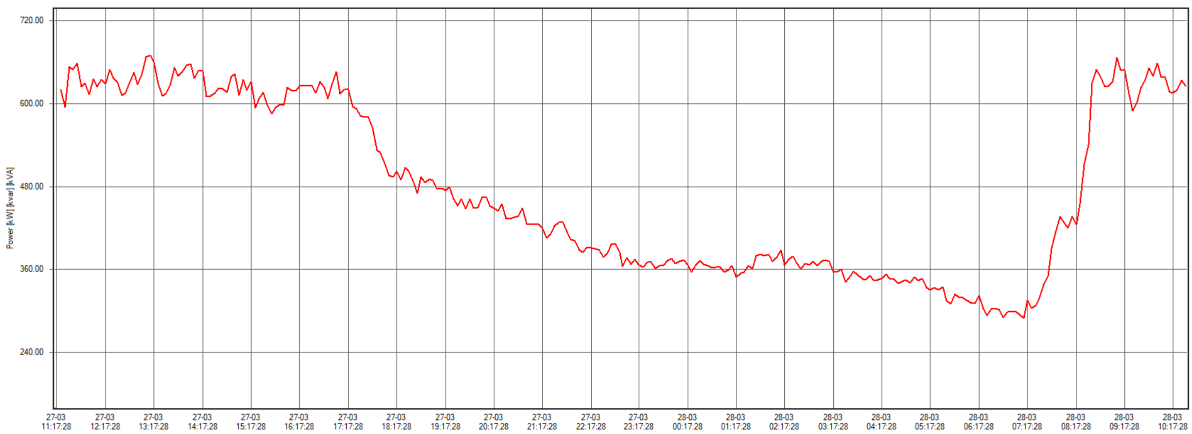


Figure 7.5.1 (c) : Transformer Time vs kW at IIM Kozhikode

- We have monitored the power in the Transformer at the IIM Kozhikode, during the data logging period the maximum consumption was 669.9 kW and on average it consumed 474.4 kW.

7.5.2 Data Logging At Compact Substation(Near Chiller Plant)

During the Carbon audit, Data logging of the LT side of the substation was carried out for 6 hours (from 11:12:38 am on 28-03-2025 to 16:02:38 pm on 28-03-2025). The measured electrical parameters are tabulated below.

Table 7.5.2(a): Measured Power parameters at IIM Kozhikode

	Transformer											
	Average		Three Phase				Voltage			Current		
	V	A	PF	Hz	kW	kVA	R	Y	B	R	Y	B
Max	232.9	593.9	0.92	50.2	283.4	319.1	234.1	231.8	232.8	692.3	678.9	705.6
Min	223.6	246	0.88	49.8	123.3	135.3	223.4	224.5	223	291.4	265.6	317.1
Avg	227.8	550.1	0.9	50	238	265	228.8	226.7	227.9	517.4	554.5	578.5

Table 7.5.2(b):Voltage and current unbalance at IIM Kozhikode

Incomer-2 Voltage and Current Unbalance			
Average Voltage Unbalance %	0.48	**Average Current Unbalance %**	5.9
Acceptable Range for (LV & MV) %	3	**Acceptable Range for (LV & MV) %**	5

Table 7.5.2(c):Power quality analysis IIM Kozhikode

POWER QUALITY ANALYSIS – THD				
Sl No	Harmonic Analysis	Phase	THD (%)	Inference
Minimum load (12:47 PM – 28/03/2025)				
1	As per IEEE 519 – 2022 the allowable voltage THD 8%	R	2.35	Under permissible limit at minimum load in all phases during load study
		Y	2.35	
		B	2.27	
2	As per IEEE 519 – 2022 the allowable current THD 8%	R	6.2	Under permissible limit at minimum load in all phases during load study
		Y	7.13	
		B	6.25	
Maximum load (13:17 PM – 28/03/2025)				
3	As per IEEE 519 – 2022 the allowable voltage THD 8%	R	2.48	Under permissible limit at maximum load in all phases during load study
		Y	2.41	
		B	2.31	
4	As per IEEE 519 – 2022 the allowable current THD 8%	R	4.5	Under permissible limit at minimum load in all phases during load study
		Y	5.40	
		B	4.77	

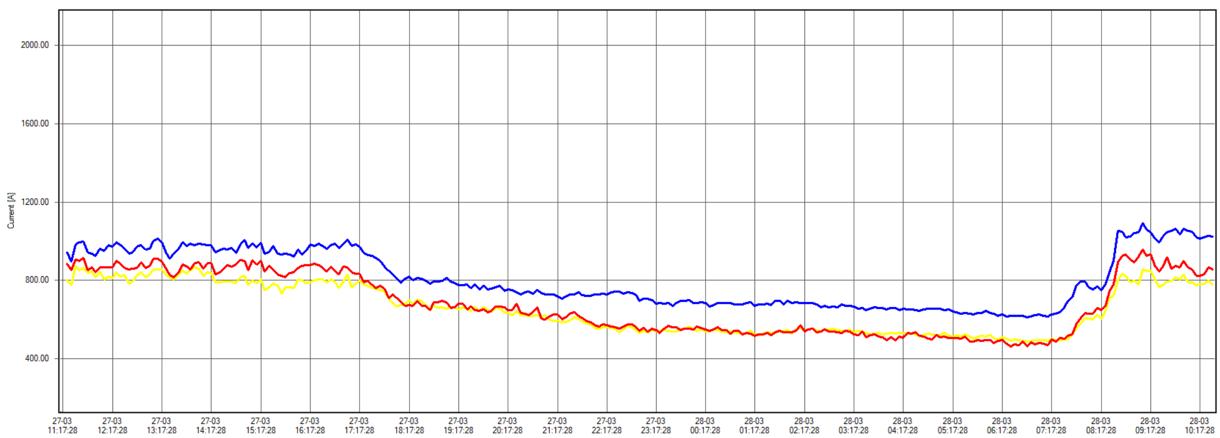


Figure 7.5.2(a) : Time vs Current graph at IIM Kozhikode

- During the data logging period each phase current consumption was measured.

- The maximum current in the R phase is 692.3 A and on average it consumes 517.4 A.
- The maximum current in the Y phase is 678.9 A and on average it consumes 554.5 A.
- The maximum current in the B phase is 705.6 A and on average it consumes 578.5 A.
- At the IIM Kozhikode Kozhikode the measured average voltage unbalance is under the limit. But the current unbalance (5.9%) is above the limit (5%). It is recommended to balance the load. Please refer to table 7.5.2 (a), (b), (c) and (d) above and figure 7.5.2 (a) and 7.5.2 (b) below.

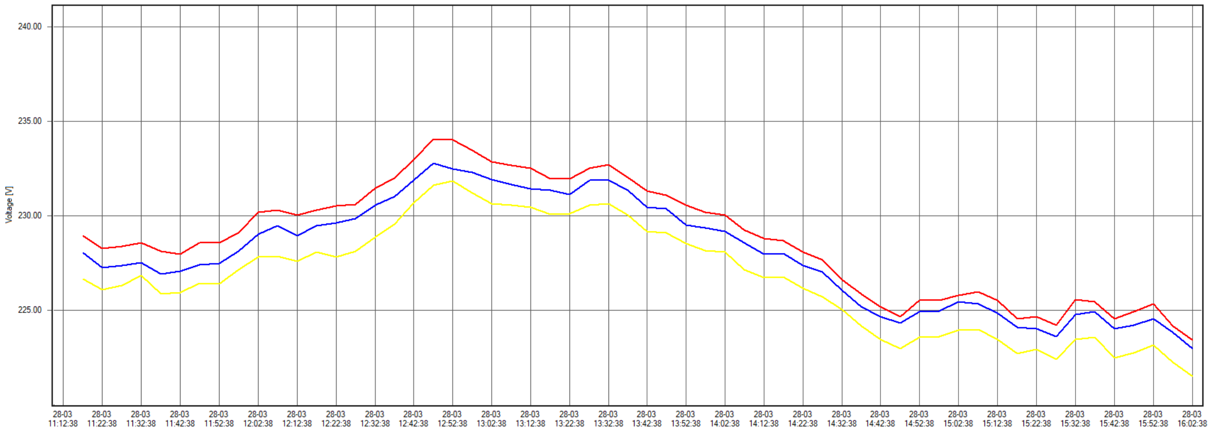


Figure 7.5.2(b) : Time vs Voltage graph at IIM Kozhikode

- During the data logging period each phase voltage was measured
- The maximum voltage in the R – Y phase is 234.1 V and on average it consumes 228.8 V
- The maximum voltage in the Y – B phase is 231.8 V and on average it consumes 226.7 V
- The maximum voltage in the B – R phase is 232.8 V and on average it consumes 227.9 V.

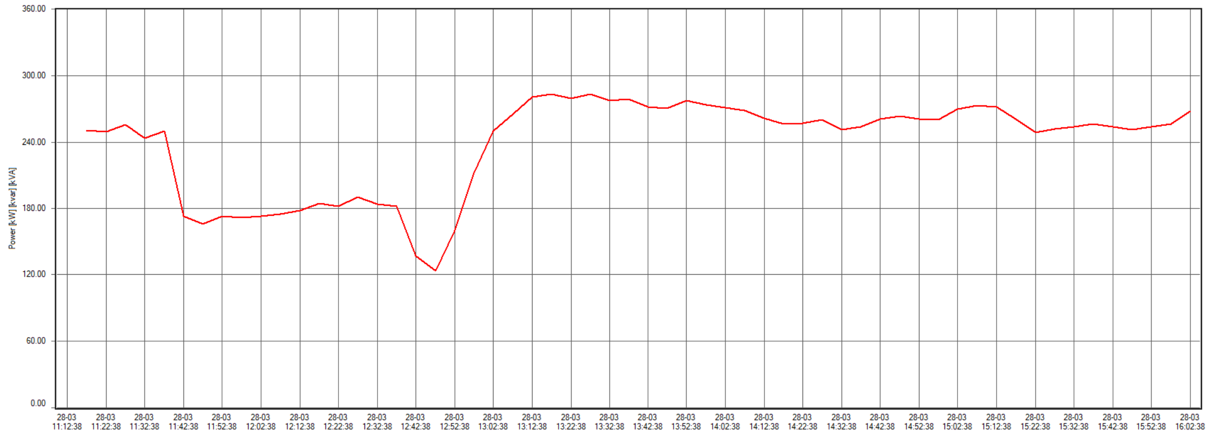


Figure 7.5.2(c) : Transformer Time vs kW at IIM Kozhikode

- We have monitored the power in the Transformer at the IIM Kozhikode, during the data logging period the maximum consumption was 283.4 kW and on average it consumed 238 kW

8. RECOMMENDATIONS & SUGGESTIONS

Carbon mitigation through energy efficiency involves reducing energy consumption to lower greenhouse gas emissions. By optimizing energy use in buildings, industries, and transportation, significant carbon reductions can be achieved.

Strategies include upgrading insulation, using energy-efficient appliances, and adopting renewable energy sources. Improved energy efficiency not only reduces carbon footprints but also lowers operational costs and enhances sustainability. These efforts are essential in meeting global climate goals and reducing reliance on fossil fuels.

During the Carbon Audit we identified several energy conservation measures (ECM) in the Institute. The detailed analysis and summary of the identified ECMs are given below.

Summary of savings opportunities identified

Annual Energy Bill (Electrical, LPG, Diesel ,Petrol – Jan' 24-Dec '24)	:	Rs.655 Lakhs
Savings potential identified, recurring annual	:	Rs. 352 Lakhs
Savings as % of Energy Bill	:	54%
Return on Investment	:	26%
One-time Cost of Implementation	:	Rs. 1,361 Lakhs
Payback Period	:	46 months
Total Electricity Savings (kWh/year)	:	44,24,197 kWh
Annual LPG Savings (kg/year)	:	16,749 kg
Total Energy savings (MTOE/Year)	:	400
Total Annual CO_2 Savings (Ton/Year)	:	3,676

8.1. Cost Benefit Analysis of Proposed ECMs

Table 8.1 : Cost benefit analysis Area wise

Area	TEM No. & Description	Annual Carbon Savings	Annual Electricity Savings	Annual LPG Savings	Annual MTOE Savings	Annual Cost Savings	One Time Cost of Implementation	Payback Period
		Tons	kWh	kgs	MTOE	Rs. Lakhs	Rs. Lakhs	Months
HVAC System	ECM AC1: Descaling of Chiller 1 & 2 to reduce the condenser and evaporator approach	113.99	139,014	NA	11.96	11.05	2.60	3
	ECM AC2: Install VFD in chiller no. 1 compressor to reduce power consumption in part load operation and save energy	36.31	44,277	NA	3.81	3.52	8.10	28
	ECM AC3: Revamping of 45.5 TR brine chiller and cold storage system for peak hour operation.	109.23	133,210	NA	11.46	10.59	2.00	2
	ECM AC4: Replace existing primary and secondary pumps with suitable capacity energy efficient pumps and save energy.	84.31	102,811	NA	8.84	8.17	9.30	14
	ECM AC5: Replacement of existing condenser water pumps with energy efficient IE5 class motors and pumps	20.78	25,338	NA	2.18	2.01	4.42	26
	ECM AC6: Automation of secondary pumps based on DP sensor at the farthest AHU	72.27	88,134	NA	7.58	7.01	1.80	3

Area	TEM No. & Description	Annual Carbon Savings	Annual Electricity Savings	Annual LPG Savings	Annual MTOE Savings	Annual Cost Savings	One Time Cost of Implementation	Payback Period
		Tons	kWh	kgs	MTOE	Rs. Lakhs	Rs. Lakhs	Months
	ECM AC7: Automate the CT fan speed based on cooling tower approach temperature and save energy	14.93	18,205	NA	1.57	1.45	0.48	4
	ECM AC8: Replace fans of CTs with suitable FRP blades for reducing power consumption and save energy	20.33	24,795	NA	2.13	1.97	2.60	16
	ECM AC9: Operate optimal number of cooling towers for single chiller operation to save energy.	4.66	5,688	NA	0.49	0.45	Nil	Immediate
	ECM AC10: Refurbishment of cooling tower fills to improve the CT effectiveness	99.30	121,101	NA	10.41	9.63	8.00	10
	ECM AC11: Replace identified AHUs/TFAs fans with energy efficient EC fans and save energy	169.23	206,380	NA	17.75	16.41	10.34	8
	ECM AC12: Install VFD and automate the fan speed based on RAT sensors in AHUs	100.09	122,059	NA	10.50	10	8	10
	ECM AC13: Replacement of existing fresh air and exhaust fans (except kitchen exhaust fans) with BLDC fans to reduce energy consumption.							
	ECM AC14: Install heat pipes in TFA to reduce cooling load of chiller and reduce chiller energy consumption and save energy							
	ECM AC15: Replace Old Under Performing Split A/c's to Energy Efficient 5-Star Inverter A/C's.	4.02	4,898	NA	0.42	-	-	-
	ECM AC16: Replace existing AC FCU motors with	20.98	25,591	NA	2.20	2.03	21.12	125

Area	TEM No. & Description	Annual Carbon Savings	Annual Electricity Savings	Annual LPG Savings	Annual MTOE Savings	Annual Cost Savings	One Time Cost of Implementation	Payback Period
		Tons	kWh	kgs	MTOE	Rs. Lakhs	Rs. Lakhs	Months
	suitable capacity DC blowers to reduce demand as well as energy consumption							
	Sub-total: HVAC System	**870**	**1,061,502**	**0**	**91**	**84**	**79**	**11**
Thermal System	ECM HWS1: Installation of heat pump for hot water usage in hostel	130.73	159,424	NA	13.71	12.67	30.14	29
	ECM HWS2: Installation of solar water heater for hot water generation in areas existing solar water heater is not connected	78.72	96,000	NA	8.26	7.63	20.00	31
	Sub-total: Thermal System	**209**	**255,424**	**0**	**22**	**20**	**50**	**30**
Kitchen System	ECM K1: Replace existing single range conventional burners in prism kitchen with radiant heating appliances to save energy.	4.75	NA	1,638	1.96	1.54	1.00	8
	ECM K2: Install biogas plant to generate renewable fuel from food waste	43.82	NA	15,111	18.06	18.88	40.00	25
	Sub-total: Kitchen System	**49**	**0**	**16,749**	**20**	**20**	**41**	**24**
Electrical System	ECM STP1: Install VFD for STP blowers and automate its speed based on the dissolved oxygen (DO) level in the aeration tank	1.92	2,336	NA	0.20	0.19	0.41	26
	ECM E1: Replace existing ceiling fans with energy efficient BLDC fans.	182.06	222,024	NA	19.09	-	-	-
	ECM E2: Upgrade solar plant capacity for electricity generation.	2,342.90	2,857,200	NA	245.72	227.15	1,190.50	63
	ECM E3: Implementation of electric mobility for							

Area	TEM No. & Description	Annual Carbon Savings	Annual Electricity Savings	Annual LPG Savings	Annual MTOE Savings	Annual Cost Savings	One Time Cost of Implementation	Payback Period
		Tons	kWh	kgs	MTOE	Rs. Lakhs	Rs. Lakhs	Months
	institution owned bus transportation.							
	ECM L1: Replacement of conventional lamps with suitable LED lamps.	21.08	25,712	NA	2.21	-	-	-
	Sub-total: Electrical System	**2,548**	**3,107,272**	**0**	**267**	**227**	**1,191**	**63**
Grand Total		**3,676**	**4,424,197**	**16,749**	**400**	**352**	**1,361**	**46**

Table 8.2. : Energy and Cost savings Summary

Area	Annual Carbon Savings	Annual Electricity Savings	Annual LPG Savings	Annual MTOE Savings	Annual Cost Savings	One Time Cost of Implementation	Payback Period
	Tons	kWh	kgs	MTOE	Rs. Lakhs	Rs. Lakhs	Months
HVAC System	870	1,061,502	0	91	84	79	11
Thermal System	209	255,424	0	22	20	50	30
Kitchen System	49	0	16,749	20	20	41	24
Electrical System	2,548	3,107,272	0	267	227	1,191	63
Grand Total	**3,676**	**4,424,197**	**16,749**	**400**	**352**	**1,361**	**46**
Total Energy cost (Electricity+Diesel+LPG+Petrol) (Rs. Lakhs)	**655**						
Savings potential	**54%**						

ROI	**26%**						

ECM AC1: Descaling of Chiller 1 & 2 to reduce the condenser and evaporator approach

Present System

- In IIM Kozhikode, there are 3 Voltas-made chillers for comfort air conditioning with 240 TR capacities. Please refer to figure AC1.1 below.
- During the Audit, Chiller 3 was under maintenance.
- The average specific power consumption of chillers 1 & 2 is 0.79 kW/TR and 0.76 kW/TR.
- The condenser approach for chillers 1 & 2 is 9°C & 15.6°C, while the evaporator approach is 2.4°C & 3.6°C, respectively.

Figure AC1.1: Chiller at IIM Kozhikode

Proposed System

- SEA suggests descaling for chillers on the condenser side and evaporator side to improve heat transfer. A high condenser or evaporator approach temperature may result from scaling or any type of fouling on the tubes. Please refer Figure AC1.2 below
- After descaling, the average condenser approach will be 1.5℃ & the proposed evaporator approach will be 1℃
- After implementing this scheme, IIM Kozhikode can potentially save 1,39,014 kWh per annum and thereby reduce 113.99 CO_2 tons of carbon emission.
- **By implementing this proposal at IIM Kozhikode will save 11.96 MTOE per annum.**

Figure AC1.2: Representative picture of descaling

Estimated benefits

Recurring annual cost savings : Rs. 11.05 Lakhs

One-time cost of implementation : Rs. 2.60 Lakhs

Payback period : 3 months

Table ECM AC1 : Savings Calculation

Description	Unit	Formula	Chiller 1	Chiller 2	Total
Chiller rated capacity	TR	A1	240	240	
Rated Power of compressor	kW	A2	162	162	
Average cooling load	TR	B1	208	221	
Average power consumption of the chiller	kW	B2	161.3	162.3	
Present average condenser approach	°C	C1	3.3	3.1	
Proposed average condenser approach after descaling on condenser side	°C	C2	1.5	1.5	
Present average evaporator approach	°C	D1	2.4	3.6	
Proposed average evaporator approach after descaling	°C	D2	1.5	1.5	
Average SEC	kW/TR	E	0.78	0.74	
Reduction in SEC (3% savings for every 1 deg drop in condenser approach) (BEE Standard)	kW/TR	F1=3%x(C1 -C2)xE	0.04	0.04	
Reduction in SEC (1.5% savings for every 1 deg drop in evaporator approach)	kW/TR	F2=1.5%x(D1-D2)xE	0.01	0.02	
Absolute reduction in power consumption from condenser tube descaling	kW	G1=F1xB1	8.7	7.8	
Absolute reduction in power consumption from evaporator tube descaling	kW	G2=F2xB1	2.2	5.1	

Description	Unit	Formula	Chiller 1	Chiller 2	Total
Average annual operating hours	Hours/ year	H	5,832	5,832	
Expected annual electricity saving	kWh	I=(G1+G2) xH	63,629	75,385	139,014
Unit cost of electricity	Rs./kWh	J	7.95	7.95	
Recurring annual cost savings	Rs. Lakhs	K=IxJ/10^5	5.06	5.99	11.05
Cost for descaling two times in a year (for Evaporator once & Condenser side descaling twice a year)	Rs. Lakhs	L	1.30	1.30	2.60
Payback period	Months	M=L/Kx12	3	3	3

ECM AC2 : Install VFD in chiller no. 1 compressor to reduce power consumption in part load operation and save energy

Present System

- In IIM Kozhikode there are 3 chillers operational and for majority of time chiller 1 & 2 is operated .But whenever there is an additional requirement needed chiller 3 is also turned ON.
- But most of the time chiller 1 is partially loaded compared to chiller 2
- The present chiller rated power of the chiller 1 is 162 kW.
- The average TR requirement for an hour was 208 TR.
- The specific power consumption of the chiller 1 is 0.74 kW/TR.

Proposed System

- SEA recommends installing a VFD on the 240 TR chiller number 1 to reduce the power consumption on the part load condition.
- Using a VFD (Variable Frequency Drive) in a chiller compressor allows for precise control of the compressor's speed, optimizing energy consumption by matching the cooling load requirements.
- This results in reduced wear and tear, extended equipment lifespan, and significant energy savings, especially in systems with varying load conditions.
- After implementing this scheme, IIM Kozhikode can potentially save 44,277kWh per annum and thereby reduce 36.31 CO_2 tons of carbon emission.
- **By implementing this proposal at IIM Kozhikode will save 3.81 MTOE per annum.**

Estimated benefits

Recurring annual cost savings	: Rs. 3.52 Lakhs
One-time cost of implementation	: Rs. 8.1 Lakhs
Payback period	: 28 months

Table ECM AC2 : Savings Calculation

Description	Unit	Formula	Chiller 1
Rated kW of present chiller	kW	A1	162
Average TR requirement per hour	TR	A3	208
Specific power consumption of chiller-1 (after periodic descaling)	kW/TR	B1	0.73
Measured average power consumption of chiller no. 1	kW	B2	151.8
Annual operating hours	hr/year	B3	5,832
Annual energy consumption	kWh/Annum	C=AxB3	885,531
Expected energy consumption after VFD automation	kWh/Annum	D=C-(Cx0.05)	841,254
Expected Annual Energy Savings	kWh/Annum	E=C-D	44,277
Unit cost of electricity	Rs/kWh	F	7.95
Recurring annual cost savings	Rs. Lakhs	G=ExF/100000	3.52
One time cost of implementation	Rs. Lakhs	H=0.05xA1	8.10
Payback period	Months	I=(H/G)x12	28

ECM AC3: Revamping of 45.5 TR brine chiller and cold storage system for peak hour operation.

Present System

- The facility currently has a 45.5 TR brine chiller, which has remained non-operational for the past six years.
- The cold storage system associated with the chiller has also been inactive during this period.
- The lack of maintenance and prolonged downtime has likely led to the deterioration of mechanical, electrical, and control components
- Due to these factors, the current system is unable to support TOD peak-hour cooling demands efficiently, leading to increased dependency on chillers .

Proposed System

- To enhance energy efficiency and ensure optimal cooling performance, the proposed system includes revamping the 45.5 TR brine chiller and the cold storage system for peak-hour operation.
- After implementing this scheme IIM Kozhikode can save up to 1,33,210 kWh per annum and reduce 109.23 CO_2 tonnes of carbon emission
- **By implementing this proposal at IIM Kozhikode will save 11.46 MTOE per annum**

Estimated benefits

Recurring annual cost savings	: Rs. 10.59 Lakhs
One-time cost of implementation	: Rs.2 Lakhs
Payback period	: 2 months

Table ECM AC3 : Savings Calculation

Description	Unit	Formula	Value
Rated kW of present chiller	kW	A1	162
Average TR requirement per hour	TR	A3	214
Average specific power consumption of chiller	kW/TR	B1	0.76
Average power consumption of chiller	kW	B2=A3*B1	162.6
Rated TR of brine chiller	TR	B3	45.5
Rated power of brine chiller	kW	C	35.7
Hours needed for brine chiller operation to meet the average TR demand	Hrs	D	8
Ton hour generated at Off peak hours from brine	Ton hour	E=B3*D	364
Approximate TR requirement for 1 hour in peak tariff time period (6-10 pm)	TR/hr	F=A3/3	71
Approximate ton hour requirement for peak hours	Ton hour	G=F*4	285
Number of days of operation per year	Days/Annum	H	365
Additional electricity consumption due to brine chiller operation	kWh/annum	I1=H*D*C	104,244
Estimated electrical energy consumption in peak hours by using existing chiller if thermal storage system is not used	kWh/Annum	I2=B2*H*4	237,454
Expected Annual Energy Savings	kWh/Annum	I3=I2-I1	133,210
Unit cost of electricity	Rs/kWh	J	7.95
Recurring annual cost savings	Rs. Lakhs	K=J*I3/10^5	10.59
Cost for brine chiller revamping	Rs. Lakhs	L	2.00
Payback period	Months	M=L/K*12	2

ECM AC4: Replace existing primary and secondary pumps with suitable capacity energy efficient pumps and save energy.

Present System

- There are 9 secondary pumps which are used for chilled water circulation through AHU and FCU units.
- The rated capacity of the secondary motors are 7.5kW.
- The secondary pumps are divided into 3 Zones ie., for the Main Building 3x 7.5kW motors are there by which only one running at a time and its rated flow is 51.1 m^3/hr with an average motor efficiency of 42.59%.
- The other Zone is ClassRoom, which also has 3x 7.5kW motors where two are running at a time and its rated flow is 37.8m^3/hr with an average motor efficiency of 34.94%.
- The Last Zone is Hostel, which has 3x 7.5kW motors by which only one is running and its rated flow is 30m^3/hr with an average efficiency of 34.23%.
- There are 3 x primary pumps in which are 7.5 kW with a designed water flow & head of 128 m3/hr & 12 m respectively, and are used for circulation of water through the chillers.
- During the audit we measured the performance parameters of the primary pumps and found the average efficiency to be 49.43%.

ECM AC4.1: Primary & Secondary pumps at IIM Kozhikode

Proposed System

- It is proposed to replace the existing pump with an energy efficient pump. Please refer figure below
- New pumps to be selected for the required flow and with the actual head of the existing pumps.
- New pumps to be selected with IE4/IE5 rated energy-efficient motors.
- After implementing this scheme IIM Kozhikode can potentially save 1,02,811 kWh per annum and thereby reduce 84.31 tons of CO_2e emission.
- **By implementing this proposal at IIM Kozhikode will save 8.84 MTOE per annum**

ECM AC4.2: Representative Picture of Energy Efficient Pump

Estimated Benefits

Recurring annual cost savings : Rs. 8.17 Lakhs
One-time cost of implementation : Rs. 9.30 Lakhs
Payback period : 14 months

Table ECM AC4 : Savings Calculation

Description	Unit	Formula	Primary Pump 1	Primary Pump 2	Primary Pump 3	Main Building		
						Secondary Pump 1	Secondary Pump 2	Secondary Pump 3
Rated Flow of chilled water pump	m3/hr	A1	128	128	128	51.1	51.1	51.1
Rated Head of chilled water pump	m	A2	12	12	12	30	30	30
Rated Motor Power	KW	A3	7.5	7.5	7.5	7.5	7.5	7.5
Rated motor Efficiency	%	A4	88.7%	88.7%	88.7%	88.7%	88.7%	88.7%
Measured flow rate of pump	m3/hr	A5	131	126	127	51	54	58
Measured head of pump	m	A6	7	8	7	12	13	12
Present Power consumption	kW	A7	5.93	5.74	5.83	4.64	4.85	4.99
Present Efficiency of pump	%	A8=A5xA6/(367xA4xA7)	47.5%	53.9%	46.8%	40.5%	44.5%	42.8%
Design flow rate of proposed pump	m3/hr	B1	132	132	132	60	60	60
Design head of proposed pump	m	B2	9	9	9	15	15	15
Proposed Efficiency of Pump	%	B3	75%	75%	75%	75%	75%	75%
Proposed Efficiency of motor	%	B4	92.6%	92.6%	92.6%	92.6%	92.6%	92.6%
Proposed power Consumption	kW	B5=B1xB2/(367xB3xB4)	4.7	4.7	4.7	3.5	3.5	3.5
Present operating hours per day	hrs/Day	C1	12	12	12	8	8	8
Present operating days per year	days/year	C2	365	365	365	365	365	365
Present annual energy consumption	kWh/year	D=A7xC1xC2	25,973	25,141	25,535	13,549	14,162	14,571
Proposed annual energy consumption	kWh/year	E=B5xC1xC2	20,415	20,415	20,415	10,311	10,311	10,311
Annual electricity saving	kWh/year	F=D-E	5,558	4,726	5,120	3,238	3,851	4,260
Electrical energy cost per unit	Rs./kWh	G	7.95	7.95	7.95	7.95	7.95	7.95
Expected Annual cost savings	Rs .Lakh	H=FxG/10^5	0.44	0.38	0.41	0.26	0.31	0.34
One time cost of implementation	Rs .Lakh	I=B5x0.15x1.25	0.87	0.87	0.87	0.66	0.66	0.66
Payback period	months	J=I/Hx12	24	28	26	31	26	23

Description	Unit	Formula	Classroom			Hostel			Total
			Secondary Pump 1	Secondary Pump 2	Secondary Pump 3	Secondary Pump 1	Secondary Pump 2	Secondary Pump 3	
Rated Flow of chilled water pump	m3/hr	A1	37.8	37.8	37.8	30.0	30.0	30.0	
Rated Head of chilled water pump	m	A2	30	30	30	38	38	38	
Rated Motor Power	KW	A3	7.5	7.5	7.5	7.5	7.5	7.5	
Rated motor Efficiency	%	A4	88.7%	88.7%	88.7%	88.7%	88.7%	88.7%	
Measured flow rate of pump	m3/hr	A5	41	40	42	39	36	37	
Measured head of pump	m	A6	19	20	20	20	23	22	
Present Power consumption	kW	A7	6.82	7.36	7.09	7.46	7.06	7.24	
Present Efficiency of pump	%	A8=A5xA6/(367xA4xA7)	35.1%	33.4%	36.4%	32.1%	36.0%	34.5%	
Design flow rate of proposed pump	m3/hr	B1	45	45	45	40	40	40	
Design head of proposed pump	m	B2	25	25	25	25	25	25	
Proposed Efficiency of Pump	%	B3	75%	75%	75%	75%	75%	75%	
Proposed Efficiency of motor	%	B4	92.6%	92.6%	92.6%	92.6%	92.6%	92.6%	
Proposed power Consumption	kW	B5=B1xB2/(367xB3xB4)	4.4	4.4	4.4	3.9	3.9	3.9	
Present operating hours per day	hrs/Day	C1	16	16	16	8	8	8	

Description	Unit	Formula	Classroom			Hostel			Total
			Secondary Pump 1	Secondary Pump 2	Secondary Pump 3	Secondary Pump 1	Secondary Pump 2	Secondary Pump 3	
Present operating days per year	days/year	C2	365	365	365	365	365	365	
Present annual energy consumption	kWh/year	D=A7xC1xC2	39,829	42,982	41,406	21,783	20,615	21,141	
Proposed annual energy consumption	kWh/year	E=B5xC1xC2	25,777	25,777	25,777	11,456	11,456	11,456	
Annual electricity saving	kWh/year	F=D-E	14,052	17,206	15,629	10,327	9,159	9,684	102,811
Electrical energy cost per unit	Rs./kWh	G	7.95	7.95	7.95	7.95	7.95	7.95	
Expected Annual cost savings	Rs .Lakh	H=FxG/10^5	1.12	1.37	1.24	0.82	0.73	0.77	8.17
One time cost of implementation	Rs .Lakh	I=B5x0.15x1.25	0.83	0.83	0.83	0.74	0.74	0.74	9.30
Payback period	months	J=I/Hx12	9	7	8	11	12	11	14

ECM AC5: Replacement of existing condenser water pumps with energy efficient IE5 class motors and pumps

Present System

- There are 3 x condenser pumps which are 22 kW used for circulation of cooling water through the Chiller condenser.
- The chilled water pumps are IE2 class motors which are not that efficient.
- During the time of the audit we found out the average power consumption of the three operational pumps was 10.36 kW.
- The designed head of the pumps is 28 m and the calculated head is 11 m for condenser pump 1 and 8 m for Condenser pumps 2 & 3.
- During the audit, we measured the performance parameters of the condenser pumps and found the average efficiency to be 55.2%.

ECM AC5.1: Condenser pumps at IIM Kozhikode

Proposed System

- It is proposed to replace the existing pump with an energy-efficient pump. Please refer figure below
- New pumps are to be selected for the required flow and with the actual head of the existing pumps.
- New pumps are to be selected with IE4/IE5-rated energy-efficient motors.
- After implementing this scheme IIM Kozhikode can potentially save 25,338 kWh per annum and thereby reduce 20.78 tons of CO_2e emission.
- **By implementing this proposal at IIM Kozhikode will save 2.18 MTOE per annum**

ECM AC5.2: Representative Picture of Energy Efficient Pump

Estimated Benefits

Recurring annual cost savings : Rs. 2.01 Lakhs
One-time cost of implementation : Rs. 4.42 Lakhs
Payback period : 26 months

Table ECM AC5 : Savings Calculation

Description	Unit	Formula	Condenser Pump 1	Condenser Pump 2	Condenser Pump 3	Total
Rated Flow of Condenser pump	m3/hr	A1	213	213	213	
Rated Head in Condenser pump	m	A2	28	28	28	
Rated Motor Power	KW	A3	22.0	22.0	22.0	
Rated efficiency of motor	%	A4	91.6%	91.6%	91.6%	
Design flow rate of chiller condenser	m3/hr	A5	196.2	196.2	196.2	
Measured flow rate of pump	m3/hr	B1	209	222	215	
Measured head of pump	m	B2	11	8	8	
Present Power consumption	kW	B3	11.17	10.01	9.92	
Present Efficiency of pump	%	C=B1xB2/(369xB3xA4)	61.2%	52.8%	51.6%	
Design flow rate of proposed pump	m3/hr	D1	225	225	225	
Design head of proposed pump	m	D2	11	11	11	
Proposed Efficiency of Pump	%	E1	80%	80%	80%	
Proposed Efficiency of motor	%	E2	94.50%	94.50%	94.50%	
Proposed power	kW	F=D1xD2/(3	8.9	8.9	8.9	

Description	Unit	Formula	Condenser Pump 1	Condenser Pump 2	Condenser Pump 3	Total
consumption		67xE1xE2)				
Present operating hours per day	Hr/Day	G1	16	16	16	
Present operating days per year	day/year	G2	365	365	365	
Present annual energy consumption	kWh/year	H=B3xG1xG2	65,233	58,458	57,933	
Proposed annual energy consumption	kWh/year	I=FxG1xG2	52,095	52,095	52,095	
Annual electricity saving	kWh	J=H-I	13,137	6,363	5,837	25,338
Electrical energy cost per unit	Rs./kWh	K	7.96	7.96	7.96	
Expected Annual cost savings	Rs .Lakhs	L=KxJ/10^5	1.05	0.51	0.46	2.01
One time cost of implementation	Rs .Lakhs	M	1.47	1.47	1.47	4.42
Payback period	months	N=(M/N)x12	17	35	38	26

ECM AC6: Automation of secondary pumps based on DP sensor at the farthest AHU

Present System

- The secondary pump in the facility has an average flow of 101m^3/hr and the head generated by the pump is 19m.
- The rated power of the motor is 15kW, and the present efficiency of the secondary pumps is 52% .
- The average power consumption of the motor in the present operating frequency is 7.09 kW.

ECM AC6.1: Secondary Pumps at IIM Kozhikode

Proposed System

- Install the Differential Pressure (DP) sensor and utilize the feedback from the DP sensor to drive the secondary pump's VFD and optimize the pumping power during unoccupied periods, once the set temperature is achieved in AHUs.
- The chilled water flow across the AHUs will automatically be controlled by the actuators based on the set temperature and the return air temperature.
- Automate the existing VFD setting of secondary pumps based on pressure feedback for the different zones.
- Pump power consumption can be fine-tuned based on actual pressure requirements for AHUs. Hence, a reduction in pumping power is possible.
- After implementing this scheme IIM Kozhikode can potentially save 88,134 kWh per annum and thereby reduce 72.27 tons of CO_2 emission.
- **By implementing this proposal at IIM Kozhikode will save 7.58 MTOE per annum**

ECM AC6.2: Proposed differential pressure sensor

ESTIMATED BENEFITS

Recurring annual cost savings	: Rs. 7.01 Lakhs
One-time cost of implementation	: Rs.1.8 Lakhs
Payback period	: 3 months

Table ECM AC6 : Savings Calculation

Description	Unit	Formula	Main Building			Classroom		
			Secondary Pump 1	Secondary Pump 2	Secondary Pump 3	Secondary Pump 1	Secondary Pump 2	Secondary Pump 3
Rated power	kW	A1	7.5	7.5	7.5	7.5	7.5	7.5
Measured flow of secondary pump	m3/hr	A2	51	54	58	41	40	42
Measured head in secondary pump	m	A3	12	13	12	19	20	20
Computed efficiency of pump	%	A4	40.5%	44.5%	42.8%	35.1%	33.4%	36.4%
Operating Frequency	Hz	A5	41.3	50	50	46.6	50	50
Measured power consumption of secondary pump at present frequency	kW	B	4.64	4.85	4.99	6.82	7.36	7.09
Estimated power consumption at proposed frequency based on affinity law	kW	C=(40/A5)^3*B	4.2	2.5	2.6	4.3	3.8	3.6
Expected power savings	kW	D=B-C	0.4	2.4	2.4	2.5	3.6	3.5
Assumed running hours at 40 hz	hrs/day	E	8	8	8	12	12	12
Operating days per year as per the maintenance team	days/year	F	365	365	365	365	365	365
Recurring annual energy savings	kWh	G=DxExF	1,240	6,911	7,111	10,979	15,732	15,154
Unit electricity cost	Rs/kWh	H	7.95	7.95	7.95	7.95	7.95	7.95
Recurring annual cost savings	Rs. lakhs	I=GxH/10^5	0.10	0.55	0.57	0.87	1.25	1.20
Onetime cost of implementation DP Sensors and automation of VFD	Rs. lakhs	J	0.20	0.20	0.20	0.20	0.20	0.20
Payback period	months	K=J/Ix12	24	4	4	3	2	2

Description	Unit	Formula	Hostel			Total
			Secondary Pump 1	Secondary Pump 2	Secondary Pump 3	
Rated power	kW	A1	7.5	7.5	7.5	
Measured flow of secondary pump	m3/hr	A2	39	36	37	
Measured head in secondary pump	m	A3	20	23	22	
Computed efficiency of pump	%	A4	32.1%	36.0%	34.6%	
Operating Frequency	Hz	A5	50	50	50	
Measured power consumption of secondary pump at present frequency	kW	B	7.46	7.06	7.24	
Estimated power consumption at proposed frequency based on affinity law	kW	C=(40/A5)^3*B	3.8	3.6	3.7	
Expected power savings	kW	D=B-C	3.6	3.4	3.5	
Assumed running hours at 40 hz	hrs/day	E	8	8	8	
Operating days per year as per the maintenance team	days/year	F	365	365	365	
Recurring annual energy savings	kWh	G=DxExF	10,630	10,060	10,317	88,134
Unit electricity cost	Rs/kWh	H	7.95	7.95	7.95	
Recurring annual cost savings	Rs. lakhs	I=GxH/10^5	0.85	0.80	0.82	7.01
Onetime cost of implementation DP Sensors and automation of VFD	Rs. lakhs	J	0.20	0.20	0.20	1.80
Payback period	months	K=J/Ix12	3	3	3	3

ECM AC7: Automate the CT fan speed based on cooling tower approach temperature and save energy

Present System

- The IIM Kozhikode has 2 cooling towers of 250 TR in which 2 cooling towers are operated for 2 chillers. Please refer figure AC7.1 below
- The rated power of the cooling tower fans is 5.5 kW, the measured range of cooling tower 1 & 2 are 3.4°C & 3.8°C.
- The measured approach for cooling tower 1 is 6.3°C, for cooling tower 2 is 5.5°C.
- Presently the cooling tower is not automated and VFD has not been installed. Each Cooling tower has 2 fans installed.
- The average measured power consumption of cooling tower 1 is 7.74 kW, whereas for the cooling tower 2 is 6.04 kW
- The effectiveness varies from 35% to 41%.

Fig AC7.1: Cooling Towers at IIM Kozhikode

Proposed System

- Install ambient wet bulb temperature-based sensor to automate the cooling tower fans and reduce its power consumption. Please refer to the figure AC7.2 below.
- These Humidity Transmitters sense the Relative Humidity and dry bulb temperature of ambient condition and they are integrated with a Psychrometric system that automatically calculates the wet bulb temperature of ambient condition.
- The temperature sensor is fitted in cooling tower inlet and outlet water to calculate

the CT Approach (Cooling outlet temperature–wet bulb temperature).

- According to the BEE standard, the Cooling tower approach limit is 4°C.
- These sensors automate the CT Fan; whenever the approach temperature drops below 4°C it will reduce the speed of the fan. And whenever the approach rises above 4°C, the CT fan runs at full speed.
- This reduces the power consumption of the CT fans & and achieves the best condensing temperature for the chiller thereby optimizing chiller plant energy consumption.
- After implementing this scheme, IIM Kozhikode can save up to 18,205 kWh per annum and thereby reduce 14.93tons CO_2e emissions per annum.
- **By implementing this proposal at IIM Kozhikode will save 1.57 MTOE per annum**

ESTIMATED BENEFITS

Recurring annual cost savings : Rs. 1.45 Lakhs

One-time cost of implementation : Rs. 0.48 Lakhs

Payback period : 4 months

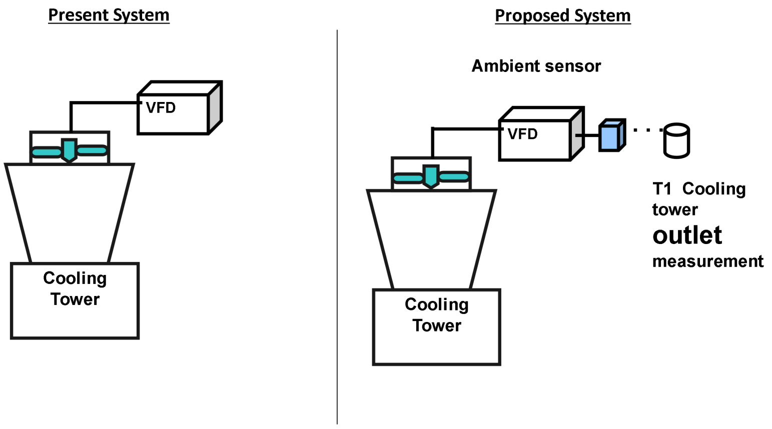


Figure AC7.2: Proposal Schematic

Table ECM AC7 : Savings Calculation

Description	Units	Formula	Cooling Tower 1	Cooling Tower 2	Total
Rated power of one CT Fan	kW	A1	5.5	5.5	
No. of Fans	No.	A2	2	2	
Total Rated power of CT fan motors	kW	A3	11	11	
Measured range of CT	°C	A4	3.4	3.8	
Measured Approach of CT	°C	A5	6.3	5.5	
Computed Effectiveness of CT	%	A6	35	41	
Actual Measured power consumption of CT fans	kW	A7	7.90	6.04	

Description	Units	Formula	Cooling Tower 1	Cooling Tower 2	Total
Proposed Power consumption after automation of VFDs of fans based on approach sensors at 45 Hz	kW	B1=(45/50)^3xA7	5.76	4.40	
Proposed Power consumption after automation of VFDs of fans based on approach sensors at 40 Hz	kW	B2=(40/50)^3xA7	4.04	3.09	
Operating days per year as per the maintenance team	day/year	C1	24	24	
Operating hr per day as per the maintenance team	hr	C2	365	365	
Assumed Operating hours per annum at 45 Hz	Hour/Annum	D1=6xC1	2,190	2,190	
Assumed Operating hours per annum at 40 Hz	Hour/Annum	D2=4xC1	1,460	1,460	
Annual electricity saving from fans operating at 45 Hz	kWh	E1=(A8xD1)-(B1xD1)	4,689	3,585	
Annual electricity saving from fans operating at 40 Hz	kWh	E2	5,629	4,303	
Annual electricity saving from automation of fan	kWh	E=E1+E2	10,317	7,888	18,205
Electrical energy cost per unit	Rs./kWh	F	7.96	7.96	
Annual cost savings	Rs. lacs	G=FxE/10^5	0.82	0.63	1.45
One time cost of implementation	Rs. lacs	H3	0.24	0.24	0.48
Payback period	months	I=H3/Gx12	4	5	4

ECM AC8: Replace fans of CTs with suitable FRP blades for reducing power consumption and save energy

Present System

- IIM Kozhikode has 2 cooling towers of 250 TR and they are induced draft cooling tower designs . Please refer figure AC8.1 below
- The rated power of the cooling tower fans is 5.5 kW, the measured range of cooling tower 1 & 2 are 3.4°C, 3.8°C .
- Two fans are working in both the cooling tower and the existing towers have become older, less efficient technology, leading to higher energy consumption and increased operational costs.
- The measured approach for cooling tower 1 is 6.3°C, for cooling tower 2 is 5.5°C.

Fig AC8.1: Cooling Towers at IIM Kozhikode

Proposed System

- We recommend replacing the existing cooling tower fans with new and energy efficient FRP fans which are lighter in weight and anti-corrosive material.
- The quiet operation of these fans involves the design and material used to make FRPs. This approach minimizes noise production, resulting in a more comfortable and productive work environment.
- Fiber-reinforced plastic fans can withstand harsh environmental conditions and resist corrosion and degradation. This means that fiberglass fans are durable and virtually impossible to break.

- After Implementing this scheme IIM Kozhikode will potentially save 24,795 kWh per annum and reduce 20.33 tons of CO_2e emission
- **By implementing this proposal at *IIM Kozhikode* will save 2.13 MTOE per annum.**

Figure ECM AC8.2 : Representative picture of FRP Blades

ESTIMATED BENEFITS

Recurring annual cost savings : Rs. 1.97 Lakhs

One-time cost of implementation : Rs. 2.60 Lakhs

Payback period : 16 months

Table ECM AC8 : Savings Calculation

Description	Units	Formula	Cooling Tower 1	Cooling Tower 2	Total
Rated power of CT Fan	kW	A1	5.5	5.5	
No. of Fans	No.	A2	2	2	
Measured Approach of CT	°C	A3	6.3	5.5	
Measured Range of CT	°C	A4	3.4	3.8	
Computed effectiveness of CT	%	A5	35	41	
Actual measured power consumption	kW	A6	7.90	6.04	
Proposed Power consumption after post installation of FRP Fan in Cooling tower	kW	B=A6X80%	6.32	4.83	
Expected Savings	kW	C=A6-B	1.58	1.21	
Operating days per year as per the maintenance team	day/year	D	365	365	
Operating hr per day as per the	hrs/day	E	24	24	

Description	Units	Formula	Cooling Tower 1	Cooling Tower 2	Total
maintenance team					
Annual electricity saving	kWh	F=D*E*C	14,052	10,743	24,795
Electrical energy cost per unit	Rs./kWh	G	7.95	7.95	
Annual cost savings	Rs. lacs	H=G*F	1.12	0.85	1.97
One time cost of implementation	Rs. lacs	I	1.30	1.30	2.60
Payback period	months	J=I/H*12	14	18	16

ECM AC9: Operates optimal number of cooling towers for single chiller operation to save energy.

Present System

- 2 cooling towers each of 250 TR capacity are installed at IIM Kozhikode for the chiller condenser water cooling.
- Presently, all the cooling towers are working, irrespective of how many chillers are running.
- The present average cooling tower approach for the cooling tower is 5.9 °C.

Proposed System

- SEA recommends operating 1 cooling tower for 1 chiller operation during favourable weather conditions (Winter season, rainy days, night time)after the refurbishment of the cooling tower.
- After implementing this scheme can save up to 5,688 kWh per annum thereby reduce 4.66 tons of CO_2e
- **By implementing this proposal at IIM Kozhikode will save 0.49 MTOE per annum**

ESTIMATED BENEFITS

Recurring annual cost savings : Rs. 0.45 Lakhs

One-time cost of implementation : Nil

Payback period : Immediate

Table ECM AC9 : Savings Calculation

Description	Unit	Formula	Values
Rated input power of cooling tower fan motor	kW	A	5.5
No. of Fans	No.	B	2
Power consumed by fans of cooling tower 1	kW	C1	7.90
Power consumed by fans of cooling tower 2	kW	C2	6.04
Annual operating hours for two cooling tower	hours	D	8,760
Annual electricity savings (running 1 CT for optimal heat rejection)	kWh	E=C1*8*100	5688
Unit cost of electricity	Rs./kWh	F	7.95

Description	Unit	Formula	Values
Recurring annual cost savings	Rs. Lakhs	G=FxE/10^5	0.45
One time cost of implementation	Rs. Lakhs	H	Nil
Payback period	Months	I=H/Gx12	Immediate

ECM AC10: Refurbishment of cooling tower fills to improve the CT effectiveness

Present System

- Two cooling towers each of 250 TR capacity are installed at IIM Kozhikode for the chiller condenser water cooling.
- Both the cooling towers were operational during the audit.
- The cooling tower 1 approach is 6.3°C were as for the cooling tower 2 is 5.5°C
- The CT 1 effectiveness is found to be 35 % and for the CT 2 the effectiveness is found to be 41%.

Proposed System

- It is suggested to refurbish the cooling tower.Refurbishment includes cleaning of fills and nozzles, ensuring uniform water flow across the fills and adequate air flow to provide better heat transfer efficiency.
- Refurbishment extends the life, performance, and efficiency of the existing cooling towers without building a new one.
- The process does not usually involve a total demolition of the existing cooling tower.
- A successful cooling tower rebuild can generate returns in both cooling capacity and structural integrity, which can extend the life of your cooling tower and produce a huge return on your investment.
- After Implementing this scheme IIM Kozhikode will potentially save 1,21,101 kWh per annum and reduce 99.3 tons of CO_2e emission
- **By implementing this proposal at IIM Kozhikode will save 10.41 MTOE per annum.**

Figure AC10.1: Proposed fills for Cooling Towers

Estimated Benefits

Recurring annual cost savings : Rs 9.63 Lakhs

One-time cost of implementation : Rs. 8 Lakhs

Payback period : 10 months

Table ECM AC10 : Savings Calculation

Description	Unit	Formula	Value				Total
Average specific power consumption of chillers (after periodic descaling)	kW/TR	A	0.76				
Chiller average TR generated	TR	B	214.0				
Present average power consumption of chillers (2 chillers running)	kW	C=AxB	163				
Months			Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec	
Cooling tower water inlet temperature	°C	D1	37.0	33.6	31.8	30.3	
Cooling tower water outlet temperature	°C	D2	33.4	29.8	27.2	26.4	
Average wet bulb temperature	°C	D3	27.5	24.0	23.6	23.5	
Average effectiveness of cooling tower	%	E1	38%	40%	56%	57%	
Proposed cooling tower system effectiveness after refurbishment and running 2 cooling towers	%	E2	65%	65%	65%	65%	
Proposed Cooling tower outlet temperature after replacement	°C	F=D1-(E2x (D1-D3))	30.8	27.4	26.5	25.9	
Expected reduction in cooling tower return water temperature	°C	G=D2-F	2.6	2.4	0.7	0.5	
Expected power savings on chiller compressors (As per BEE,	kW	H=(G/0.55) x3%xC	22.84	21.65	6.48	4.61	

Description	Unit	Formula	Value				Total
3% reduction in power consumption for every 0.55° C decrease in return water temperature)							
Chiller average annual operating hours	hrs	I	2160	2184	2208	2208	
Annual energy savings	kWh	K=H*I	49,342	47,275	14,299	10,186	121,101
Unit electricity cost	Rs/kWh	L	7.95	7.95	7.95	7.95	
Recurring annual cost savings	Rs. lakhs	M=L*K/10^5	3.92	3.76	1.14	0.81	9.63
One time cost of implementation	Rs. lakhs	N	8.00				8.00
Payback period	months	O	10				10

ECM AC11: Replace identified AHUs/TFAs fans with energy efficient EC fans and save energy

PRESENT SYSTEM

- In IIM Kozhikode the audit team did a performance study of AHU's/TFA's in the facility.
- All the fans were using induction motors; Most of them were driven by a belt.
- The fan motor capacity varies from 0.75 kW to 11 kW.
- All AHU are VFD driven but are not automated and are running on full load.

PROPOSED SYSTEM

- Replace identified fans with optimum capacity, energy-efficient BLDC motors and fans. Please refer to figure AC11.1 below.
- BLDC motors are more efficient than induction motors because they have no slip and provide precise control over speed and torque, resulting in lower energy consumption. Additionally, BLDC motors are smaller, lighter, and generate less heat, making them ideal for applications where space and efficiency are critical.
- Proposed new motors are to be selected for the rated parameters.
- They can be easily integrated with BMS control and are relatively maintenance free.
- After implementing this scheme IIM Kozhikode can save up to 206,380 kWh per annum and reduce 169.23 CO_2 tons of carbon emission

By implementing this proposal at IIM Kozhikode will save 17.75 MTOE per annum

Figure AC11.1: Proposed EC motor and fan for AHU's/TFA's

ESTIMATED BENEFITS

Recurring annual cost savings : Rs 16.41 Lakhs

One-time cost of implementation : Rs. 10.34 Lakhs

Payback period : 8 months

Table ECM AC11 : Savings Calculation

			Phase 5 AHUs/TFAs			
Description	**Unit**	**Formula**	**Dining Hall AHU**	**Classroom AHU x8**	**Cafe AHU**	**Classroom TFA x8**
Designed Airflow	CFM	A1	9,300	3,100	7,100	2,500
	m3/hr	A2	15,789	5,263	12,054	4,244
Rated power of motor	kW	B	3.7	1.5	1.5	1.5
Name plate motor efficiency	%	C	85%	82.8%	82.8%	82.8%
Desired air flow	m3/s	D	2.58	0.86	1.97	0.69
Desired static pressure	mmWC	E	50	40	50	40
Expected new fan efficiency	%	F	75%	75%	75%	75%
Expected new motor efficiency	%	G	91%	90%	90%	90%
Expected new fan power consumption	kW	H=(DxE)/(102xFxG)	1.86	0.50	1.43	0.40
Running hours per day	h/day	I	15	9	18	9
Running days per year	day/year	J	304	304	304	304
Annual energy savings	kWh/year	K=(B-H)xIxJ	8,411	21,882	371	24,001
Unit power cost	Rs/kWh	L	7.95	7.95	7.95	7.95
Annual cost savings	Rs. Lakhs	M=KxL/10^5	0.67	1.74	0.03	1.91
One-time cost of implementation	Rs. Lakhs	N	0.46	1.00	0.36	0.81
Payback period	months	O=(N/M)x12	8	7	146	5

			PART B AHU's					
Description	**Unit**	**Formula**	**Video Conference & Studio AHU**	**CC Lab 2 AHU**	**Corporate Hall**	**CC Live AHU**	**Library L - 4 AHU**	**Library Ground 1 AHU**
Designed Airflow	CFM	A1	3,100	6,100	11,000	21,500	9,500	7,300
	m3/hr	A2	5,263	10,357	18,676	36,503	16,129	12,394
Rated power of motor	kW	B	1.5	3.7	5.5	11.0	5.5	3.7
Name plate motor efficiency	%	C	82.8%	85%	86%	89.8%	86%	85.0%
Desired air flow	m3/s	D	0.86	1.69	3.06	5.97	2.64	2.03
Desired static pressure	mmWC	E	40	50	50	80	60	50
Expected new fan efficiency	%	F	75%	75%	75%	75%	75%	75%
Expected new motor efficiency	%	G	90%	91%	91%	93%	91%	91%
Expected new fan power consumption	kW	H=(DxE)/(102xFxG)	0.50	1.22	2.19	6.72	2.27	1.46
Running hours per day	h/day	I	6	15	9	15	6	18
Running days per year	day/year	J	365	304	365	304	365	365
Annual energy savings	kWh/year	K=(B-H)xIxJ	2,189	11,322	10,858	19,537	7,064	14,740
Unit power cost	Rs/kWh	L	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost savings	Rs. Lakhs	M=KxL/10^5	0.17	0.90	0.86	1.55	0.56	1.17
One-time cost of implementation	Rs. Lakhs	N	0.13	0.30	0.55	1.68	0.57	0.36
Payback period	months	O=(N/M)x12	9	4	8	13	12	4

			PART B AHU's					
Description	Unit	Formula	Library First Floor 1 AHU	LF 2 AHU	Library Museum AHU	Library Museum ISRO AHU	Library RBI AHU	Admin -1 Level AHU
Designed Airflow	CFM	A1	9,300	7,000	17,000	2,100	4,000	5,900
	m3/hr	A2	15,789	11,885	28,862	3,565	6,791	10,017
Rated power of motor	kW	B	5.5	3.7	11.0	0.75	0.75	3.7
Name plate motor efficiency	%	C	86.0%	85.0%	89.8%	79.6%	79.6%	85%
Desired air flow	m3/s	D	2.58	1.94	4.72	0.58	1.11	1.64
Desired static pressure	mmWC	E	60	50	80	40	40	50
Expected new fan efficiency	%	F	75%	75%	75%	75%	75%	75%
Expected new motor efficiency	%	G	91%	91%	93%	90%	90%	91%
Expected new fan power consumption	kW	H=(DxE)/(102xFxG)	2.23	1.40	5.31	0.34	0.65	1.18
Running hours per day	h/day	I	18	18	6	6	6	9
Running days per year	day/year	J	365	365	365	365	365	365
Annual energy savings	kWh/year	K=(B-H)xIxJ	21,507	15,134	12,461	900	229	8,288
Unit power cost	Rs/kWh	L	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost savings	Rs. Lakhs	M=KxL/10^5	1.71	1.20	0.99	0.07	0.02	0.66
One-time cost of implementation	Rs. Lakhs	N	0.56	0.35	1.33	0.08	0.16	0.29
Payback period	months	O=(N/M)x12	4	3	16	14	106	5

			PART B AHU's				
Description	Unit	Formula	Admin Street Level AHU	Admin +1 Level AHU	Auditorium AHU	Board Room AHU	Total
Designed Airflow	CFM	A1	9,050	4,000	10,000	3,300	

			PART B AHU's				
Description	Unit	Formula	Admin Street Level AHU	Admin +1 Level AHU	Auditorium AHU	Board Room AHU	Total
	m3/hr	A2	15,365	6,791	16,978	5,603	
Rated power of motor	kW	B	3.7	3.7	5.5	2.2	
Name plate motor efficiency	%	C	85%	85%	86.0%	84.0%	
Desired air flow	m3/s	D	2.51	1.11	2.78	0.92	
Desired static pressure	mmWC	E	50	40	60	40	
Expected new fan efficiency	%	F	75%	75%	75%	75%	
Expected new motor efficiency	%	G	91%	91%	91%	90%	
Expected new fan power consumption	kW	H=(DxE)/(102xFxG)	1.81	0.64	2.39	0.53	
Running hours per day	h/day	I	9	9	8	6	
Running days per year	day/year	J	365	365	304	365	
Annual energy savings	kWh/year	K=(B-H)xIxJ	6,223	10,057	7,554	3,652	206,380
Unit power cost	Rs/kWh	L	7.95	7.95	7.95	7.95	
Annual cost savings	Rs. Lakhs	M=KxL/10^5	0.49	0.80	0.60	0.29	16.41
One-time cost of implementation	Rs. Lakhs	N	0.45	0.16	0.60	0.13	10.34
Payback period	months	O=(N/M)x12	11	2	12	6	8

ECM AC12: Install VFD and automate the fan speed based on RAT sensors in AHUs

Present System

- The audit team did a performance study of AHU's in the facility.
- The fan motor capacity varies from 0.75 kW to 11 kW.
- Although these fans have VFD they are not working on the basis of RAT sensors on the AHU's.
- Hence all AHUs are operating at full speed for all the time they are in operation.

Proposed System

- We recommend running AHU fans based on the feedback from RAT sensor : Return air Temperature sensor which senses the temperature of return air in AHU. Please refer the figure AC12.1 below
- It enables the AHU system to adjust the airflow and cooling capacity based on real-time return air temperature.
- It prevents unnecessary cooling or heating, leading to energy savings and reduced operational costs.
- It provides accurate feedback on the indoor environment, allowing precise control over temperature.
- After implementing this scheme IIM Kozhikode can save up to 1,22,059 kWh per annum and reduce 100.09 CO_2 tons of carbon emission

By implementing this proposal at IIM Kozhikode will save 10.50 MTOE per annum

Figure AC12.1: Proposed picture of RAT Sensor

Estimated Benefits

Recurring annual cost savings	: Rs 10 Lakhs
One-time cost of implementation	: Rs. 8 Lakhs
Payback period	: 10 months

Table ECM AC12 : Savings Calculation

Description	unit	Formula	Dining Hall AHU	Classroom AHU x8	Cafe AHU	Video Conference & Studio AHU	CC Lab 2 AHU	Corporate Hall
Rated TR	TR	A	25.56	7.62	15.24	7.5	13.5	20.2
Rated kW of the fan	kW	C	3.7	1.5	1.5	1.5	3.7	5.5
Present Operating frequency	Hz	C2	50	50	50	50	50	50
Expected power consumption during 45 Hz	kW	D1=(45/C2)^3xB	2.70	1.09	1.09	1.09	2.70	4.01
Expected power consumption during 40 Hz	kW	D2=(40/C2)^3xB	1.89	0.77	0.77	0.77	1.89	2.82
Expected power consumption during 35 Hz	kW	D3=(30/C2)^3xB	1.27	0.51	0.51	0.51	1.27	1.89
Operating hours per year as per maintenance team	Hr/day	E	15	9	18	6	15	9
Operating days per day as per maintenance team	day/year	F	304	304	304	365	304	365
Assumed Operating hours per annum at low demand at 45 Hz	Hour/Annum	G1	912	1,216	912	1,460	1,216	1,095
Assumed Operating hours per annum at low demand at 40 Hz	Hour/Annum	G2	608	912	608	1095	912	730
Assumed Operating hours per annum at low demand at 35 Hz	Hour/Annum	G3	608	608	304	730	608	365
Annual electricity saving from fans operating at 45 Hz	kWh	H1	914	494	371	593	1,219	1,632
Annual electricity saving from fans	kWh	H2	1,098	668	445	802	1,647	1,959

Description	unit	Formula	Dining Hall AHU	Classroom AHU x8	Cafe AHU	Video Conference & Studio AHU	CC Lab 2 AHU	Corporate Hall
operating at 40 Hz								
Annual electricity saving from fans operating at 35 Hz	kWh	H3	1,478	599	300	719	1,478	1,319
Annual electricity saving from automation of fan	kWh	H4=(H1+H2+H3)	3,490	14,089	1,115	2,114	4,344	4,910
Electrical energy cost per unit	Rs./kWh	H	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost savings	Rs. Lakh	I=GxH/10^5	0.28	1.12	0.09	0.17	0.35	0.39
Cost of installation of VFD	Rs. Lakh	J1	0.00	0.00	0.00	0.12	0.30	0.44
One time cost for automation of fans with RAT	Rs. lakh	J2	0.10	0.10	0.10	0.10	0.10	0.10
Total one time cost implementation	Rs. lakh	J=J1+J2	0.10	0.80	0.10	0.22	0.40	0.54
Payback Period	months	K=J/I*12	4	9	14	16	14	17

Description	unit	Formula	CC Live AHU	Library L - 4 AHU	Library Ground 1 AHU	Library First Floor 1 AHU	LF 2 AHU	Library Museum AHU
Rated TR	TR	A	41.6	23	13	21	15	36.2
Rated kW of the fan	kW	C	11	5.5	3.7	5.5	3.7	11.0
Present Operating frequency	Hz	C2	50	50	50	50	50	50
Expected power consumption during 45 Hz	kW	D1=(45/C2)^3xB	8.02	4.01	2.70	4.01	2.70	8.02
Expected power consumption during 40 Hz	kW	D2=(40/C2)^	5.63	2.82	1.89	2.82	1.89	5.63

		3xB						
Expected power consumption during 35 Hz	kW	D3=(30/C2)^ 3xB	3.77	1.89	1.27	1.89	1.27	3.77
Operating hours per year as per maintenance team	Hr/day	E	15	6	18	18	18	6
Operating days per day as per maintenance team	day/year	F	304	365	365	365	365	365
Assumed Operating hours per annum at low demand at 45 Hz	Hour/Annum	G1	1,216	1,460	2,190	1,460	1,460	1,460
Assumed Operating hours per annum at low demand at 40 Hz	Hour/Annum	G2	912	1,095	1,460	730	1,825	1,825
Assumed Operating hours per annum at low demand at 35 Hz	Hour/Annum	G3	608	730	730	365	1,095	1,095
Annual electricity saving from fans operating at 45 Hz	kWh	H1	3,625	2,176	2,196	2,176	1,464	4,352
Annual electricity saving from fans operating at 40 Hz	kWh	H2	4,896	2,939	2,636	1,959	3,295	9,797
Annual electricity saving from fans operating at 35 Hz	kWh	H3	4,394	2,638	1,775	1,319	2,662	7,914
Annual electricity saving from automation of fan	kWh	H4=(H1+H2+ H3)	12,915	7,753	6,607	5,454	7,421	22,062
Electrical energy cost per unit	Rs./kWh	H	7.95	7.95	7.95	7.95	7.95	7.95
Annual cost savings	Rs. Lakh	I=GxH/10^5	1.03	0.62	0.53	0.43	0.59	1.75
Cost of installation of VFD	Rs. Lakh	J1	0.88	0.44	0.30	0.44	0.30	0.88
One time cost for automation of fans with RAT	Rs. lakh	J2	0.10	0.10	0.10	0.10	0.10	0.10
Total one time cost implementation	Rs. lakh	J=J1+J2	0.98	0.54	0.40	0.54	0.40	0.98
Payback Period	months	K=J/I*12	11	11	9	15	8	7

Description	unit	Formula	Library Museum ISRO AHU	Library RBI AHU	Admin -1 Level AHU	Admin Street Level AHU	Admin +1 Level AHU	Board Room AHU	Total
Rated TR	TR	A	4.5	8.2	12	22	10	10	
Rated kW of the fan	kW	C	0.75	1.5	3.7	3.7	3.7	1.5	
Present Operating frequency	Hz	C2	50	50	50	50	50	50	
Expected power consumption during 45 Hz	kW	D1=(45/C2)^3xB	0.55	1.09	2.70	2.70	2.70	1.09	
Expected power consumption during 40 Hz	kW	D2=(40/C2)^3xB	0.38	0.77	1.89	1.89	1.89	0.77	
Expected power consumption during 35 Hz	kW	D3=(30/C2)^3xB	0.26	0.51	1.27	1.27	1.27	0.51	
Operating hours per year as per maintenance team	Hr/day	E	6	6	9	9	9	6	
Operating days per day as per maintenance team	day/year	F	365	365	365	365	365	365	
Assumed Operating hours per annum at low demand at 45 Hz	Hour/Annum	G1	1,460	1,460	1,460	1,460	1,460	1,460	
Assumed Operating hours per annum at low demand at 40 Hz	Hour/Annum	G2	1,825	1,825	1,825	1,825	1,825	1,825	
Assumed Operating hours per annum at low demand at 35 Hz	Hour/Annum	G3	1,095	1,095	1,095	1,095	1,095	1,095	
Annual electricity saving from fans operating at 45 Hz	kWh	H1	297	593	1,464	1,464	1,464	593	

Description	unit	Formula	Library Museum ISRO AHU	Library RBI AHU	Admin -1 Level AHU	Admin Street Level AHU	Admin +1 Level AHU	Board Room AHU	Total
Annual electricity saving from fans operating at 40 Hz	kWh	H2	668	1,336	3,295	3,295	3,295	1,336	
Annual electricity saving from fans operating at 35 Hz	kWh	H3	540	1,079	2,662	2,662	2,662	1,079	
Annual electricity saving from automation of fan	kWh	H4=(H1+H2 +H3)	1,504	3,009	7,421	7,421	7,421	3,009	29,784
Electrical energy cost per unit	Rs./kWh	H	7.95	7.95	7.95	7.95	7.95	7.95	
Annual cost savings	Rs. Lakh	I=GxH/10^5	0.12	0.24	0.59	0.59	0.59	0.24	2
Cost of installation of VFD	Rs. Lakh	J1	0.06	0.12	0.30	0.30	0.30	0.12	
One time cost for automation of fans with RAT	Rs. lakh	J2	0.10	0.10	0.10	0.10	0.10	0.10	
Total one time cost implementation	Rs. lakh	J=J1+J2	0.16	0.22	0.40	0.40	0.40	0.22	2
Payback Period	months	K=J/I*12	16	11	8	8	8	11	9

ECM AC13: Replacement of existing fresh air and exhaust fans (except kitchen exhaust fans) with BLDC fans to reduce energy consumption.

Present System

- During the carbon audit we studied the performance of ventilation fans.
- All the ventilation fans utilizes an AC induction motor which is connected using a belt to the centrifugal fan.
- In belt driven systems wear and tear, belt slippage etc. are common and cause downtime.

Proposed System

- SEA proposes to replace the existing exhaust fans with energy efficient BLDC motors and fans. Please refer figure AC13.1 below
- BLDC motors are more efficient than induction motors because they have no slip and provide precise control over speed and torque, resulting in lower energy consumption. Additionally, BLDC motors are smaller, lighter, and generate less heat, making them ideal for applications where space and efficiency are critical.
- New fans to be selected for the design flow and pressure of the existing fans.
- Using BLDC fans for kitchen exhaust is not proposed as the oil and humidity content in exhaust air may cause failures in the electronic system of BLDC motors.

Figure AC13.1: Proposed Energy Efficient BLDC Fan

ECM AC14: Install heat pipes in TFA to reduce cooling load of chiller and reduce chiller energy consumption and save energy

Present System

- The current system struggles to maintain optimal humidity levels in the targeted functional areas leading to less efficient temperature regulation.
- Due to inadequate humidity control, the air conditioning system consumes additional energy to compensate for the fluctuations in humidity and temperature.
- Sub-optimal humidity control may affect comfort levels and productivity, leading to higher energy use to correct thermal discomfort.

Proposed System

- We recommend installing a heat pipe in TFAs to effectively manage humidity levels, enhancing both temperature and humidity control.
- It operates based on the principle of phase change, which makes it effective for transferring heat without the need for large amounts of energy.
- The heat pipe will improve humidity regulation by transferring heat and moisture more efficiently, reducing the need for additional dehumidification or cooling.
- By maintaining optimal humidity levels, the cooling load on the air conditioning system will be reduced, leading to lower energy consumption.
- Improved humidity control will enhance comfort levels in the TFAs, potentially increasing worker productivity and reducing the need for excessive air conditioning operation.

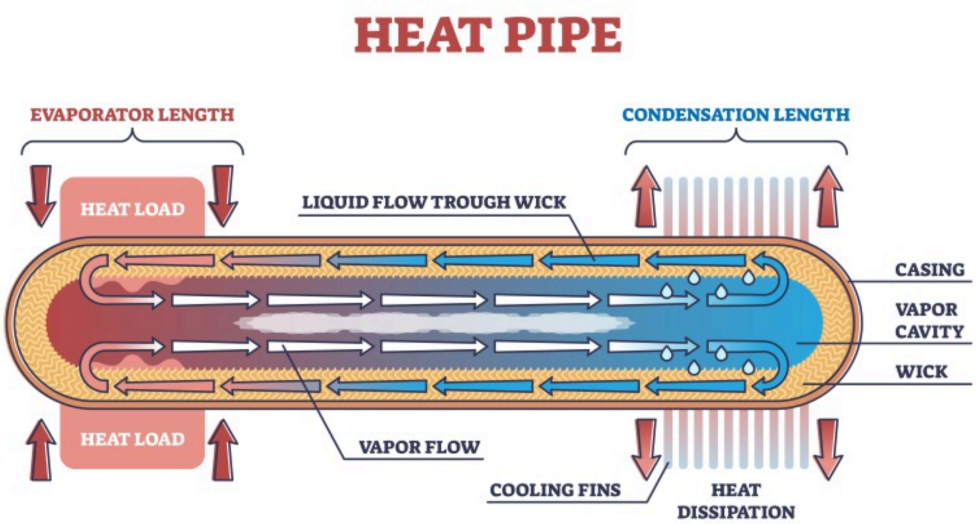


Figure AC14.1: Representative Picture of Heat Pipe

ECM AC15: Replace Old Under Performing Split A/c's to Energy Efficient 5-Star Inverter A/C's.

Present System

- Presently, IIM Kozhikode is using split air conditioners (ACs) for cooling, but some of these units lack a star rating.
- The non star AC will have higher energy consumption and thereby higher operating costs compared to Star rated AC.
- The BEE star rating system is used to indicate the energy efficiency of appliances, including air conditioners. The higher the star rating, the more energy-efficient the unit is, which can lead to cost savings and a smaller environmental impact.

Proposed System

- If the institute is looking to improve its energy efficiency or reduce operating costs, upgrading or replacing the underperforming AC units with higher-rated or more modern units could be a good step.
- This would not only help with energy savings but also potentially enhance guest comfort and align with sustainability goals.
- After implementing this scheme IIM Kozhikode can save up to 4,898 kWh per annum and reduce 4.02 CO_2e tons of carbon emission

By implementing this proposal at IIM Kozhikode will save 0.42 MTOE per annum.

Figure AC15.1 : Representative picture of 5 star AC

Table ECM AC15 : Savings Calculation

Description	Units	Value
Proposed savings as per previous audit	kWh/Year	6,123
Assumed Savings achieved by replacing 20% of the A/c's	kWh/Year	1,225
Assumed Savings that can be achieved by replacing the remaining 80% of the A/C's	kWh/Year	4,898

ECM AC16: Replace existing AC FCU motors with suitable capacity DC blowers to reduce demand as well as energy savings.

Present System

- The existing Fan Coil Unit (FCU) motors are standard induction motors, which are less energy-efficient.
- The induction motors consume more power due to their relatively high energy usage and lack of variable speed control, resulting in higher energy costs.
- These motors operate at a fixed speed, even during periods when reduced airflow is sufficient, leading to unnecessary energy consumption.
- Induction motors may require more frequent maintenance and have a shorter lifespan compared to more advanced motor technologies.

Proposed System

- SEA proposes to replace the existing induction motors in the FCUs with energy-efficient Brushless DC (BLDC) motors.
- BLDC motors are more energy-efficient, as they use less power for the same or even better performance than induction motors. This will lead to a significant reduction in overall energy consumption.
- BLDC motors can operate at variable speeds, allowing the system to adjust airflow based on cooling needs, which further optimizes energy usage by avoiding overcooling and unnecessary motor operation.
- The higher efficiency of BLDC motors will directly reduce energy costs associated with cooling operations.
- BLDC motors have fewer moving parts, which increases their reliability and lifespan, leading to reduced maintenance requirements and lower long-term costs.
- After implementing this scheme IIM Kozhikode can save up to 25591 kWh per annum and reduce 20.98 CO_2e tons of carbon emission

By implementing this proposal at IIM Kozhikode will save 2.20 MTOE per annum

Estimated Benefits

Recurring annual cost savings	: Rs 2 Lakhs
One-time cost of implementation	: Rs. 21 Lakhs
Payback period	: 125 months

Table ECM AC16 : Savings Calculation

Description	Unit	Formula	Value
Total Number of FCUs of 1 TR in (Phase 5)	Nos	A	253
Measured power of present AC motor	kW	B	0.045
Proposed power consumption of DC motor	kW	C	0.025
Annual operating hours	hours/annum	D	4,733
Total Expected Annual Energy savings	kWh	F=Ax(B-C)xD	23,949
Electricity cost	Rs./kWh	L	7.95
Recurring annual cost savings	Rs. Lakhs	M=LxK	1.90
One-time cost of implementation (motor replacement)	Rs. Lakhs	N	20.24
Total Number of FCUs of 1.5 TR	Nos	A	6
Measured power of present AC motor	kW	B	0.058
Proposed power consumption of DC motor	kW	C	0.036
Annual operating hours	hours/annum	D	4,733
Total Expected Annual Energy savings	kWh	F=Ax(B-C)xD	625
Electricity cost	Rs./kWh	L	7.95
Recurring annual cost savings	Rs. Lakhs	M=LxK	0.05
One-time cost of implementation (motor replacement)	Rs. Lakhs	N	0.48
Total Number of FCUs of 2 TR	Nos	A	5
Measured power of present AC motor	kW	B	0.093
Proposed power consumption of DC motor	kW	C	0.050
Annual operating hours	hours/annum	D	4,733
Total Expected Annual Energy savings	kWh	F=Ax(B-C)xD	1,018
Electricity cost	Rs./kWh	L	7.95
Recurring annual cost savings	Rs. Lakhs	M=LxK	0.08
One-time cost of implementation (motor replacement)	Rs. Lakhs	N	0.40
Total energy savings	kWh	O	25591
Total Cost savings	Rs. Lakhs	P	2
Total investment	Rs. Lakhs	Q	21
Payback period	months	R=Q/Px12	125

ECM HWS1: Installation of heat pump for hot water usage in hostels

PRESENT SYSTEM

- In IIM Kozhikode, coil heaters are currently used in single rooms for hot water generation in Phase 5.
- Electric coil heaters are operated individually in each room to meet hot water demand.
- Primarily powered by electricity, leading to high energy consumption.
- Low efficiency due to heat losses, especially when heaters are used intermittently.

PROPOSED SYSTEM

- It is proposed to install a heat pump with an energy efficient screw or scroll compressor type heat pump of 44 kW rated heating capacity.
- The new heat pump is designed based on the total requirement of hot water at the facility.
- The new heat pump will have a minimum heating COP of 3.5 .
- The cooling effect of the heat pump can be utilized by the AHU.
- This reduces the chiller load thereby saving chiller energy consumption.
- After implementing this scheme, IIM Kozhikode can potentially save 97,349 kWh per annum
- **By implementing this proposal, IIM Kozhikode will save 45.5 MTOE per annum.**

ESTIMATED BENEFITS

Recurring annual cost savings : Rs. 7.74 Lakhs
One-time cost of implementation : Rs. 8.79 Lakhs
Payback period : 14 months

Table ECM HWS1 : Savings Calculation

Description	Units	Formula	Value
Average hot water consumption per hour	LPH	A	2,100
Average inlet water temperature (return + makeup water)	°C	B	35
Hot water supply temperature required in rooms/utility area	°C	C	50
Heat required to generate hot water	kcal/h	D=A*(C-B) *1.2	37,800

Description	Units	Formula	Value
Absolute thermal capacity (1 kW = 860 kcal)	kWthermal	E=D/860	44
Minimum heating COP of heat pump	kW/kW	F	3.5
Electricity consumption of heat pump	kW	G=E/F	13
Additional power consumption for circulation pumps and other auxiliaries	kW	H=G*0.2	2.5
Net energy consumption of proposed heat pump	kW	I=(G+H)	15
Number of geysers in the facility	No.	J	253
Power consumption of one geyser	kW	K	2
Average operating hours	hours/annum	L=3*365	300
Annual Energy consumption of geysers	kWh	N=J*K*L*M	113,850
Annual energy consumption of Heat pump	kWh	O=I*3*365	16501
Annual Energy savings	kWh	P=N-O	97349
Electricity cost	Rs. /kWh	Q	7.95
Net recurring annual cost savings	Rs. Lakhs	R=P*Q	7.74
One-time cost of implementation	Rs. Lakhs	S	8.79
Payback period	months	T=S/R*12	14

ECM HWS2: Installation of solar water heater for hot water generation.

PRESENT SYSTEM

- Presently at IIM Kozhikode, coil heaters are currently used in single rooms for hot water generation in Phase 5.
- Electric coil heaters are operated individually in each room to meet hot water demand.
- Primarily powered by electricity, leading to high energy consumption.
- Low efficiency due to heat losses, especially when heaters are used intermittently.

PROPOSED SYSTEM

- SEA proposes installing solar water heating systems for hot water generation and use of high-efficiency solar collectors with appropriate storage tanks for consistent hot water supply.
- The average hot water consumption per hour is 2100 LPH.
- .Reduce dependency on electric coil heaters, significantly lowering electricity consumption.
- Use of thermal insulation in storage tanks to minimize heat loss.
- Reduction in carbon footprint due to the use of renewable solar energy.
- Annual energy savings after installing solar water heater is 96000 kWh
- **By implementing this proposal, IIM Kozhikode will save 45.5 MTOE per annum.**

ESTIMATED BENEFITS

Recurring annual cost savings : Rs.6.6 Lakhs
One-time cost of implementation : Rs. 20 Lakhs
Payback period : 31 months

Table ECM HWS2 : Savings Calculation

Description	Units	Formula	Value
Estimated volume of water in solar HW system	Litres	A2	3750
Estimated temperature of solar hot water	°C	A3	60
Total heat potential in solar hot water tank	kcal	A4=A2*(A3-B3)	37,500
Average hot water consumption per hour	LPH	B1	3,750
Average solar radiation	W/m2	D	550

Description	Units	Formula	Value
Number of solar collector panels required (2 sq.m absorber area for each collector panel)	No.	E1=(Cx1.163)/(Dx2)	40
Average inlet water temperature (return + makeup water)	°C	B2	40
Temperature of hot water required in the guest rooms	°C	B3	50
Heat load requirement	kcal/Hour	D1=B1*(B3-B2)	37,500
	kWthermal	D2=D1/860	44
Estimated time for which solar hot water can be used as a backup source	Hours/ day	E=A4/D1	1.00
Power consumption of one geyser	kW	F1	2.0
Total number of geysers	Number	F2	160
Annual energy savings after installing solar water heater	kWh/year	G=ExF1xF2xF3x300	96000
Cost of electricity	Rs./kWh	H	7.95
Recurring annual energy cost savings	Rs. Lakhs	I=G*H/10^5	7.6
One time cost of implementation	Rs. Lakhs	J	20.0
Payback period	Months	K=J/I*12	31

ECM K1: Replacement of existing burners with radiant heat burners for slow cooking applications in cafeteria kitchen.

PRESENT SYSTEM

- LPG is used in kitchens for cooking applications.
- The gas stoves are equipped with conventional cast iron burners.
- Total no. of gas burners and hot plates are 13 and 1 respectively.
- The Audit Team, inspected the kitchen of Prism Hospitality
- LPG consumption (Jul 24 to Dec 24) is 39,947 Kg.
- The maximum thermal efficiency of conventional cast iron burners is in the range of 45-48% as per the International Journal of Engineering Research & Technology (IJERT).

PROPOSED SYSTEM

- Replace conventional-type LPG gas stoves and burners with energy-efficient radiant heating technology. Please refer to the picture K1.1 below.
- The proposed heating system has a thermal efficiency in the range of 65-68%.
- Proposed heating system is indirect heating, thus it improves the heat distribution over the vessel/pan and as there are no carbon deposits on the vessels it in turn saves water and detergent.
- The proposed radiant heating burners can be fueled by LPG or PNG/Biogas.
- We can save up to 20% on gas by replacing conventional burners with energy efficient burners.
- Lower ambient heat in the kitchen is one of the indirect benefits.
- There are retrofit and replacement options available depending on aging of burners, inner dimension of the stoves and burner dimensions. This must be verified by the vendor.
- By implementing this proposal at IIM Kozhikode will potentially save 1,638 Kg LPG per annum thereby reducing 4.75 tons of CO_2e emission per annum.
- **By implementing this proposal, IIM Kozhikode will save 1.96 MTOE per annum**

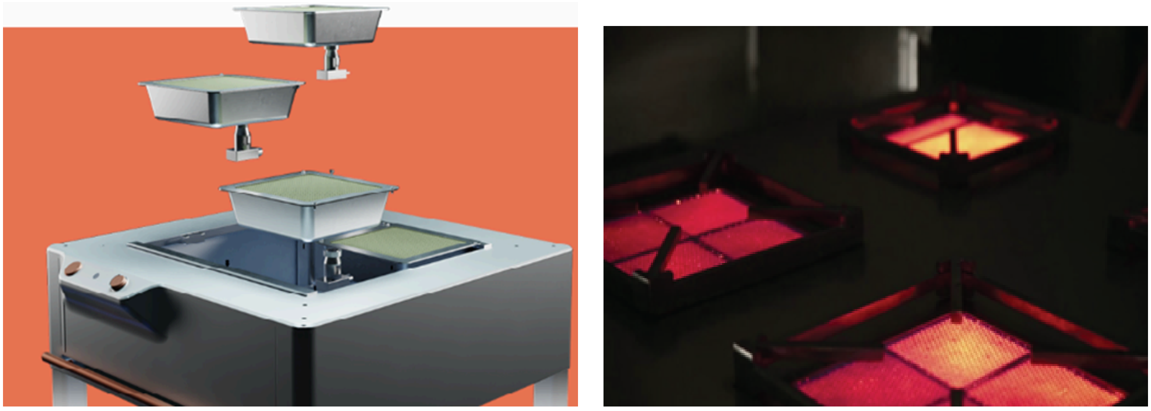


Figure K1.1:* *Representative Picture of Energy Efficient Burner

Estimated benefits

Recurring annual cost savings : Rs. 1.54 Lakhs
One-time cost of implementation : Rs. 1 Lakhs
Payback period : 8 months

Table ECM K1 : Savings Calculation

Description	Unit	Formula	Value
LPG consumption for prism kitchen (2024)	kg	A	39,947
LPG Consumption for single range burners without including high flame cooking burners	kg	B	5,325
Energy utilized by present single range burners (45% efficiency)	Mcal/year	C=(Bx11950x45%)/1000	28,635
Estimated LPG consumption by using radiant burners (65% efficiency)	kg/year	D=(Cx1000)/(65%x11950)	3,686
Total LPG savings by replacing conventional burners with radiant burners	kg/year	E=B-D	1,638
Cost of LPG per kg	Rs/kg	F	94.22
Expected annual cost savings	Rs. Lakhs	G=ExF/10^5	1.54
Estimated one-time cost of implementation	Rs. Lakhs	H	1.00
Payback period	Months	I=H/Gx12	8

ECM K2: Installation of biogas plant for generating fuel from food waste.

Present System

- The average food waste generated per day is approximately 400 Kg.
- During the audit we observed that there is a potential for utilizing the kitchen waste for biogas production.

Proposed System

- Generating kitchen fuel from biological waste could be the first and simplest step towards reducing usage of non-renewable energy.
- Biomass can be converted to methane by anaerobic bacteria.
- The biogas plant capacity we recommend is 90 m^3/day, which can offset 15,111 Kg of LPG per annum
- By implementation of this scheme in IIM Kozhikode can potentially save 43.82 tons of CO_2
- **By implementing this proposal, IIM Kozhikode will save 18.06 MTOE per annum**

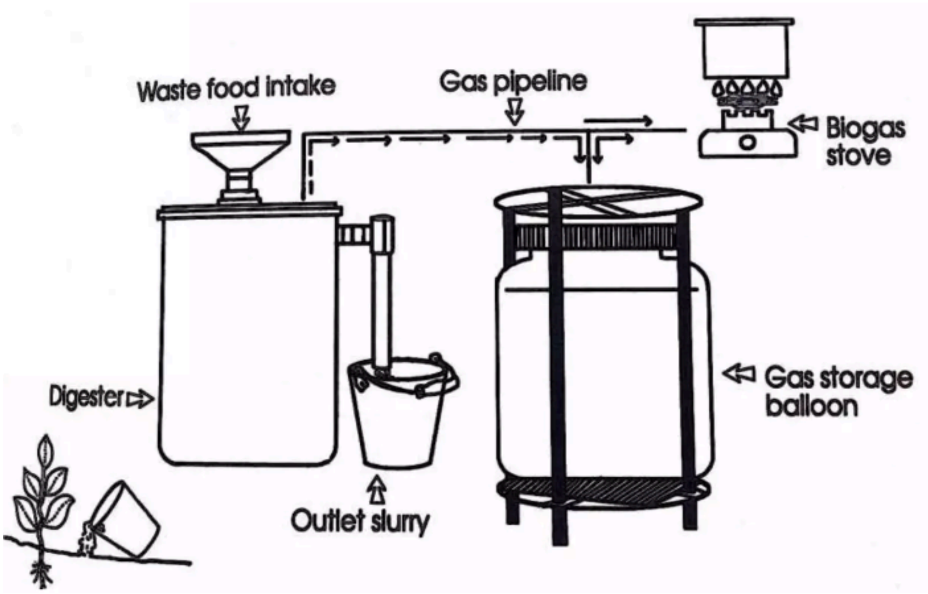


Figure K2 : Representative Picture of Biogas plant

Estimated benefits

Recurring annual cost savings : Rs. 18.88 Lakhs
One-time cost of implementation : Rs. 40 Lakhs

Payback period : 25 months

Description	Unit	Formula	Value
Average food waste generated per day	kg/day	A	400
Bio gas production capacity per day	m3/day	B=Ax0.225	90
LPG replacement per year	kg/year	C=(Bx0.46)x365	15,111
Cost of LPG per kg	Rs/kg	D	94.22
LPG cost savings per year	Rs. Lakhs	E=CxD/10^5	14.24
Power consumption of OWC	kW	F1	32
Annual operating hours of OWC	hrs/year	F2	1,825
Per unit cost of electricity	Rs/kWh	G	7.95
Electricity cost savings by stopping the cold room operation and removing the OWC	Rs. Lakhs	H=F1xF2xG/10^5	4.64
Total cost savings	Rs. Lakhs	I=E+H	18.88
One-time cost of implementation	Rs. Lakhs	J	40.00
Payback period	Months	K=J/Ix12	25

ECM STP1 : Install VFD for STP blowers and automate it's speed based on the dissolved oxygen (DO) level in the aeration tank

Present System

- The facility uses 2 STP Plants one of 350 Kld & other of 140 Kld.
- There are 3 blowers in the 350 Kld plant and 2 blowers in the 140 Kld plant.
- The 350 Kld plant was considered and the rated power of the blowers was 3.7 in Blower 1 and 7.5 in Blower 3. The Blower 2 was under maintenance during the Audit.
- Two were running and the other was kept as standby. The blowers have no automation or speed controls and are operated for 12 hrs a day each.
- During the carbon audit the performance assessment of STP blowers were carried out.

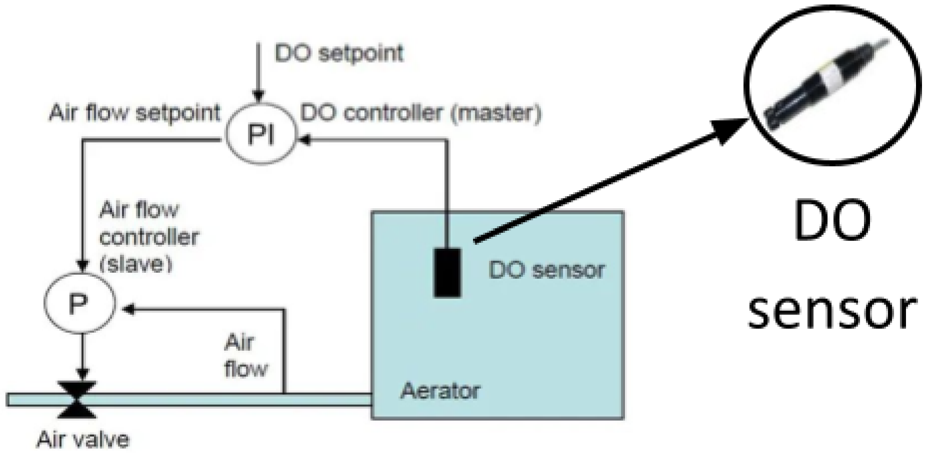
ECM STP1.1: Blowers at IIM Kozhikode

Proposed System

- SEA recommends Installing dissolved oxygen-based sensor at the STP blower to automate the aeration process effectively through VFD speed control.
- In secondary wastewater treatment, it is recommended to have at least 5 mg/L of dissolved oxygen to avoid dead zones in the biological flock by keeping the critical bacteria alive instead of dying and settling out of the treatment mixture.
- This can be achieved by installing a Dissolved Oxygen (O_2) sensor.
- According to the United States Environmental Protection Agency (USEPA) the energy cost can be reduced by 15% in the STP blowers after this implementation.
- All DO sensors stop working when coated with biofilm or a slime layer and require

regular cleaning (weekly or more often).

- After implementing this scheme IIM Kozhikode can save up to 2,336 kWh per annum and reduce 1.92 tonnes of CO_2 emission
- **By implementing this proposal at IIM Kozhikode will save 0.20 MTOE per annum**



ECM STP1.2: Representative picture of DO Sensor

Estimated Benefits

Recurring annual cost savings : Rs. 0.19 Lakhs

One-time cost of implementation : Rs. 0.41 Lakhs

Payback period : 26 month

Table ECM STP1 : Savings Calculation

Description	Unit	Formula	Blower 1	Blower 3	Total
Rated power of STP blower	kW	A	3.7	7.5	
Measured power of STP blower	kW	B	3.20	4.64	
Present running hours per blower as per the maintenance team	hrs/day	C	12	12	
Calculated electricity consumption of Air blower per day	kWh/day	D=BxC	38.40	55.68	
Assumed reduction in working hours of air blower after installation of DO based sensor system	Hrs/day	E1	2.00	2.00	
Proposed reduction in energy consumption for air blower after installation of DO based sensor system	kWh/day	E2=B*E1	6.40	9.28	
Annual operating days as per the maintenance team	days/year	F	365	365	
Expected annual electricity saving	kWh/annu	G=ExF	2,336	3,387	2,336

Description	Unit	Formula	Blower 1	Blower 3	Total
	m				
Unit cost of electricity	Rs/kWh	H	7.95	7.95	
Expected annual cost savings	Rs. Lakhs	I=GxH/10^5	0.19	0.27	0.19
Estimated one-time cost of implementation	Rs. Lakhs	J	0.41	0.52	0.41
Payback period	Months	K=J/Ix12	26	23	26

ECM E1: Replace existing ceiling fans with energy efficient BLDC fans.

Present System

- Currently, The current system utilizes conventional ceiling fans installed in most of the parts of the facility.
- These fans are typically older models and use induction motors which are less energy-efficient.
- The existing ceiling fans are powered by electricity from the grid.
- High electricity consumption: Conventional ceiling fans use more power to operate compared to newer, energy-efficient fan models.

Proposed System

- The proposal is to replace the existing ceiling fans with energy-efficient BLDC (Brushless DC) fans throughout the Institute.
- BLDC fans use Brushless DC motors, which are more energy-efficient and quieter compared to conventional induction motor fans.
- BLDC fans will continue to operate on electricity from the grid but will consume significantly less energy compared to conventional fans.
- These fans consume up to 50% less electricity than traditional ceiling fans, reducing the institute's energy demands.

Table ECM E1 : Savings Calculation

Description	Units	Value
Proposed savings as per previous audit	kWh/Year	277,530
Savings achieved by replacing 20% of the ceiling fans	kWh/Year	55,506
Savings that can be achieved by replacing the remaining 80% of the lamps	kWh/Year	222,024

ECM E2: Upgrade solar plant capacity for electricity generation.

Present System

- Currently, IIM Kozhikode has a rooftop solar photovoltaic (PV) system installed to generate renewable energy.
- The energy produced by the 50kW solar PV plant is used within the institution which has a minor offset on the carbon footprint in the Institute
- The institute is considering a 2 MW solar plant for increasing their renewable energy mix in electricity usage to reduce the CO_2e emissions.

Proposed System

- The proposal is to upgrade the solar PV system in the facility to meet energy needs so that the institution runs on green energy.
- The solar panels harness solar energy during daylight hours, which can be used to power the institute's operations, including lighting, HVAC, and other electrical systems
- Area of 1.13 lakhs sq.feet (including pond area and substation area) can accommodate a 2.3 MWp solar plant which can generate 28.5 lakhs kWh annually which offsets the purchase by 42.1%.
- By implementation of this scheme IIM Kozhikode can potentially save up to 28,57,200 kWh per annum and thereby reduce 2342.9 tonnes of CO_2
- **By implementing this proposal, IIM Kozhikode will save 245.72 MTOE per ann**

Figure ECM E2 : Representative picture of Solar plant

Estimated Benefits

Recurring annual cost savings : Rs. 227.15 Lakhs

One-time cost of implementation : Rs. 1,190.5 Lakhs

Payback period : 63 month

Table ECM E2 : Savings Calculation

Description	Unit	Formula	Total Value
Area available for installation of solar plant	sq.ft	A	113900
Number of solar panels that can be accommodated in the proposed area	no.	B=A/(2.4x10.76)	4,411
Capacity of the proposed solar plant (assuming each solar panel is 540W)	kWp	C=Bx540/1000	2,381
As per the climatic conditions at the location 1kwp generates at least 4 units/day. Hence total electricity generation for 2381 kWp per day	kWh	D=Cx4	9,524
Annual energy yield (for 300 days)	kWh	E1=Dx300	2,857,200
Unit cost of electricity bought from the service provider	Rs./kWh	F	7.95
Estimated annual financial savings on electricity bill	Rs. Lakhs	G=E2xF	227.15
Investment cost for 2.3 MWp solar plant @ Rs.50,000/kWp	Rs. Lakhs	H=Cx50000/10^5	1190.50
Payback period	months	I=H/Gx12	63

ECM E3: Implementation of electric mobility for institution owned bus transportation.

Present System

- Currently, IIM Kozhikode currently uses 3 intercity buses which uses diesel as there fuel source to travel from IIM to their respective destinations,
- Only one bus is considered here, ie., the fuel consumption of that bus is 4,509 L of diesel.
- The unit cost of diesel is 94.83 Rs.
- The city bus has two run times ie., morning & evening.

Proposed System

- The proposal is to convert at least one bus into an electric bus which can drastically reduce the carbon emission produced by the bus.
- The electricity consumption of the bus will be 23,040 kWh/annum.

Estimated Benefits

Recurring annual cost savings : Rs. 2.45 Lakhs

One-time cost of implementation : Rs. 52 Lakhs

Payback period : 255 month

Table ECM E3 : Savings Calculation

Description	Unit	Formula	Total Value
Total number of buses	Number	A	3
Number of bus considered for replacement	Number	A2	1
Present annual diesel consumption of one bus	litre	B	4510
Per unit cost of diesel	Rs./litre	C	94.83
Annual cost of diesel fuel	Rs. lakhs	D=B*C/10^5	4.28
Total distance travelled by bus a day (Morning + Evening intercity service)	km	E=16*4	64
Expected range (kwh/km) of electric bus	kWh/ km	F	1.2
Expected electricity consumption per day	kWh/day	G=E*F	77
Expected Annual electricity consumption	kWh/Annum	H=G*300	23040
per unit cost of electricity	Rs/kWh	I	7.95
Annual cost of electricity	Rs.lakhs	J=H*I/10^5	1.83

Description	Unit	Formula	Total Value
Estimated annual financial savings	Rs.lakhs	K=D-J	2.45
Investment for electric bus (deducing salvage value of 8 lakhs)	Rs.lakhs	L	52
Payback period	months	M=L/K*12	255

ECM L1: Replacement of conventional lamps with suitable LED lamps.

PRESENT SYSTEM

- The facility currently uses fluorescent tube lights in various areas.
- These tube lights consume higher wattage, typically around 36W per tube, leading to increased energy consumption.
- The existing lighting system results in higher electricity bills due to inefficient energy usage.
- Frequent maintenance is required, as these tube lights have a shorter lifespan compared to LED alternatives.
- The lighting quality may not be optimal, with flickering issues and lower luminous efficacy over time.

PROPOSED SYSTEM

- SEA proposes replacing existing fluorescent tube lights with energy-efficient LED tube lights in identified areas.
- The proposed LED tube lights will consume around 18W per tube, reducing energy consumption by nearly 50%.
- Longer lifespan of LED lights (typically 50,000 hours) will reduce maintenance costs and frequency of replacements.
- LED lights produce less heat, leading to lower air-conditioning loads and further energy savings.
- Improved lighting quality, with higher luminous efficacy, instant illumination, and reduced flickering issues.
- Overall energy savings and cost reduction, with an expected return on investment (ROI) within a short period.
- Contributes to the institute's sustainability goals, reducing carbon footprint and enhancing environmental responsibility.
- By implementing this proposal at IIM Kozhikode will potentially save 25,712 kWh per annum thereby reducing 21.08 tons of CO_2 emission per annum.

By implementing this proposal, IIM Kozhikode will save 2.21 MTOE per annum

Figure L1: Propose LED Tube

Table ECM L1 : Savings Calculation

Description	Units	Value
Proposed savings as per previous audit	kWh/Year	64,280
Savings achieved by replacing 60% of the lamps	kWh/Year	38,568
Savings can be achieved by replacing the remaining 40% of the lamps	kWh/Year	25,712

9. CONCLUSION

A Carbon Footprint Audit was conducted at IIM Kozhikode located at Kozhikode during february 2025 by Sopanam Energy Aesthetics (SEA), Kozhikode for the period the reporting period (Jan '24 to Dec '24) to assess the Absolute CO_2e emission by the Institute.

- The Total Absolute CO_2e emission for the reporting period is (including scope 1, scope 2 & scope 3) 10,055.4 tonnes.
- The estimated carbon sequestration for the reporting period is 202.02 Metric tonnes.

Summary of savings possible by implementing the recommendations and suggestions.

- Electricity consumption will be decreased by 44,24,197 kWh which is 65.3% of Electricity consumption for 2024.
- LPG consumption will be reduced by 16,749 kg per year which is 31.09% of LPG consumption for 2024.
- Annual MTOE will be reduced by 400 which is 55.52% of MTOE for 2024.
- Greenhouse gas emissions with an equivalent CO_2e of 3,676 tonnes will be decreased which is 26.17% of CO_2 emission for 2024.

In conclusion, the carbon audit has provided a comprehensive analysis of the facility's carbon footprint, identifying key areas of high emissions. By assessing energy use, transportation, waste management, and other operational factors, the audit highlights several opportunities for emission reductions. Implementing energy-efficient technologies, optimizing resource usage, and transitioning to renewable energy sources can significantly lower the facility's carbon output. The findings emphasize the importance of adopting sustainable practices to mitigate climate impact and align with global environmental goals. A focused approach to reducing emissions will enhance both the facility's sustainability and cost-effectiveness.

ANNEXURE I

LIST OF ABBREVIATION

A	Ampere
GHG	GreenHouse gas
CD	Contract Demand
CEA	Central Electricity Authority
CF	Carbon Footprint
CFL	Compact Fluorescent Lamp
CFM	Cubic Feet per Minute
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide equivalent
COP	Coefficient of Performance
DG	Diesel Generator
ECBC	Energy Conservation Building Code
EPI	Energy Performance Index
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
HP	Horse Power
HT	High Tension
IEEE	Institute of Electrical & Electronics Engineers
IPCC	Intergovernmental Panel on Climate Change
kL	Kilo Liter
kVA/ VA	Kilo Volt Ampere/ Volt Ampere
kVAR/ VAR	Kilo Volt Ampere Reactive/Volt Ampere Reactive
kW/ W	Kilo Watt/ Watt
PF	Power Factor
RMD	Recorded Maximum Demand
SEC	Specific Energy Consumption
tCO_2e	Tonne of Carbon Dioxide equivalent

ANNEXURE II

DATA SHEETS

1. List of GEM Portal Purchase Data

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
1	Air Freshener Liquid	80	10	5	0.1
2	Air Freshener Solid and Gel	1800	79.5	4	0.3
3	Badge Holders – I Card	2920	22	2.5	0.1
4	Ball Point Pens (V2) as per IS 3705	2300	2.2	5	0.0
5	Bathing Soap as per IS 13498	225	28	1.8	0.1
6	Bathing Soap Bar (V2)	1050	57	1.8	0.1
7	Battery Cell as per IS 9128, IS 8144	900	5	10	0.1
8	Binder Clips (V2)	175	4	3.5	0.0
9	binding punch machine	60	3.1	6	0.0
10	Black Lead Pencils (V2) as per IS 1375	20	1	3	0.0
11	Bond Paper (V2) as per IS 1848 (Part 1)	5	0.5	1.3	0.0
12	Box File	525	50	2.5	0.1
13	Broom (V2)	419	27	2	0.1
14	Broom Sticks	60	10	1.8	0.0
15	Buses (V2)	1	14000	1.1	15.4
16	Business Letterhead or DO Letter (V2)	5000	27	1.3	0.0
17	Chair Office (V2)	240	1200	15	18.0
18	Cleaning Duster (V2)	200	4	2	0.0
19	Clips, Paper as per IS 5650	210	11.5	3.5	0.0

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
20	cobweb brush	70	10	2.5	0.0
21	Coir Brushes	145	17	1.5	0.0
22	Coloured Chalks, Moulded as per IS 4222	10	0.5	1.8	0.0
23	conference folder	3615	87	3	0.3
24	Customised Envelopes	2000	1	1.3	0.0
25	Desktop Calculator – Electronics	15	0.5	8	0.0
26	Desktop Computers	34	65	10	0.7
27	Dishwashing Products (V2) as per IS 6047	10	1	2.5	0.0
28	Disinfectant Fluids, Phenolic Type as per IS 1061 (V2)	33	23.3	4	0.1
29	dust pans	185	7.3	2.5	0.0
30	Electric Kettles and Jugs for Household as per IS 367	20	10	7	0.1
31	Emergency Foldable Rescue Stretcher	1	0.2	4	0.0
32	Endpoint Protection Software / Appliances (V3)	600	Nill	4	2.4
33	Eraser	800	1.2	3	0.0
34	Exam Pad	50	10	1.5	0.0
35	Floor Cleaner (V2)	25	11	2.5	0.0
36	Fluid Correction Pen (V2)	115	1.3	4	0.0
37	Gel Pen (V2)	2000	2.8	5	0.0
38	Gift Pen	3500	1.3	6	0.0
39	Glue Stick (V2)	420	1.2	3	0.0
40	Highlighter Pen	550	28.8	5	0.1
41	Household Disinfectants or Disinfectant Fluids Phenolic Type as per IS 1061	30	30	4	0.1
42	Household Laundry Detergent Powders as per IS 4955	1495	695	2.5	1.7
43	Insecticides for mosquitoes cockroaches and other insects (Liquid vaporizer and spray)	80	27	6	0.2

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
44	knife blades	100	20	6	0.1
45	Laptop – Notebook	5	1	75	0.1
46	Lever Arch File	610	18	2.5	0.0
47	Liquid Crystal Display LCD Panel or Monitors	1	30	9	0.3
48	Manual Pencil Sharpener (V2)	20	0.5	4	0.0
49	Markers – White Board	2540	34.5	5	0.2
50	Metric Scales (Plastic) for General Purposes as per IS 1480	50	0.2	3	0.0
51	Movable Stand for Mounting Digital Display	2	23	6	0.1
52	Multi Adjustable Bench (V2)	1	10	6	0.1
53	Multifunction Machines MFM	2	50	8	0.4
54	Multimedia Projector (MMP)	2	50	7.5	0.4
55	Nitrile Coated Hand Gloves	500	1.8	3.5	0.0
56	Office Bags and Laptop Bags	3281	507	5.5	2.8
57	Office Chair (V3)	12	60	6	0.4
58	Olympic Bar (Version 2)	2	50	6.5	0.3
59	Padlock (General Use)	70	35	6	0.2
60	Pallet Truck (V2)	1	8000	6	48.0
61	Paper Adhesive, Liquid Gum and Office Paste Type as per IS 2257 (Rev)	125	0.6	2.5	0.0
62	Paper Shredding Machines (V2)	2	77	8	0.6
63	Paper weights	25	5	5.5	0.0
64	Pen Drive	10	2	10	0.0
65	Pencil box	200	0.5	3	0.0
66	Permanent Marker Pen	350	1.7	4	0.0
67	Photo Cutter	1	2	6	0.0
68	Plain Copier Paper (V2) as per IS 14490	4382	177	1.3	0.2

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
69	Plastic Folder with Printing	1000	3	3	0.0
70	platform brush	100	12	2.5	0.0
71	portable hard disk	1	2	9	0.0
72	Professional Large Format Display	3	80	8	0.6
73	Report Cover	50	0.1	3	0.0
74	Revolving Chair (V4)	10	50	6	0.3
75	Roller Ball Pen (V2)	1230	1.6	4	0.0
76	Round Head Fasteners-Drawing Board pin as per IS 5205	10	1	5	0.0
77	rubber bands	150	0.4	2	0.0
78	rubber Gloves for electrical purpose as per IS 4770	430	13	4	0.1
79	Rubberized weight plates	7	70	6.5	0.5
80	Sanitary napkins incinerator machine with smoke control units	2	50	7	0.4
81	sanitary napkins vending machine	5	150	6	0.9
82	School Chalks, Moulded, White as per IS 2694	68	2.51	0.8	0.0
83	scissors	230	2.5	5.5	0.0
84	scrubbing brush	390	23.5	3	0.1
85	self adhesive paper note	500	1.5	2	0.0
86	Squeegee Washer Wiper Mopper (V2)	1090	138	2.5	0.3
87	Stapler Pin / Staples (V2)	885	4.8	5	0.0
88	Sticky Notepad	225	2.5	2	0.0
89	Storage cum Filing Cabinet	1	90	6.5	0.6
90	Sweeping SS Handle Broom Stick	135	45	3	0.1
91	Tags for Files (V2) as per IS 8499	50	1	2	0.0
92	Tailor Scale	45	1.5	3	0.0

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
93	Tissue box	200	20	1.5	0.0
94	Tissue Papers (V2)	150	0.7	1.2	0.0
95	Toilet Brush (V2)	45	4	3	0.0
96	Toilet Cleaner Liquid (V2) conforming to IS 7983	344	280	1.8	0.5
97	Toilet Paper (V2) as per IS 14661	3300	24	1.3	0.0
98	Toilet Soap as per IS 2888 (V2)	904	80.7	2.5	0.2
99	Transparent Tape (V2)	740	10.2	5	0.1
100	Treadmill (V2)	3	110	6.5	0.7
101	Universal Category	3214	349	3	1.0
102	Whiteboard Duster (V2)	115	1.3	3	0.0
103	whiteboard erasers and dusters	100	2.5	3	0.0
TOTAL		**60019**	**27359.31**	**506.6**	**101.0**

2. List of General Purchase Data

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
1	Cartridges	11	5.50	6	0.033
2	Designing & Printing of Grade Sheets for Programmes Office 1000 Nos.	1000	1.50	2.5	0.00375
3	Gel pen with IIMK print for Kochi Campus	220	2.00	4	0.008
4	Samsung LED 65″ Smart (65DU7700)	1	16.00	6	0.096

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
5	"L" shaped office tables & Drawer Set in 16mm 710 marine Plywood with colour laminated with standard fixing hardware	2	–	100	0.2
6	"Supply, Installation, Testing & Commissioning of Outdoor Gym Equipments at IIMK	–	1830.00	4	7.32
7	Single Wall Stainless Steel Water Bottle	620	160.00	6.5	1.04
8	16 mm Multicolor Lanyard with hook	45	0.45	4	0.0018
9	4 x 6 Writing Board w/o movable stand	1	15.00	3	0.045
10	Samsung LED 43" Smart (43DU7000)	1	16.00	6	0.096
11	Plastic ID Card holder	45	0.45	5	0.00225
12	A5 Size Notepad	5000	100.00	2	0.2
13	Academic Handbook 14x21	800	320.00	2	0.64
14	Arise Arjuna Statue Light weight Antique type	10	18.00	4	0.072
15	Arise Arjuna Statue – Antique type	15	43.00	4	0.172
16	Arise Arjuna Steel Momento and package	50	85.00	6	0.51
17	Arjuna Memento	10	33.00	5	0.165
18	Arjuna Statue & Arise Arjuna Steel Momento including customized Box	25	47.50	6	0.285
19	Backpack Bags Type-I	41	–	3	0.123
20	Bed Sheet 300TC Satin Stripe White Size: 150 x 229 cm Pillow Cover 300TC satin stripe white	40	140.00	4	0.56
21	Black Ricoh Original Toner Cartridge for Ricoh M 2701	–	0.50	6	0.003
22	Blue Lanyard with white "IIMK" print along with Pouch A2 106*82 mm	40	1.00	4.5	0.0045
23	Canon laser printer	1	7.00	6	0.042
24	cartridges	3	1.50	6	0.009

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
25	Certificate Folder	1000	390.00	3	1.17
26	Certificate Folder	26	–	1.25	0.0325
27	Certificate Folder	12	5.00	3	0.015
28	Chafing Dish	8	16.00	5	0.08
29	Classroom Chairs (CB 802 MB) (Pushback Mechanism with Hydraulic system and Base fixed on floor	20	100.00	6	0.6
30	Cloth Bag	60	15.00	3	0.045
31	Coir Mats	6	24.00	2.5	0.06
32	Commercial Induction Cooker	8	22.00	6	0.132
33	Daily Vehicle Inspection Register	20	45.00	2.5	0.1125
34	Designing and Printing Grade Sheets	2770	41.50	2.5	0.10375
35	Designing and Printing of Research Newsletter	100	60.00	2.5	0.15
36	Drum Unit NPG87 for Canon IR 2745	1	2.00	6	0.012
37	Dy 1/8 Printing of notebook 60 pages (30 leaf) Cover Multi Colour 29*21 cm	1000	105.00	2	0.21
38	Dyson Purifier Cool (TP-07)	1	5.00	6	0.03
39	Electric Wheelchair battery	1	0.25	8	0.002
40	Entrust EM2 YMCKT Ribbon x 05 Nos	5	0.05	6	0.0003
41	D 1/4 single colour Cover 170gsm,art paper multicolour printing front and back centre stapling	500	45.00	2.5	0.1125
42	HID Ultra Card for GARGO DTCe ID Card Printer	500	1.45	6	0.0087
43	EPGP Answer Sheet	11500	700.00	2	1.4
44	EPGP Answer Sheet	20000	450.00	2	0.9

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
45	Face & EM Prox Card Based Time Attendance and Access Control Door Controller	3	-	7.2	0.0216
46	File Folder	95	38.00	3	0.114
47	Floor Mat Rubberised 3.15 Meters Roll	7	105.00	3.5	0.3675
48	Godrej Refrigerator RT EON Alpha 270 B, 253 Ltrs 25RRISJSJ	1	50.00	6	0.3
49	Gold Medals	12	-	1.05	0.0126
50	Gowns for Students	150	60.00	3	0.18
51	Grade sheets	1000	1.50	2.5	0.00375
52	Heavy Duty Cross Cut Paper Shredder: (CC-3230 CD)	3	35.00	6	0.21
53	HP Elite DragonFly G4 Business Notebook	1	2.00	6	0.012
54	HP Elite DSFF 600 G9 R 260W Desktop PC - 2 Nos & Canon PIXMA iX6870 Inkjet Printer	1	18.00	6	0.108
55	HP Pro Tower 400 G9 Desktop PC	2	9.00	6	0.054
56	HPE ProLiant DL20 Gen11 1U $SFF Rack Server	1	5.00	6	0.03
57	Interactive Touch Display Panel (75")	1	9.00	6	0.054
58	IT consumables	-	120.00	4	0.48
59	Keyboard	5	-	9.6	0.048
60	Matrix Face Detection Machine (Model - Cosec Agro Face 200T)	1	-	18	0.018
61	WD My passport 2TB Portable SSD	1	2.00	6	0.012
62	Smart Interactive Flat Display, IPS Panel 75"- LH-75CT1ND	1	9.00	6	0.054
63	Mouse H P	20	-	1.8	0.036
64	Mouse Pad	10	-	0.4	0.004
65	JK Radial Tyres with tube & Flap	8	120.00	5.5	0.66
66	Kurta with Churidar	163	65.20	3	0.1956
67	Kurta with Churidar	182	72.80	3	0.2184

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
68	Lanyard Tag with printing of *"IIMK Logo*	50	0.50	6	0.003
69	Lanyard Tag with printing of IIMK Logo	75	0.75	6	0.0045
70	Laptop Type-I [B10MBAT] HP ProBook 450 G10 Notebook PC	1	1.50	6	0.009
71	LCD Display LG 43" Model LM5600 PTC ATROld TV buy back (TCL, 43P615, IN43P6152201515)	1	40.00	6	0.24
72	LG 55 inch Signage Display for LIC & LG Super Sign Software License	1	18.00	6	0.108
73	Machine Trolley	2	60.00	5	0.3
74	Maroon Silk Sarees	232	139.00	4	0.556
75	Mattress Single, Pillows	950	1548.00	3.5	5.418
76	MDP Certificate Folder	41	17.00	3	0.051
77	Kurta Only	20	16.80	3	0.0504
78	Kurta Only	20	18.20	3	0.0546
79	Card Case	50	0.50	6	0.003
80	Card Pouch	75	0.75	6	0.0045
81	Laptop Type-II [A1VX6PT] HP ZBook Firefly 16 G11 Mobile Workstation	1	1.50	6	0.009
82	Name boards	205	20.20	4.5	0.0909
83	Natural Leather Backpack Bag	14	8.50	15	0.1275
84	Nylon tag & card holder	600	12.00	6	0.072
85	Pearl Trolly/Stand-Trolly 2520 P6 (Pearl Metal Desk –P6)	1	7.00	5	0.035
86	Pen drive	18	–	0.4	0.0072
87	Pen Unomax	75	1.50	6	0.009
88	Pitney Bowes Franking Ink Cartridge- 793	2	1.50	6	0.009

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
89	Plastic Pedestal Dustbin	300	125.00	6	0.75
90	Presenter Logitech R400	19	-	1.5	0.0285
91	Toners	30	-	6	0.18
92	Purchase of Tea/Coffee Mugs-275, Glasses-275, Kettle-50, Borosil Glass jug-125 & PR/PC Basket Tray-28	-	70.00	2.5	0.175
93	RFID Card Contactless Smart Card 1kb	900	5.00	7	0.035
94	Samsung Galaxy Tab S9 Book Cover	1	0.80	6	0.0048
95	Silk Kurta	70	14.00	4	0.056
96	Silk Kurtis	6	3.60	4	0.0144
97	Silk Sarees	18	11.00	4	0.044
98	Single Wall Stainless Steel Water Bottle	41	10.25	4	0.041
99	Smart grid Onyx High-Back Chair for Office x 01 Nos.	1	7.00	5	0.035
100	Special Note Pad	1000	200.00	1.5	0.3
101	Notepad	10000	1820.00	1.300	2.366
102	Spine Board,Hospital Bed with Cot,Wireless Bell x 01 each Patient Examination Chair x 02 Nos.	-	30.00	1	0.03
103	Stainless Steel Chair	100	300.00	6.15	1.845
104	Stainless steel water bottle	200	50.00	6.15	0.3075
105	Steel waste bin	9	2.00	2.9	0.0058
106	Students Name Plate	300	68.00	3	0.204
107	Supply, Installation and Commissioning of Electrically operated 300 Kg Metallic Bell (Bronze-Copper and Tin in appropriate ratio) at Entrance Tower of IIMK Campus	-	325.00	1	0.325
108	Supply, Installation, Configuration and Integration of Print Management Solutions at IIMK Campus	-	260.00	1	0.26

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
109	Supply, Installation, Testing & Commissioning of AV Equipment In MDC Classrooms At IIMK	-	50.00	1	0.05
110	Tablet Samsung S9 (11") RAM/Storage :12GB/256GB (Beige)	1	2.00	100	0.2
111	Teacup	140	29.50	1.2	0.0354
112	Toner Cartridge for HP 1566 (78 A)	2	1.00	6	0.006
113	Toner Cartridge for HP LJ Pro CF 230 A	20	10.00	6	0.06
114	Toner Cartridge for Ricoh IM 2500 (MP3554)	2	1.00	6	0.006
115	Toner cartridges	141	66.00	6	0.396
116	Trolley Bag	25	87.50	4.5	0.39375
117	Container for placing tea, Coffee, Sugar powder	35	5.25	6.15	0.0322875
118	Melamine Tray	35	5.25	3.5	0.018375
119	Epson Black Ink Bottle for L3110 (003)	1	0.30	6	0.0018
120	Pen Drive 32 GB (with metal body)	10	0.20	50	0.01
121	Toner Cartridge for HP 183 W2313A	2	1.00	6	0.006
122	Umbrella	20	8.00	5	0.04
123	USB3 Type –C to HDMI Adapter Cable	4	-	0.2	0.0008
124	Visa File Soft Cardboard Brown	120	10.00	0.9	0.009
125	Viscose Silk Stole (Various Colours)	1321	132.00	5	0.66
126	Water Bottle	161	41.00	6.15	0.25215
127	weighing machine	3	5.00	30	0.15
128	White Board Resin Magnetic	2	-	20	0.04
129	White Lanyard Tag with blue printing of IIMK Logo	1675	16.75	6	0.1005

Sl. No	Item Name	Quantity (Nos.)	Quantity in kg	Emission factor	CO_2e Emissions (Tonnes/annum)
130	White Lanyard with Blue Print "IIMK" and IIMK Logo along with Pouch A2 106*82 mm	41	0.50	6	0.003
131	White Lanyard with Blue print	500	1.00	6	0.006
132	White Lanyard	650	6.00	6	0.036
133	Card Case	1675	16.75	3	0.05025
134	Wrist Watch	8	-	6	0.048
135	Zebra Blinds (Shade No: B.30-4) x 51 Sqft.	-	40.00	6	0.24
136	Zebra Blinds x 882.54 Sq. ft.	-	12.00	6	0.072
	TOTAL				**37.09**

3. List of Major works executed/completed by the Civil Engineering Dept. of IIMK during the year 2024

Sl No	Name of Work	Work Order/ Executed Amount in Rs.	Estimated Gross Quantity (kg)	Total embodied CO_2e emission (tCO_2e)	Estimated annual emissions (tCO_2e/annum)
1	Repair & Maintenance Works in Institutional Appointment House-Civil Works	₹18,07,260	291494	21.8	7.3
2	Repair & Maintenance Works in Institutional Appointment House-Interior Works	₹9,03,213	1806	2.7	0.9
3	Providing Floral Images on the wall portion along the passage to academic block	₹2,18,008	436	0.7	0.2
4	Construction of Pathway along Boundary wall in IIMK Campus (Stretch -1)	₹22,36,550	360734	27.0	9.0

5	Providing Pedestrian Passage near Classroom Blocks	₹4,37,548	70572	5.3	1.8
6	Painting & Allied works in connection with the Annual convocation 2024	₹6,71,263	1790	0.1	0.0
7	Replacing MS Handrail with stainless steel handrails along the convocation route	₹2,50,171	801	1.2	0.4
8	Periodic Contract for civil maintenance/minor works in IIMK Campus	₹21,17,900	341597	25.6	8.5
9	Construction of Peripheral Drainage at Utility Building in Phase V Area	₹7,34,537	118474	8.9	3.0
10	Painting and Allied Maintenance at Various Hostels in IIMK Campus	₹16,53,767	4410	0.1	0.0
11	Civil maintenance works at various canteens in IIMK campus	₹9,49,132	153086	11.5	3.8
12	Providing Protective mesh at Hostel M N P and Q in IIMK Campus	₹5,48,623	3817	9.5	3.2
13	Creating server room (For BMS-A/C) & Allied works at Phase V Utility Building in IIMK Campus	₹5,89,331	95053	7.1	2.4
14	Annual Maintenance Contract for cleaning of water storage tanks installed in IIMK Campus	₹2,05,509	206	0.3	0.1
15	Increasing the seating capacity of C6 Class Room at MDC in IIMK Campus	₹14,58,820	3890	8.8	2.9
16	Floor Finishing Works near Reception Area	₹4,79,612	77357	5.8	1.9
17	Supply, Installation, Testing and Commissioning of Multi Disc Sludge Dewatering Screw Press to STP (Plant-1) in IIMK Campus	₹24,33,250	261640	19.6	6.5
18	Replacing MS Handrail with Stainless Steel Handrails at Stepped Path ways to Hostels	₹3,26,705	871	2.2	0.7
19	Creating Finance Lab at-1 level of Computer Centre	₹4,73,805	76420	5.7	1.9

20	Construction of Retaining wall near F6 residence	₹9,58,314	154567	11.6	3.9
21	Setting of Faculty Lounge Cum Meeting Room at Faculty Block –1	₹3,47,222	56004	4.2	1.4
22	Creating Storage Space below Phase V Class room Block	₹3,94,381	63610	4.8	1.6
23	Allied Maintenance works at Sewage Treatment Plant near main gate in IIMK Campus	₹7,20,618	116229	8.7	2.9
24	Creating Additional Toilet facilities near Classroom Blocks	₹10,46,343	168765	12.6	4.2
25	Providing Floor Mats to Students GYM	₹2,93,211	195 nos.	0.8	0.3
26	Providing Storage Space for Civil Maintenance at Housing Block B in IIMK Campus	₹2,45,083	39530	3.0	1.0
27	Replacement of Existing Flushing Cisterns with Dual Flush Units at various staff/Faculty Quarters at Residential Hills	₹3,81,125	405	1.2	0.4
28	Replacing MS Handrail with Stainless Steel sections at Academic Block A	₹3,30,686	882	2.2	0.7
	Total	**-**	**-**	**-**	**70.9**

REFERENCES

Classification	Source	Emission Factor	Unit	Reference
Scope 1	Diesel	2.64	kg CO2e/litre	U.S. Environmental Protection Agency
Scope 1	LPG	2.9	kg CO2e/kg	Department of Environment, Food and Rural Affairs (DEFRA)
Scope 1	Petrol	2.31	kg CO2e/litre	Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines / Environmental Protection Agency (EPA)
Scope 1	Refrigerant(R407)	1774	kg CO2e/kg	Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report 2007
Scope 1	Refrigerant(R32)	677	kg CO2e/kg	Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report 2007
Scope 1	Refrigerant(R22)	1810	kg CO2e/kg	Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report 2007
Scope 1	Refrigerant(R410)	2088	kg CO2e/kg	Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report
Scope 2	Electricity	0.82	kg CO2e/kWh	CO2 Baseline Database for the Indian Power Sector(Central Electricity Authority)
Scope 3	Air Travel	0.127	kg CO2e/pax km	Department of Environment, Food and Rural Affairs (DEFRA) 2024
Scope 3	Waste Water	0.185	kg CO2e/kL	Department of Environment, Food and Rural Affairs (DEFRA) 2024
Scope 3	Food Waste	0.0088	kg CO2e/kg	Department of Environment, Food and Rural Affairs (DEFRA) 2024
Scope 3	Petrol Car	0.2	kg CO2e/Km	Department of Environment, Food and Rural Affairs (DEFRA) 2024
Scope 3	Diesel Bus	0.85	kg CO2e/Km	Bharat Stage VI (BS-VI)
Scope 3	Diesel Truck	0.592	kg CO2e/Km	India GHG Program 2015
Scope 3	Grocery	2.33	kg CO2e/kg	Poore and Nemcek (2019)
Scope 3	Vegetables	0.37	kg CO2e/kg	Journal of cleaner production 2016
Scope 3	Fruits	0.503	kg CO2e/kg	Sustainable Production and Consumption 2024
Scope 3	Non Veg	6.889	kg CO2e/kg	The Waste and Research Action Programme (WRAP)
Scope 3	Bakery	2.45	kg CO2e/kg	The International Journal of Life Cycle Assessment

Classification	Source	Emission Factor	Unit	Reference
Scope 3	Diary	2.4	kg CO2e/kg	Food and Agriculture Organization (FAO)
Scope 3	General Purchase	–	kg CO2e/kg	Department of Environment, Food and Rural Affairs (DEFRA) 2024, India GHG Program 2015
Scope 3	Steel	2.5	kg CO2e/kg	Energy and Environment management in steel sector by Ministry of Steel
Scope 3	Sand	0.0066	kg CO2e/kg	Global Emission Model for Integrated System(GEMIS) 2021
Scope 3	Aggregates	0.00775	kg CO2e/kg	Department of Environment, Food and Rural Affairs (DEFRA) 2024
Scope 3	Average construction	0.0748	kg CO2e/kg	Department of Environment, Food and Rural Affairs (DEFRA) 2024
Scope 3	Tiles	0.74	kg CO2e/kg	Inventory of Carbon & Energy (ICE) from the University of Bath
Scope 3	Acrylic	3.5	kg CO2e/kg	Report by Woodly, which examines the carbon footprint of various plastics.

ANNEXURE III

CERTIFICATES

Certificate Number 161331850/176660597

Aneesh Rajendran

has successfully completed the

ISO 14064 -1, ISO 14064-2 & ISO 14064-3 Greenhouse Gas Accounting (GHG) Lead Verifier / Lead Validator Training Course

Held at SGS India Pvt. Ltd.

On 9 December 2024 - 12 December 2024

Kashish Kapoor

Kashish Kapoor
Head - Training Academy

SGS India Private Limited
Regd. Off: SGS House, 4-B, Adi Shankaracharya Marg,
Vikhroli (West), Mumbai 400 083,

Maharashtra, India

t+ +91 22 66408888 (Board)
www.sgs.com

BUREAU OF ENERGY EFFICIENCY

Examination Registration No. : EA-32889 Serial Number 16812

Certificate Registration No. : 16812/20

Certificate For Certified Energy Manager

This is to certify that Mr./Mrs./Ms. JISHNU SANATH Son/Daughter of Mr./Mrs. JINAN K S who has passed the National Examination for certification of energy manager held in the month of September 2019 is qualified as certified energy manager subject to the provisions of Bureau of Energy Efficiency (Certification Procedures for Energy Managers) Regulations, 2010.

This certificate shall be valid for five years with effect from the date of award of this certificate and shall be renewable subject to attending the prescribed refresher training course once in every five years.

His /Her name has been entered in the Register of certified energy manager at Serial Number 16812 being maintained by the Bureau of Energy Efficiency under the aforesaid regulations.

Mr./Mrs./Ms. JISHNU SANATH is deemed to have qualified for appointment or designation as energy manager under clause (*l*) of Section 14 of the Energy Conservation Act, 2001 (Act No.52 of 2001).

Given under the seal of the Bureau of Energy Efficiency, this 1st day of March, 2020

Secretary
Bureau of Energy Efficiency
New Delhi

Dates of attending the refresher course	Secretary's Signature	Dates of attending the refresher course	Secretary's Signature

ऊर्जा दक्षता ब्यूरो

परीक्षा रजिस्ट्रीकरण सं. : EA-32889 क्रम सं. 16812

प्रमाणपत्र रजिस्ट्रीकरण सं. : 16812/20

प्रमाणित ऊर्जा प्रबंधक के लिए प्रमाणपत्र

यह प्रमाणित किया जाता है कि श्री / श्रीमती / सुश्री जिष्णु सनथ जो श्री / श्रीमती जिनान के एस के पुत्र / पुत्री हैं जिन्होंने वर्ष 2019 मास सितंबर में आयोजित ऊर्जा प्रबंधक प्रमाणन के लिए राष्ट्रीय परीक्षा उत्तीर्ण की है, ऊर्जा दक्षता ब्यूरो (ऊर्जा प्रबंधकों के लिए प्रमाणन प्रक्रिया) विनियम 2010 के उपबंधों के अध्यधीन रहते हुए प्रमाणित ऊर्जा प्रबंधक के रूप में अर्हक हैं ।

यह प्रमाणपत्र, प्रदान किए जाने की तारीख से पांच वर्ष के लिए विधिमान्य होगा और प्रत्येक पांच वर्ष में एक बार विहित पुनश्चर्या प्रशिक्षण पाठ्यक्रम में उपस्थित रहने के अध्यधीन रहते हुए पुन: नवीकरण किया जाएगा ।

उनके नाम को पूर्वोक्त विनियमों के अधीन ऊर्जा दक्षता ब्यूरो द्वारा अनुरक्षित क्रम संख्या 16812 पर प्रमाणित ऊर्जा प्रबंधक के रजिस्टर में प्रविष्ट कर दिया गया है ।

श्री / श्रीमती / सुश्री जिष्णु सनथ ऊर्जा संरक्षण अधिनियम 2001 (2001 का अधिनियम संख्यांक 52) की धारा 14 के खंड (*l*) के अधीन ऊर्जा प्रबंधक के रूप में नियुक्ति या पदनाम के लिए अर्हित समझे गए हैं ।

2020 मास मार्च दिन 1 को ऊर्जा दक्षता ब्यूरो के अधीन दिया गया है ।

सचिव
ऊर्जा दक्षता ब्यूरो
नई दिल्ली

पुनश्चर्या पाठ्यक्रम में उपस्थित रहने की तारीखें	सचिव के हस्ताक्षर	पुनश्चर्या पाठ्यक्रम में उपस्थित रहने की तारीखें	सचिव के हस्ताक्षर

Reg No.: EA-32889/21 Certificate No.: 10591

NATIONAL PRODUCTIVITY COUNCIL

National Productivity Council

(National Certifying Agency)

PROVISIONAL CERTIFICATE

This is to certify that Mr./ Mrs./ Ms. JISHNU SANATH *son / daughter of Mr.* JINAN K S *has passed the National certification Examination for Energy Auditors held in* September 2021 *conducted on behalf of the Bureau of Energy Efficiency, Ministry of Power, Government of India. He / She is qualified as* ***Certified Energy Manager*** *as well as* ***Certified Energy Auditor.***

He / She shall be entitled to practice as Energy Auditor under the Energy Conservation Act 2001, subject to the fulfillment of qualifications for Accredited Energy Auditor and issuance of certificate of Accreditation by the Bureau of Energy Efficiency under the said Act.

This certificate is valid till the Bureau of Energy Efficiency issues an official certificate.

Place : Chennai, India
Date : 21st December, 2021

Digitally Signed: DEVERAPALLI SREENIVASULU
Tue Dec 21 16:31:59 IST 2021
CoE, NPC AIPChennai

Controller of Examination

Energy Management Centre - Kerala
(Department of Power, Govt of Kerala)

CERTIFICATE OF EMPANELMENT

*This is to certify that **M/s. Sopanam Energy Aesthetics** (24/68, Sopanam Complex, Near Mini Civil Station, Irinjalakuda, Thrissur, Kerala - 680125) is empanelled as Energy Audit firm in Energy Management Centre Kerala to conduct mandatory energy audit as per Government of Kerala G.O (Rt) No.2/2011/PD dated 01.01.2011.*

Empanelment No:
EMCEEA- 5624F

Scope/Area	Building	Industry -Electrical	Industry Thermal
	Yes	Yes	Yes

This empanelment is valid up to 06/12/2027
Issuing Date: 07/12/2024
Place: Thiruvananthapuram

Director,
Energy Management Centre Kerala