Program Title: **Energy and Greenhouse Gas Auditing of MSU-IIT Buildings**

Project Leader: **Prof. Hernando P. Bacosa, Ph.D.**

Period Covered: **July 1, 2024 to September 30, 2024 (3rd Quarter)**

Inclusive Dates: **March 1, 2024 to December 31, 2024**

QUARTERLY PROGRESS REPORT (Form 1)

I. Introduction and Objectives

The Philippines has shown a high ambition to increase the proportion of renewable energy and enhance its efficiency within the nation's energy mix (Aleluia et al., 2022). The government enacted the Republic Act No. 11285 (Energy Efficiency and Conservation Act) in 2019, aiming to establish energy efficiency and conservation measures, improve the effective utilization of energy, and offer incentives for related projects. Simultaneously, the Department of Energy (DOE) made a National Energy Efficiency and Conservation Plan and Roadmap (2023-2050) which provides an updated outline of the strategic plans and actions for energy efficiency compliance (EEC) in the Philippines across all sectors (Philippine Energy Plan, 2019). In compliant to the Paris Agreement, the country is set to achieve its goals to reduce GHG emissions by 75% by 2030 (Lavasa, 2015). Under AmBisyon Natin 2040, the country is also fixed to achieve economic growth that is relevant, inclusive and sustainable with educational services as one of the priorities. These goals cannot be achieved without the active participation of all sectors particularly the valuable contribution of higher education institutions (HEIs).

The Mindanao State University – Iligan Institute of Technology (MSU-IIT) situated in Northern Mindanao is aligned with the Sustainable Development Goals (SDGs). The institution is focused on climate change and energy efficiency which aligns with SDGs 7 and 13. As the country is moving towards energy sustainability, the university also aims to have access to affordable, reliable, sustainable, and modern energy. It also correlates in combating climate change and its impacts through mitigation, adaptation, and resilience-building measures. Throughout the past decade, the university has a very high consumption of electricity. High electricity consumption can significantly impact both its financial health and environmental footprint. The increased energy use directly leads to higher operational costs, resulting in elevated utility bills. This financial strain diverts funds from essential areas such as academic programs, research initiatives, and student services. Consequently, the university may face budget constraints, limiting its ability to invest in new technologies, infrastructure upgrades, or additional faculty and staff. Moreover, high electricity consumption has considerable environmental implications. Greater energy use results in higher greenhouse gas emissions, exacerbating climate change. This environmental impact extends beyond the university, affecting the broader community and the planet. By consuming large amounts of electricity, the university also contributes to local air pollution and resource depletion.

Energy audit is one of the first phase to achieve energy efficiency, hence it is globally recognized and validated approach (Lavasa, 2015); Magrini et al., 2016). It is a systematic assessment and evaluation of energy use and efficiency within a building, facility, or industrial process. The primary goal of an energy audit is to identify opportunities for energy savings, reduce energy waste, and improve overall energy performance (Kluczek & Olszewski, 2017).

Significance. As far as renovations are concerned, energy audit plays a significant role in the campus retrofit with the aim to identify energy usage failures (Krarti, 2020). Energy audit is an adequate practice to optimize energy in industrial sites and buildings while diagnosing the operating problems that could affect an energy-efficient operation (Al Momani et al., 2023). In the view of energy conservation measures, it is crucial to outline the importance of complex solutions (Kluczek & Olszewski, 2017). Namely, upgrades in the university's electrical system or at least adjustments of existing systems to achieve the top performance of retrofitted buildings. In the context of economic development, energy conservation measures can be undertaken with minimum cost.

Objectives. Therefore, this study delivers the first phase of standard energy audit procedures in MSU-IIT. Specifically, the objectives are: (1) to conduct a comprehensive diagnostic energy audit at selected buildings of MSU-IIT, (2) to conduct the static illuminance test at selected buildings, and (3) to conduct humidity test on each rooms of the buildings. This study will serve as baseline for a university in the Philippines. To the best of our knowledge, this is also the first-time that a comprehensive diagnostic energy audit will be performed in a university in the country. The results of this study will emphasize balanced solutions on energy and environment, and make use of the best available and economically justified technologies which adheres to major improvement of energy efficiency in an institution.

II. Materials and Methods

This project's method is effectively implemented using a Project Management Tracker that is currently developing. Fig. 1 depicts an example of the tracker. Meanwhile, this paper's Sections 2.1 and 2.2 to 2.5 corresponds to Project Management and Methods employed, respectively, throughout the energy audit of selected MSU-IIT buildings.

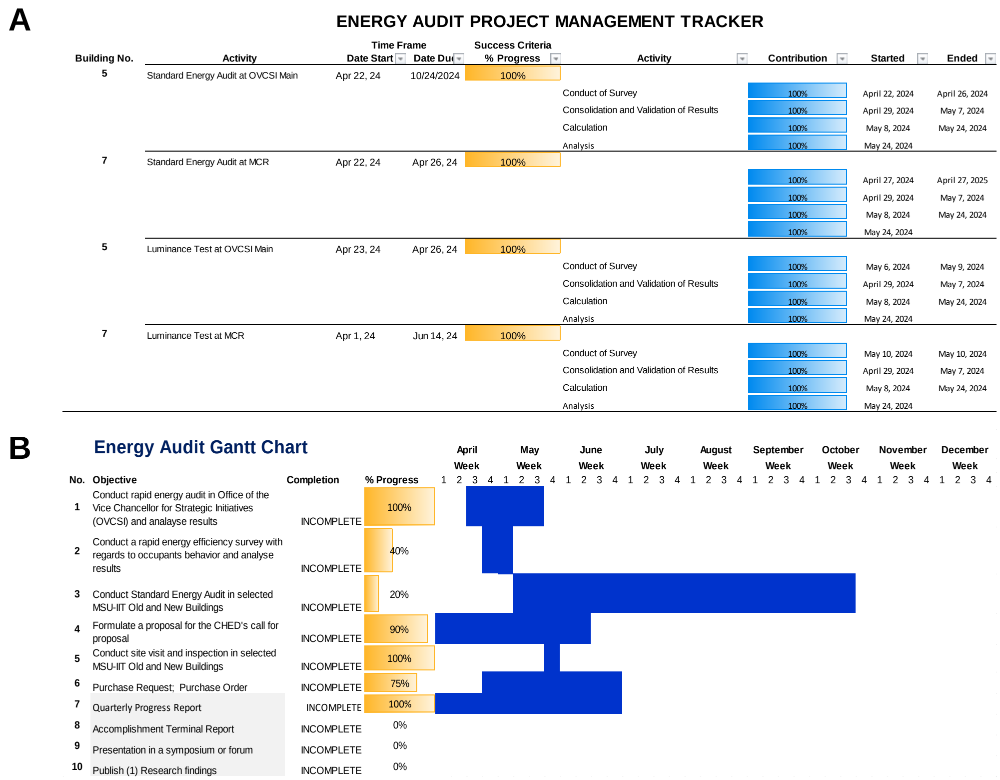

Fig. 1. Energy and greenhouse gas auditing of MSU-IIT buildings example of a) project management tracker and b) Gantt chart

2.1 Energy audit and greenhouse gas auditing project management

The project management employed in this project is through weekly meeting, project members progress reports, weekly evaluation of data, updating of the project management tracker, and currently, developing a project database. The weekly meeting is held every Monday of the week from 1:30-2:30 p.m. These activities are justified in Fig. 2.

A

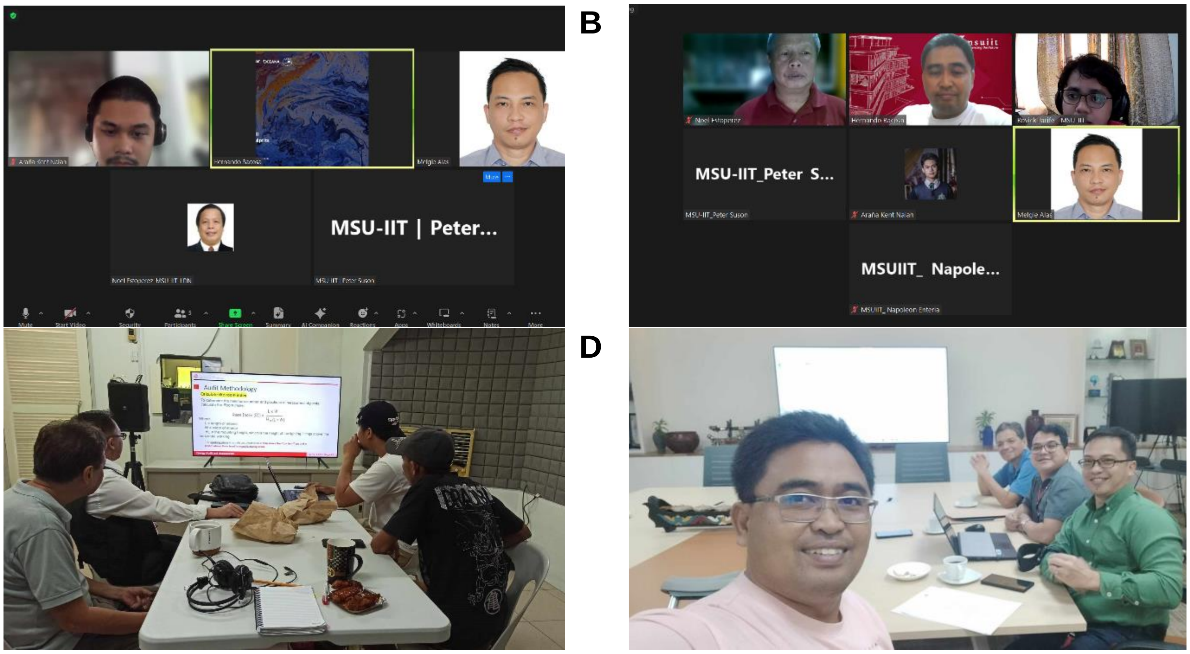

Fig. 2. Energy and greenhouse gas audit team project meetings at a) and b) thru zoom meeting, c) data analysis at the MCR office, and d) project proposal to the chancellor's office

Then, the project's organizational structure is developed based from the project member's multiple expertise in their field (Fig. 3).

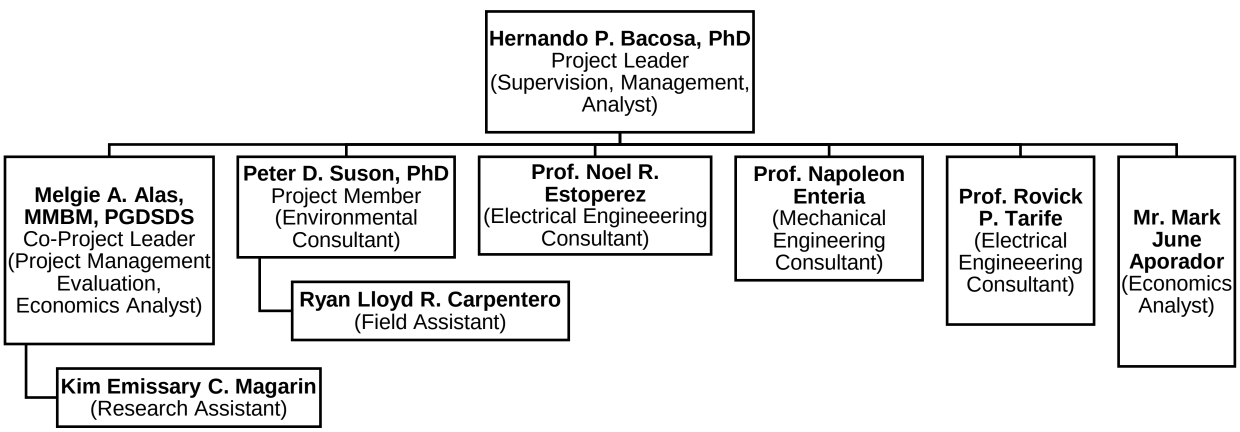

Fig. 3. Energy and greenhouse gas auditing of MSU-IIT buildings functional project organizational structure.

Herein, Dr. Hernando P. Bacosa, PhD, is designated as the project leader responsible for implementing and supervising the project, ultimately ensuring its success. Mr. Alas and

Mr. Aporador are assigned to handle data evaluation and economic analysis tasks. Meanwhile, Dr. Suson is responsible for supervising and evaluating the project's environmental results.

Dr. Estoperez and Dr. Tarife are assigned to evaluate the methods and data throughout the diagnostic energy audit, which involves a complex array of data. Dr. Enteria is tasked with evaluating and validating the results of the building envelope survey and humidity tests. Mr. Magarin is responsible for preparing reports, conducting surveys, validating data, and designing materials for publication. Mr. Carpentero assists the research assistant throughout the study.

2.2 Study area and its location profile

This study is currently conducted at the selected MSU-IIT Buildings (Table 1). The university is situated in Iligan City, in the province of Lanao del Norte, on the island of Mindanao in the Philippines. It lies along the northern coast of the island, facing Iligan Bay, and covers an area of approximately 813.37 square kilometers. The city's topography is diverse, featuring coastal areas, flat plains, and mountainous regions. Economically, Iligan City is an important industrial hub in Mindanao. It hosts several major industries, including steel manufacturing, cement production, and hydroelectric power generation. The city’s primary electrical producer is the National Power Corporation (NPC), which operates the Agus Hydroelectric Complex. This complex consists of several hydroelectric power plants located along the Agus River, which flows from Lake Lanao to Iligan Bay. The major plants in this complex include Agus I, II, IV, V, VI, and VII. Agus provides a substantial portion of the electricity consumed in the region. The hydroelectric power plants are generating an installed capacity of 727 megawatts (MW) of renewable energy. It has a dependable capacity of around 400 MW according to Mindanao Development Authority (MinDA).

Table 1. Study areas of the comprehensive energy and greenhouse gas auditing of MSU-IIT buildings.

BUILDING NO.	BUILDING NAME
1	ADMINISTRATION BUILDING
2	OFFICE OF THE CHANCELLOR
3	OFFICE OF COMMUNICATIONS
5-A	OFFICE OF THE VICE CHANCELLOR FOR STRATEGIC INITIATIVES (OVCSI) / REGISTRAR
5-B	OFFICE OF THE VICE CHANCELLOR FOR INTERNATIONAL AFFAIRS (OVCIA)/LEGAL OFFICE
6	MAIN LIBRARY BUILDING
7-A	MSU-IIT CENTER FOR RESILIENCY (MCR)/ SECURITY AND INVESTIGATION DIVISION (SID) BUILDING
8	KNOWLEDGE AND TECHNOLOGY TRANSFER OFFICE (KTTO) BUILDING
14-A	COLLEGE OF SCIENCE AND MATHEMATICS (CSM) MAIN BUILDING
14-B	COLLEGE OF SCIENCE AND MATHEMATICS (CSM) ANNEX
19-A	COLLEGE OF ARTS AND SOCIAL STUDIES (CASS) OLD BUILDING
19-B	COLLEGE OF ARTS AND SOCIAL STUDIES (CASS) NEW ACADEMIC BUILDING
25-A	COLLEGE OF ENGINEERING (COE) MAIN BUILDING
25-B	COLLEGE OF ENGINEERING (COE) RIGHT-WING
25-C	COLLEGE OF ENGINEERING (COE) LEFT-WING

2.3 Diagnostic Energy Audit

This study is conducted through numerous phases. To begin with, the diagnostic energy audit helps determine which item of equipment is a large energy user and where energy is being wasted. The historical audit deals with overall or general energy consumption. The diagnostic audit deals with detailed specific uses of energy in all forms. In order to produce the required information, a complete inventory of all energy-using systems is prepared (Krarti, 2020). The second step is to conduct a walk-through audit of the premises to identify operational and physical problems. An example of an operational problem is a piece of equipment operating when it should be off. Physical problems include leaking faucets, windows that fit poorly, and missing pipe insulation, among others. It is very important to understand the existing situation before attempting improvements; otherwise, corrective efforts could be misdirected and ineffective and, hence, financially wasteful.

The objectives of the diagnostic audit are:

(a) To identify, by way of an equipment survey, the items of equipment that are the large users of energy, so action can be taken to reduce their energy consumption and cost of operation;

(b) To identify, by way of a building survey, areas that require upgrading or maintenance to improve energy efficiency and thus reduce the cost of operation;

(c) To obtain the best possible return for money and effort spent on energy management.

2.3.1 Preparation and Planning

Conducting a diagnostic energy audit requires thorough preparation and planning to ensure the accuracy and comprehensiveness of the results. The initial step involves defining the scope of the audit, identifying the specific areas and systems to be examined. This includes understanding the building's layout, its usage patterns, and the types of equipment and systems installed. Gathering existing energy bills, equipment manuals, and previous audit reports, if available, helps establish a baseline for the audit. Proper preparation lays the foundation for a systematic and effective energy assessment.

2.3.2 Equipment Survey

The first step of the diagnostic energy audit focuses on conducting an equipment survey. This involves inspecting all major energy-consuming equipment, such as HVAC systems, lighting, appliances, and industrial machinery. During this phase, auditors document the type, age, condition, and operating schedules of each piece of equipment. Using a standardized checklist ensures consistency and thoroughness. Photographs and detailed notes capture the current state of the equipment. This systematic approach helps identify outdated or inefficient equipment that may contribute to excessive energy consumption.

2.3.3 Building and Mechanical Systems Survey

Following the equipment survey, the next step is to conduct a building and mechanical systems survey. This involves evaluating the building's envelope, insulation, windows, doors, and other structural components that affect energy efficiency. Additionally, mechanical systems such as plumbing, ventilation, and elevators are assessed for their energy performance. Using tools like thermal imaging cameras can help detect heat loss areas and insulation deficiencies. This comprehensive assessment helps identify potential improvements in the building's overall energy performance.

2.3.4 Data Collection and Analysis

Accurate data collection is crucial for a successful energy audit. Using instruments such as power meters, data loggers, and temperature sensors provides precise measurements of energy usage and environmental conditions. Collected data is meticulously recorded and organized for analysis. Analyzing the data involves comparing the recorded energy consumption against industry benchmarks and identifying patterns or anomalies. Energy modeling software can simulate different scenarios and predict the impact of potential energy-saving measures. This analytical approach helps pinpoint areas with the highest energy-saving potential.

2.3.5 Involvement of Personnel

Effective energy audits often involve collaboration with building personnel who are familiar with the daily operations and maintenance practices. Engaging with facility managers, maintenance staff, and occupants can provide valuable insights into operational habits and areas of concern that might not be immediately apparent from the data alone. Their input helps understand the context behind certain energy usage patterns and in identifying practical and feasible energy-saving opportunities.

2.3.6 Documentation and Reporting

Comprehensive documentation of the audit process and findings is essential for transparency and future reference. The audit report includes detailed descriptions of the methods used, the data collected, and the analysis performed. Visual aids such as graphs, charts, and photographs enhance the clarity of the report. The report also provides clear and actionable recommendations for improving energy efficiency, including cost estimates, potential savings, and implementation timelines. This structured documentation ensures that the findings and recommendations are easily understood and actionable by building owners and managers.

2.4 Conducting Illuminance Test

The energy audit already carried out records the number of lamps being used, their wattage, and the amount of light they provide. The next step is to find out whether the lighting levels are adequate in the various areas and whether changes should be made either on account of under/over-lighting levels or energy wastage.

2.4.1 Preparation of the Space

To ensure accurate and representative measurements, it is critical to set up the testing environment to reflect typical conditions. This involves arranging furniture and equipment as they would be during normal use. Stabilizing the lighting is crucial, as some light sources, such as fluorescent or LED lights, may take a few minutes to reach their optimal brightness. Proper preparation minimizes variability and ensures that the illuminance measurements reflect real-world conditions.

2.4.2 Marking Measurement Points

Establishing a measurement grid allows for systematic and comprehensive coverage of the area. The choice of grid spacing depends on the purpose of the test; for general ambient lighting, a wider grid might be sufficient, while specific task areas may require denser measurements. Marking these points on both a floor plan and physically in the space ensures consistency and repeatability in the measurements. This methodical approach helps identify uneven lighting and areas that might require adjustments.

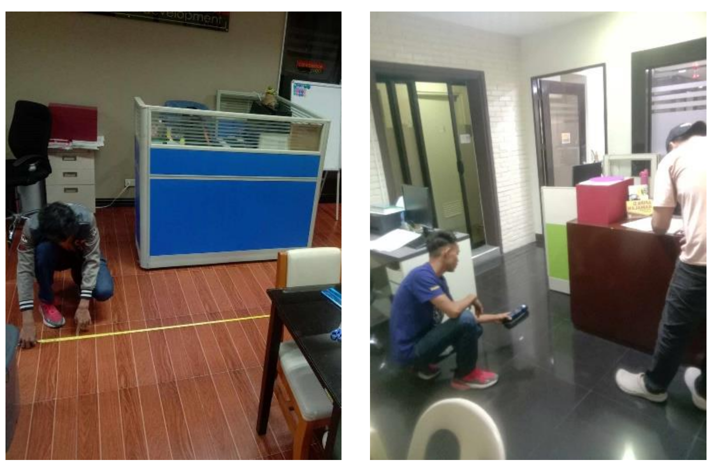

Fig. 4. The conducting of illuminance test and selection of test points at the OVCSI and MCR office

2.4.3 Calibration of the Light Meter

Calibrating the light meter according to the manufacturer's instructions is essential for obtaining accurate readings. Ensuring the meter is set to measure in lux, the standard unit of illuminance, provides consistency in the data collected. Regular calibration checks are necessary, especially if the testing involves multiple sessions or locations, to maintain the reliability of the measurements.

2.4.4 Measuring Illuminance

At each marked point, the light meter is placed steadily, using a tripod if necessary to maintain the correct height and angle. The measurement process requires careful handling to avoid any interference, such as casting shadows on the meter or blocking the light source. Recording the illuminance levels accurately at each point is crucial for the integrity of the test results. This step-by-step approach ensures that the data collected is comprehensive and reflective of the actual lighting conditions.

2.4.5 Avoiding Interference

Minimizing interference during measurements is vital for obtaining true readings. This includes controlling for additional light sources that may not be part of the regular lighting setup, such as sunlight through windows. Ensuring that the person taking the measurements does not inadvertently affect the readings by casting shadows or blocking light further ensures the accuracy of the data.

2.4.6 Documenting the Results

Accurate documentation of all measurements, including the exact location and conditions of each reading, is necessary for analysis and future reference. Photographs of the setup and measurement points can provide additional context and help in verifying the conditions during the test. Proper documentation supports the reliability and repeatability of the test, facilitating comparisons with recommended standards and identifying areas for improvement.

2.5 Conducting Humidity Test

2.5.1 Preparation and Planning

Conducting humidity tests in buildings requires careful preparation and planning to ensure accurate and meaningful results. The first step is to determine the specific areas and conditions to be tested. This involves identifying spaces that are prone to humidity-related issues, such as basements, bathrooms, kitchens, and areas with poor ventilation. It's important to plan the timing of the tests to capture typical humidity levels, which might vary throughout the day and across different seasons. Proper preparation helps in obtaining a comprehensive understanding of the building's humidity profile.

2.5.2 Selection of Equipment

Selecting the right equipment is crucial for conducting effective humidity tests. Hygrometers and data loggers are commonly used tools that measure and record relative humidity levels over time. Hygrometers provide instant readings, while data loggers can track humidity levels continuously over a period, offering a detailed profile of humidity fluctuations. Calibration of these instruments before use is essential to ensure accuracy. This step ensures that the readings are reliable and reflective of the actual environmental conditions.

2.5.3 Placement of Sensors

Strategic placement of humidity sensors is key to obtaining representative data. Sensors should be placed in locations that are indicative of the overall humidity levels in the building. These include areas near potential sources of moisture, such as windows, doors, plumbing fixtures, and HVAC systems. Additionally, placing sensors at different heights can provide insights into humidity stratification within a room. Proper sensor placement helps capture a comprehensive picture of humidity distribution and potential problem areas.

2.5.4 Conducting the Tests

During the testing phase, it's important to maintain consistent environmental conditions to avoid skewing the results. This means avoiding activities that could temporarily alter humidity levels, such as cooking, bathing, or operating humidifiers and dehumidifiers. Regularly checking and recording the data from hygrometers and data loggers ensures that any anomalies are noted and understood. This methodical approach provides a reliable dataset for analysis.

2.5.5 Data Analysis

After collecting the data, a thorough analysis is necessary to interpret the results. Comparing the recorded humidity levels against recommended standards can help identify areas of concern. For instance, consistently high humidity levels may indicate poor ventilation or water intrusion issues, while low humidity levels could suggest the need for humidification to maintain comfort and preserve materials. Analyzing trends over time also helps understand the building’s response to different environmental conditions.

2.5.6 Documentation and Reporting

Proper documentation of the humidity test process and results is essential for future reference and action planning. Detailed records should include the locations and conditions of each measurement, the equipment used, and any observations made during the testing period. Photographs and floor plans can be helpful in visualizing sensor placements and test conditions. A comprehensive report summarizing the findings, along with recommendations for addressing any identified issues, provides a clear roadmap for improving indoor air quality and building performance.

Conducting humidity tests with these structured methodologies ensures that the data collected is accurate, reliable, and actionable, ultimately contributing to the health, comfort, and longevity of the building and its occupants.

III. Results and Discussions

This project's timeline and activities completed, on-going and to be completed are defined in detail in Section 3.1. Meanwhile, Sections 3.2, 3.3 and 3.4 are presents the preliminary results and analysis during the energy audit from July to September 2024.

3.1 Project's activities

The projected activities for this project, based on its objectives, are illustrated in Figure 5. This figure represents significant progress throughout the project's duration. However, the project is not yet complete. The data consolidation and analysis require rigorous validation to produce clear and precise data regarding energy consumption in each selected study building.

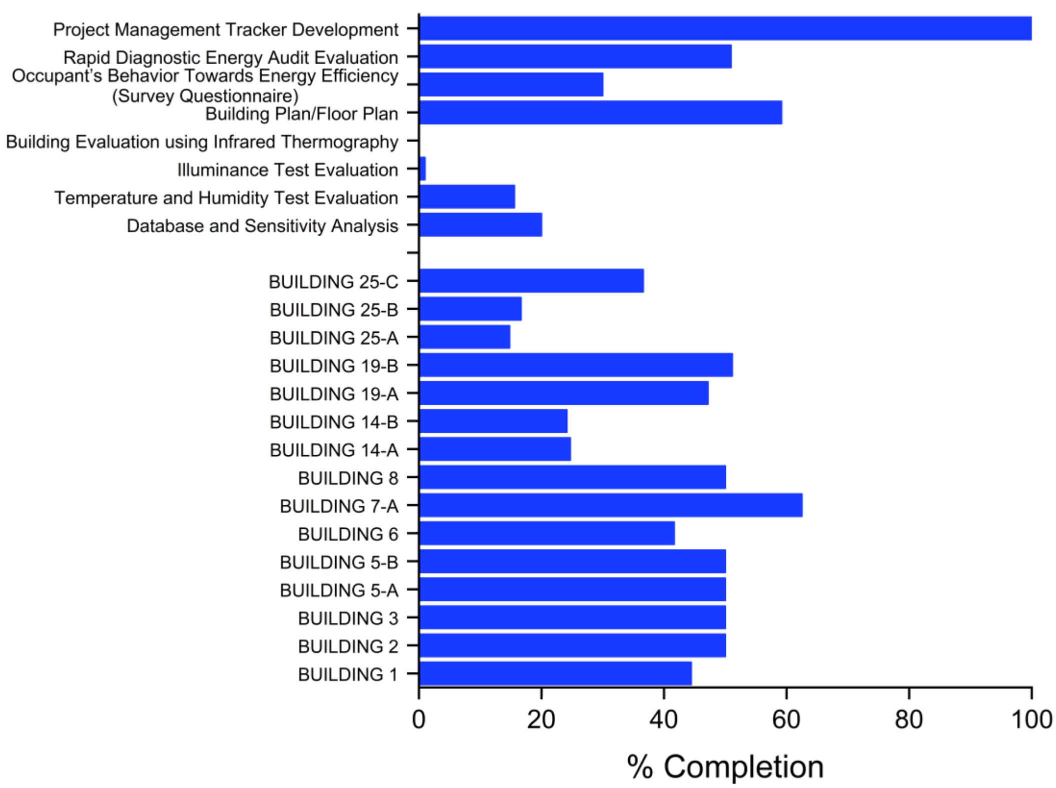

Fig. 5. Summary of the activities of the energy and greenhouse gas auditing of MSU-IIT buildings project during the third quarter of year 2024.

3.1 Diagnostic Energy Audit at Selected Buildings of MSU-IIT

This study's rapid diagnostic energy audit results in 10 out of 15 buildings of MSU-IIT are summarized in Table 2. Fig. 6 defined the hotspots in these buildings which are the primary contributor to the high energy consumption.

Table 2. Calculated energy consumption in selected buildings of MSU-IIT according to Day, Month, and Year.

Building No.	Total kilowatts	Energy Consumed (kwh)		
		Day	Month	Year
1 - Admin Building	110.19	693.19	15,004.80	180,057.65
2 - Office of the Chancellor	33.76	269.04	6,011.07	72,052.76
3 - Office of Communications	5.46	39.66	857.52	10,290.28
5A - OVCSI/Registrar/IDS Library/HRM Laboratory	89.54	591.08	12,224.78	146,697.41
5B - OVCIA/Legal Office/HRMD	22.92	147.62	3,265.85	39,190.05
6 - Main Library	115.89	738.28	15,884.68	190,616.06
7 - MCR/SID	16.64	108.48	2,367.44	28,409.19
8 - KTTO	26.65	155.46	3,210.50	38,525.94
19A - CASS (Old Building)	176.86	1,071.49	21,895.27	262,743.31
19B - CASS (New Building)	213.68	1,639.28	34,207.25	410,486.95
Grand Total	**811.59**	**5,453.58**	**114,929.16**	**1,379,069.60**

Fig. 6. Breakdown of energy consumption of MSU-IIT buildings according to four (4) classifications: Operations, Lighting, Electrical Appliances, HVAC (Heating, Ventilation and Air Conditioning)

From the partial audit, Academic buildings such as CASS (Old and New) had the most amount of energy consumption with 1,071.49 and 1,639.26 kWh respectively (Table 2). As for administrative buildings, Admin and Main library had considerable amount of electrical consumption with 693.19 and 738.28 kWh. The largest contributor of energy consumption across all buildings are HVAC. These results highlights areas of high energy usage and potential opportunities for energy efficiency improvements.

Table 3. Summary of functional equipment of each building

	Building No.										
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**	**Total**
Operations	405	84	24	198	58	303	56	71	224	229	1652
Lighting	258	132	28	282	76	278	22	146	622	483	2327
Electrical Appliances	62	15	2	37	13	36	7	12	13	25	222
HVAC	39	8	5	22	7	29	5	9	99	45	268
Total:	**764**	**239**	**59**	**539**	**154**	**646**	**90**	**238**	**958**	**782**	**-**

Table 4. Summary of non-functional equipment of each building

	Building No.										
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**	**Total**
Operations	39	9	1	15	2	33	12	5	37	24	177
Lighting	12	3	1	40	0	20	3	6	64	3	152
Electrical Appliances	4	0	0	3	0	4	1	0	3	0	15
HVAC	0	0	1	3	2	3	0	0	18	0	27
Total:	**55**	**12**	**3**	**61**	**4**	**60**	**16**	**11**	**122**	**27**	**-**

The functional and non-functional equipment of each buildings was accounted. The detailed breakdown of each classes can be found at the Annex A-H. The highest number of equipment was located at Building 19A (CASS Old building). In addition, lighting and HVAC had an extensive amount of items that was identified at Building 19A (Table 3). Building 1 (Admin) had the largest number of equipment under Operations and Electrical Appliances. These results highlight the importance of improving institute-wide regulations on energy consumption to further reduce the amount of electric consumption and its corresponding greenhouse gas emissions.

The daily carbon emission of MSU-IIT buildings resulted a similar result to the energy consumption. Buildings 19A and 19B were major contributors to GHG emissions at 595.21 and 910.98 kg CO_2 respectively (Table 5). These results are directly proportional to energy consumption which highlights the needs for retrofits and emphasizing the importance of focusing the energy efficiency measures in these hotspots.

Table 5. Calculated greenhouse gas in (kg CO_2) in selected buildings of MSU-IIT according to Day, Month, and Year.

Building No.	GHG Emitted (kg CO_2)		
	Day	Month	Year
1 - Admin Building	385.06	8,335.17	100,022.02
2 - Office of the Chancellor	149.45	3,339.15	40,069.75
3 - Office of Communications	21.59	476.35	5,716.25
5A - OVCSI/Registrar/IDS Library/HRM Laboratory	328.34	6,790.87	81,490.41
5B - OVCIA/Legal Office/HRMD	82.00	1,814.17	21,770.08
6 - Main Library	410.12	8,823.93	105,887.22
7 - MCR/SID	60.26	1,315.11	15,781.30
8 - KTTO	86.35	1,783.43	21,401.16
19A - CASS (Old Building)	595.21	12,162.83	145,953.91
19B - CASS (New Building)	910.98	19,003.57	228,042.83
Grand Total	**3,029.38**	**63,844.58**	**766,134.94**

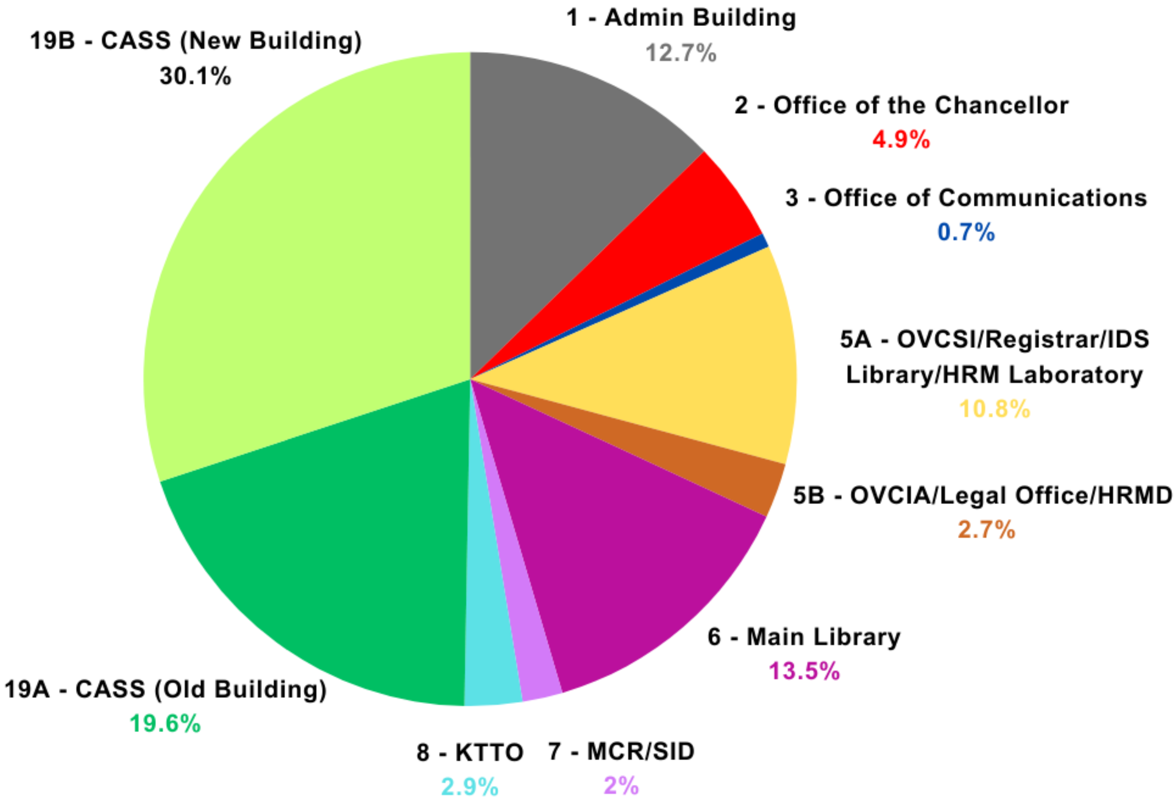

Fig. 7. Greenhouse gas emission (kg CO_2) of MSU-IIT buildings

The Office of Communications had the lowest GHG emissions with emissions of 0.7%, (Fig. 7). From these data, it can be inferred that areas with higher energy consumption, such as Buildings 1, 6, 19A, and 19B contribute more to GHG emissions. This suggests that efforts to reduce energy consumption in these areas could lead to a significant reduction in GHG emissions.

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V. Problems/Difficulties encountered

The problem encountered in this project is listed as follows.

1) Lack of personal protective equipment
2) Lack of equipment/devices that would aid the energy audit
3) The illuminance test cannot be done throughout the day, and no budget allocation for the research assistant and field assistant when conducting this activity at night.
4) Interference of daily activities of the staff in their work area during the diagnostic test.
5) Lack of software that would aid the database to perform comprehensive data analysis
6) There is also a need for the building plan of the study sites.

VI. Proposed or Suggested Solutions

This project's list of proposed solutions is as follows:

1) A careful evaluation and personally owned PPE were provided by the field assistant.
2) Some equipment, such as the ladder, light meter, humidity test meter, digital voltmeter, and others, are provided by the project team members to sustain the project.
3) We cannot perform the illuminance test for all buildings; therefore, our proposed target is to set one building as our benchmark for this activity.
4) Since the PPD did not account for the purchase of additional equipment needed for the survey, project members contributed to procuring or borrowing the essential equipment.

ANNEX

A. Detailed breakdown of functional equipment of each building under Operations

Operations	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
AVR	9	6	1	12	1	24	-	-	15	20
Base Radio	-	-	-	-	-	-	1	-	-	-
Battery	-	-	-	1	-	-	-	-	-	-
Binding Machine	-	-	-	-	-	1	-	-	-	-
Camera	-	-	-	1	-	-	-	-	-	-
CCTV	-	-	-	-	-	-	-	-	40	-
Cellphone	-	7	-	8	1	-	1	-	-	-
Charger	-	-	-	-	2	-	-	-	-	-
Copier	8	-	-	1	-	10	-	2	-	2
CPU	43	10	1	17	1	21	4	8	15	13
Digital Mixer	-	-	-	-	-	-	-	-	1	-
Earbuds	-	-	-	1	-	-	-	-	-	-
Earphones	-	-	-	-	-	-	-	-	2	-
Fingerprint Scanner	-	-	-	2	1	-	-	-	-	-
Hard drive	-	-	-	-	-	-	1	-	-	-
Headset	-	-	-	3	-	-	1	-	-	-
Inkjet Printer	59	8	3	21	8	44	6	13	21	19
Keyboard	76	13	5	33	8	51	10	13	24	41
Laminator Machine	1	-	-	1	-	-	-	-	-	-
Lapel	-	-	-	-	-	-	-	-	1	-
Laptop	9	-	-	9	7	6	3	1	15	20
Laserjet Printer	6	-	-	2	-	5	1	-	3	2
Mic Pad	-	-	-	-	-	-	-	-	-	1
Monitor	76	13	7	36	8	56	10	14	29	60
Mouse	77	13	5	30	9	56	9	13	18	23
Paper Shredder	2	1	-	-	1	1	-	-	-	-
Power Bank	-	1	-	-	-	-	-	-	-	-
Projector	-	-	-	2	1	2	1	-	-	3
RDS	-	-	-	-	-	-	-	-	-	-
Router	-	1	-	1	-	-	3	-	-	-
Scanner	4	1	-	-	5	1	-	-	-	2
Speaker	11	5	1	6	1	8	3	3	10	7
Speaker - Mic pod	-	-	-	-	-	-	-	-	-	1
Tablet	-	-	-	1	2	-	-	-	-	-
Telephone	15	1	1	4	1	12	1	1	5	1
Time Recorder	1	-	-	-	-	-	-	-	-	-
TV	8	4	-	5	1	5	1	3	24	11
UPS	-	-	-	1	-	-	-	-	1	1
Wireless Microphone	-	-	-	-	-	-	-	-	-	2
Total:	**405**	**84**	**24**	**198**	**58**	**303**	**56**	**71**	**224**	**229**

B. Detailed breakdown of functional equipment of each building under Lighting

Lighting	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Bulb	159	5	19	87	30	175	9	96	315	23
Bulb - Chandelier	-	-	-	-	1	-	5	-	8	-
Fluorescent	30	16	4	141	9	91	-	-	38	460
Lamp Shade	2	3	-	-	-	-	-	-	-	-
LED Light	-	-	-	-	2	-	-	-	-	-
Panel LED	-	29	-	-	-	4	-	-	225	-
Pinlight	67	70	5	54	34	8	8	22	35	-
Pinlight - Two Eye	-	9	-	-	-	-	-	-	-	-
Ring Light	-	-	-	-	-	-	-	-	1	-
Spot Light	-	-	-	-	-	-	-	28	-	-
Total:	**405**	**84**	**24**	**198**	**58**	**303**	**56**	**71**	**224**	**229**

C. Detailed breakdown of functional equipment of each building under Electrical Appliances.

Electrical Appliances	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Air Fryer	-	-	-	1	-	-	-	-	-	-
Air Humidifier	-	1	-	-	-	-	-	-	1	-
Air Purifier	13	3	1	2	1	7	-	1	2	4
Beverage Cooler	-	-	-	1	-	-	-	-	-	-
Blender	-	-	-	3	-	-	-	-	-	-
Chest Freezer	-	-	-	1	-	-	-	-	-	-
Coffee Boiler	-	-	-	-	-	1	-	-	-	-
Coffee Capsule Machine	1	-	-	-	-	-	-	-	-	-
Coffee Maker	6	3	1	2	1	4	1	1	1	4
Coffee Percolator	-	-	-	1	-	-	-	-	-	-
Deep Fryer	-	-	-	2	-	-	-	-	-	-
Dish Sterilizer	1	-	-	-	-	-	-	-	-	1
DVD Player	-	-	-	-	-	-	-	-	-	-
Electric Airpot	2	2	-	3	1	-	-	1	1	2
Electric Ceramic Stove	-	-	-	3	-	-	-	-	-	-
Electric Cooker	-	-	-	-	-	1	-	-	-	-
Electric Kettle	1	-	-	-	-	-	-	-	-	-
Electric Skillet	1	-	-	-	-	-	-	-	-	-
Electric Stove	2	-	-	-	-	-	-	2	-	-
Exhaust Fan	-	-	-	-	2	-	-	-	-	-
Floor Polisher	-	-	-	-	-	-	-	-	1	-
Food Cooker	2	-	-	-	-	-	1	-	-	-
Food Processor	1	-	-	1	-	-	-	-	-	-
Food Warmer	-	-	-	1	-	-	-	-	-	-
Kitchen Aid	-	-	-	3	-	-	-	-	-	-
Microwave Oven	4	1	-	1	1	3	1	-	1	3
Mini Refrigerator	-	-	-	-	1	1	-	-	-	-

Electrical Appliances	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Mixer	-	-	-	1	-	-	-	-	-	-
Oven Toaster	4	-	-	1	-	1	-	-	-	2
Refrigerator	9	2	-	3	2	4	1	3	-	4
Rice Cooker	4	-	-	2	-	3	1	2	1	1
Small Pan	-	-	-	1	-	-	-	-	-	-
Tableware Sterilizer	-	-	-	1	-	-	-	-	-	-
UV Sterilizer	-	-	-	-	1	-	-	-	-	-
Vacuum	-	-	-	-	-	1	-	-	-	-
Water Dispenser	11	3	-	3	3	10	2	2	5	4
Total:	**62**	**15**	**2**	**37**	**13**	**36**	**7**	**12**	**13**	**25**

D. Detailed breakdown of functional equipment of each building under HVAC (Heating, Ventilation and Air Conditioning).

HVAC	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Ceiling Fan	-	-	1	-	-	-	-	-	3	-
Ceiling Fan - Chandelier	-	-	-	-	-	-	-	-	1	-
Mini Fan	2	-	2	-	-	1	-	-	-	-
Orbit Fan	2	-	-	3	-	-	-	-	-	-
Split Type - Ceiling Cassette	-	1	-	-	-	-	-	-	-	43
Split Type - Floor Standing	2	2	-	7	1	2	-	-	3	-
Split Type - Underceiling	1	-	-	-	-	1	-	-	-	-
Split Type - Wall Mounted	6	5	2	8	3	10	2	9	37	1
Stand Fan	5	-	-	-	-	1	-	-	3	1
Turbo Fan	-	-	-	-	-	-	-	-	-	-
Wall Fan	-	-	-	-	-	-	-	-	3	-
Window Type	21	-	-	4	3	14	3	-	49	-
Total:	**39**	**8**	**5**	**22**	**7**	**29**	**5**	**9**	**99**	**45**

E. Detailed breakdown of non-functional equipment of each building under Operations

Operations	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
AVR	2	-	-	1	-	5	-	-	2	1
Base Radio	-	-	-	-	-	-	-	-	-	-
Battery	-	-	-	-	-	-	-	-	-	-
Binding Machine	-	-	-	-	-	-	-	-	-	-
Camera	-	-	-	-	-	-	-	-	-	-
CCTV	-	-	-	4	-	-	-	-	-	-
Cellphone	-	-	-	-	-	-	-	-	-	-
Charger	-	-	-	-	-	-	-	-	-	-

Operations	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Copier	-	-	-	2	-	1	-	-	-	-
CPU	5	-	-	1	-	5	1	1	6	2
Digital Mixer	-	-	-	-	-	-	-	-	-	-
Earbuds	-	-	-	-	-	-	-	-	-	-
Earphones	-	-	-	-	-	-	-	-	-	-
Fingerprint Scanner	-	-	-	-	-	-	-	-	-	-
Hard drive	-	-	-	-	-	-	-	-	-	-
Headset	-	-	-	-	-	-	-	-	-	-
Inkjet Printer	4	2	-	2	-	4	3	-	5	8
Keyboard	6	-	-	-	-	3	-	-	4	2
Laminator Machine	-	-	-	-	-	-	-	-	-	-
Lapel	-	-	-	-	-	-	-	-	-	-
Laptop	-	-	-	-	-	-	-	-	-	-
Laserjet Printer	-	-	-	1	-	-	-	-	-	1
Mic Pad	-	-	-	-	-	-	-	-	-	-
Monitor	14	2	1	2	-	11	1	1	10	5
Mouse	5	-	-	-	-	1	-	1	2	1
Paper Shredder	-	-	-	-	-	-	-	-	-	-
Power Bank	-	-	-	-	-	-	-	-	-	-
Projector	-	-	-	-	-	-	-	-	1	1
RDS	-	-	-	-	-	-	1	-	-	-
Router	-	-	-	1	-	-	-	-	-	-
Scanner	1	2	-	1	1	-	-	1	-	1
Speaker	1	-	-	-	1	-	-	1	2	1
Speaker - Mic pod	-	-	-	-	-	-	-	-	-	-
Tablet	-	-	-	-	-	-	-	-	-	-
Telephone	-	3	-	-	-	2	1	-	1	-
Time Recorder	-	-	-	-	-	-	-	-	-	-
TV	1	-	-	-	-	1	5	-	4	1
UPS	-	-	-	-	-	-	-	-	-	-
Wireless Microphone	-	-	-	-	-	-	-	-	-	-
Total:	**39**	**9**	**1**	**15**	**2**	**33**	**12**	**5**	**37**	**24**

F. Detailed breakdown of non-functional equipment of each building under Lighting

Lighting	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Bulb	7	-	-	21	-	20	3	5	52	-
Bulb - Chandelier	-	-	-	-	-	-	-	-	3	-
Fluorescent	5	-	1	15	-	-	-	-	3	3
Lamp Shade	-	-	-	-	-	-	-	-	-	-
LED Light	-	-	-	-	-	-	-	-	-	-
Panel LED	-	1	-	-	-	-	-	-	-	-
Pinlight	-	2	-	4	-	-	-	1	6	-
Pinlight - Two Eye	-	-	-	-	-	-	-	-	-	-
Ring Light	-	-	-	-	-	-	-	-	-	-

Lighting	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Spot Light	-	-	-	-	-	-	-	-	-	-
Total:	**12**	**3**	**1**	**40**	**0**	**20**	**3**	**6**	**64**	**3**

G. Detailed breakdown of non-functional equipment of each building under Electrical Appliances.

Electrical Appliances	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Air Fryer	-	-	-	-	-	-	-	-	-	-
Air Humidifier	-	-	-	-	-	-	-	-	-	-
Air Purifier	1	-	-	-	-	-	-	-	-	-
Beverage Cooler	-	-	-	-	-	-	-	-	-	-
Blender	-	-	-	-	-	-	-	-	-	-
Chest Freezer	-	-	-	-	-	-	-	-	-	-
Coffee Boiler	-	-	-	-	-	-	-	-	1	-
Coffee Capsule Machine	-	-	-	-	-	-	-	-	-	-
Coffee Maker	-	-	-	3	-	1	-	-	-	-
Coffee Percolator	-	-	-	-	-	-	-	-	-	-
Deep Fryer	-	-	-	-	-	-	-	-	-	-
Dish Sterilizer	-	-	-	-	-	1	-	-	-	-
DVD Player	-	-	-	-	-	-	-	-	1	-
Electric Airpot	-	-	-	-	-	-	-	-	-	-
Electric Ceramic Stove	-	-	-	-	-	-	-	-	-	-
Electric Cooker	-	-	-	-	-	-	-	-	-	-
Electric Kettle	-	-	-	-	-	-	-	-	-	-
Electric Skillet	-	-	-	-	-	-	-	-	-	-
Electric Stove	-	-	-	-	-	-	-	-	-	-
Exhaust Fan	-	-	-	-	-	-	-	-	-	-
Floor Polisher	-	-	-	-	-	-	-	-	-	-
Food Cooker	-	-	-	-	-	-	-	-	-	-
Food Processor	-	-	-	-	-	-	-	-	-	-
Food Warmer	-	-	-	-	-	-	-	-	-	-
Kitchen Aid	-	-	-	-	-	-	-	-	-	-
Microwave Oven	-	-	-	-	-	-	-	-	-	-
Mini Refrigerator	-	-	-	-	-	-	-	-	-	-
Mixer	-	-	-	-	-	-	-	-	-	-
Oven Toaster	-	-	-	-	-	-	-	-	-	-
Refrigerator	-	-	-	-	-	-	-	-	1	-
Rice Cooker	-	-	-	-	-	-	-	-	-	-
Small Pan	-	-	-	-	-	-	-	-	-	-
Tableware Sterilizer	-	-	-	-	-	-	-	-	-	-
UV Sterilizer	-	-	-	-	-	-	-	-	-	-
Vacuum	-	-	-	-	-	-	-	-	-	-

Electrical Appliances	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Water Dispenser	3	-	-	-	-	2	1	-	-	-
Total:	**4**	**0**	**0**	**3**	**0**	**4**	**1**	**0**	**3**	**0**

H. Detailed breakdown of non-functional equipment of each building under HVAC (Heating, Ventilation and Air Conditioning).

HVAC	Building No.									
Equipment	**1**	**2**	**3**	**5A**	**5B**	**6**	**7**	**8**	**19A**	**19B**
Ceiling Fan	-	-	-	3	-	-	-	-	3	-
Ceiling Fan - Chandelier	-	-	-	-	-	-	-	-	-	-
Mini Fan	-	-	-	-	-	-	-	-	-	-
Orbit Fan	-	-	-	-	-	-	-	-	-	-
Split Type - Ceiling Cassette	-	-	-	-	-	-	-	-	-	-
Split Type - Floor Standing	-	-	-	-	-	-	-	-	2	-
Split Type - Underceiling	-	-	-	-	-	2	-	-	-	-
Split Type - Wall Mounted	-	-	-	-	1	-	-	-	4	-
Stand Fan	-	-	-	-	-	1	-	-	-	-
Turbo Fan	-	-	1	-	-	-	-	-	-	-
Wall Fan	-	-	-	-	-	-	-	-	-	-
Window Type	-	-	-	-	1	-	-	-	9	-
Total:	**0**	**0**	**1**	**3**	**2**	**3**	**0**	**0**	**18**	**0**

Certification of Progress Report

3rd Quarter (2024)

Energy and Greenhouse Gas Auditing of MSU-IIT Buildings

This is to certify that the progress report for the project titled "**Energy and Greenhouse Gas Auditing of MSU-IIT Buildings"** has been duly prepared and reviewed as of October 9, 2024. The report outlines the significant milestones achieved, the current status of ongoing activities, and the planned future steps necessary to complete the project successfully.

This certification acknowledges the dedicated efforts of the project team and their commitment to achieving the project objectives.

HERNANDO P. BACOSA, PhD
Project Leader

October 9, 2024
Date

OVCRE-DR
Form (2020)

Department of Research
QUARTERLY PROGRESS REPORT (Form 2)

For the Period: March 1, 2024 to December 31, 2024 of 3rd Quarter (Inclusive Dates July 1, 2024 to September 30, 2024)

PROGRAM TITLE: **Energy and Greenhouse Gas Auditing of MSU-IIT Buildings**

PROJECT TITLE/DURATION: **10 Months**

PROJECT LEADER: **HERNANDO P. BACOSA, PhD**

TARGET ACTIVITIES FOR THE PERIOD (BASED ON APPROVED PROPOSAL)	ACTUAL ACCOMPLISHMENT	PERCENTAGE ACCOMPLISHMENT		PROJECT EXPENDITURES FOR THE PERIOD	REMARKS
		FOR THE PERIOD	CUMMULATIVE START (FROM START)		
Rapid Building Assessment	Initial identification and mapping of the buildings that are selected in the rapid energy audit	100%	100%	-	The rapid building assessment commenced.
Purchase and Preparation of Materials	Equipment purchase request is on-going	100%	100%	15,000	The purchase request was granted, received, and used in the field survey.
Hiring and Deployment of Research Assistant	The research assistant was hired and is currently working.	100%	100%	30,403.20	Utilized salary allocation
Hiring and Deployment of Field Assistant	The research assistant was hired and is currently working.	100%	100%	14,104.38	Utilized salary allocation
Rapid Diagnostic Energy Audit	The rapid diagnostic energy audit was performed at the selected buildings	70%	50.95%	-	Inventory and analysis was done

Comprehensive Diagnostic Energy Audit		Comprehensive energy audit was performed in the administration buildings No. 1, 2, 3 5-A, 5-B, 7-A, 19-A and 19-B				
Building Name	Building No.					
Administration	1	Inventory/Diagnostic Energy Audit	100%	44.44%	-	Inventory and analysis was done
Office of the Chancellor	2	Inventory/Diagnostic Energy Audit	100%	50%	-	Inventory and analysis was done
Office of Communications	3	Inventory/Diagnostic Energy Audit	100%	50%	-	Inventory and analysis was done
OVCSI/Registrar	5-A	Inventory/Diagnostic Energy Audit; Illuminance Test; Humidity Test	100%	50%	-	Inventory and analysis was done
OVCIA/Legal Office	5-B	Inventory/Diagnostic Energy Audit	100%	50%	-	Inventory and analysis was done
Main Library	6	Inventory/Diagnostic Energy Audit	100%	41.67%	-	Inventory and analysis was done
MCR/SID	7-A	Inventory/Diagnostic Energy Audit; Illuminance Test; Humidity Test	100%	62.5%	-	Inventory and analysis was done
KTTO	8	Inventory/Diagnostic Energy Audit	100%	50%	-	Inventory and analysis was done
CSM-MAIN	14-A	Inventory/Diagnostic Energy Audit	30%	24.7&	-	Preliminary building assessment
CSM-ANNEX	14-B	Inventory/Diagnostic Energy Audit	30%	24.14%	-	Preliminary building assessment
CASS-A	19-A	Inventory/Diagnostic Energy Audit	100%	47.17%	-	Inventory and analysis was done
CASS-B	19-B	Inventory/Diagnostic Energy Audit	100%	51.14%	-	Inventory and analysis was done
COE-A	25-A	Inventory/Diagnostic Energy Audit	95%	14.8%	-	Preliminary building assessment
COE-B	25-B	Inventory/Diagnostic Energy Audit	95%	16.67%	-	Preliminary building assessment

COE-C	25-C	Inventory/Diagnostic Energy Audit	95%	36.61%	-	Preliminary building assessment

I CERTIFY, ON MY HONOR, TO THE CORRECTNESS OF THE ABOVE INFORMATION

HERNANDO P. BACOSA, PhD
Project Leader

Date: 10/9/2024

Noted:

EPHRIME B. METILLO, PhD
Vice Chancellor for Research and Enterprise

Date

NOTE:
Upload accomplished form to REIS together with Form 1.