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Assessment of Energy Savings Potentials at University in Lanao del Norte, Philippines

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Abstract— *Every year, people become more dependent on electricity. Most devices for communication, business transactions, and even teaching use technology that consumes energy. In the Philippine setting, energy consumption raised to 74.15 billion kWh with 707 kWh per capita as of 2014. In comparison, they were facing the challenges of depletion of energy sources and other environmental challenges. In contrast, there were energy and other environmental challenges. An energy audit was conducted at MSU-Iligan Institute of Technology in the Philippines, looking to reduce energy costs. Results show that space cooling and lighting have the highest electrical consumption of the total university electricity demand (29%). Space cooling consumed the maximum power (49%) in academic buildings, while lighting consumed the most power (39%) in all buildings. An Energy Awareness Evaluation survey was conducted among students, faculty, staff, and the management at MSU-IIT to assess the university's users' willingness to adopt an energy management system that would require a collective effort from its stakeholders. The survey results reveal how its stakeholders perceived energy management as implemented in the institution. Thus, this study proposes energy-saving measures and a regular energy audit to save and monitor the energy consumption at the university and provide the institution management with insights and references critical for decision making and adoption of a sound energy management policy.*

Keywords—*Energy saving, university campus, Electricity consumption, Electricity demand.*

I. Introduction

In large institutions, such as universities, electricity is the most predominantly used energy source. Most universities consume a large amount of energy for daily usage [1]. Thus, energy availability, consumption, and related costs are significant challenges. The presence of dormitories and laboratories adds to these challenges. Energy availability or otherwise have profound effects on the institution's academic, social, and economic activities [2].

There is a considerable population size of students, academic and administrative staff, researchers, and others who work or study at the university in tertiary institutions [3]. Thus, the energy needed for operations, including teaching and research, provisions of support services, and residences and hostels, is almost comparable to a small commercial facility. Universities involve many building users and facilities and thus have a tremendous energy consumption, so the increase in electricity use and subsequent costs are becoming a more significant concern [4].

Being a miniature city, the university campus consumes power for lighting, water supply, air-conditioning, ventilation, laboratory equipment, and water pumps, amongst others [5]. Conserving this energy will reduce energy consumption, operating costs, fewer lighting fixtures replacements, and a reduction in accumulated heat generated. This helps mitigate climate change and make buildings more environmentally sustainable [6].

Campus energy potential studies involve an energy auditing process that provides an opinion of the availability of energy efficiency resources on campus and allows the development of cost and savings strategies [7]. A campus energy potential study offers many of the same benefits as standard energy studies, such as understanding how efficient the campus is in energy utilization and a plan for energy reduction projects [4].

The main objectives of the present study are to investigate the energy utilization pattern of MSU-IIT and to determine the awareness level of its stakeholders on energy management and assess their willingness to adopt energy management policies, and lastly to recommend energy conservation measures to curb excessive energy consumption in the university.

II. Materials and Methods

A. Study Area

This study was carried out at MSU-Iligan Institute of Technology, as shown in Figure 1. The population of the university is about 9,472, which comprises 7,853 undergraduate students, 662 graduate students, 397 staff, 502 faculties, and 58 lecturers (https://www.msuiit.edu.ph/faculty-staff/). Inside the campus, there are 12 transformers catering electricity to various buildings such as Clinic, Admin, School of Computer Studies (SCS), Integrated Development School (IDS), Ceramics, College of Arts and Social Sciences (CASS), Technology Business Incubator (TBI), Elementary Training Center (ETC), College of Science and Mathematics (CSM), Gym, College of Education (CED) and College of Engineering (COE).

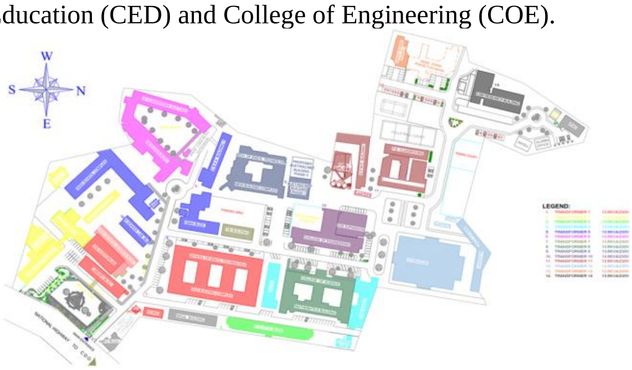

Fig. 1. Site Map of MSU-Iligan Institute of Technology

B. *Data Collection and Analysis*

Technical and qualitative data were collected to analyze and identify potential energy conservation measures (ECMs) at MSU-IIT, which, when implemented, will make the energy usage more efficient, less expensive, and more environmentally friendly.

C. *Technical Data and Inspection*

A walk-through energy audit was carried out at MSU-IIT to acquire the power ratings of the electrical appliances/equipment in use. The number of illumination and data of all electrical appliances/equipment from the property custodian was also utilized for cross-reference with the existing electrical appliances/equipment. Power ratings were checked against the nameplates on the machines wherever possible. In theory, the power rating multiplied by the total hours of operation would give the total energy use for the equipment. In practice, the actual energy use could be lower because the real electrical power required might be less than that shown in the manufacturer's quoted power rating or the nameplate on the machine [8].

Additional 2010-2018 data collected include average peak power consumed, the total population of staff and faculty, the total population of students, and the disposable income of electricity. For relevance, the bulk of these data was analyzed from the perspective of the most recent three-month monitoring data (January – March 2018), available to researchers, of the twelve transformers.

D. *Self-Assessment on Energy Management Awareness*

An Energy Awareness Evaluation survey was conducted among students, faculty, staff, and the management at MSU-IIT to assess the university's users' willingness to adopt an energy management system that would require a collective effort from all its member's stakeholders. The Self-Assessment survey questionnaires were based on BRECSU published BS EN CPG 167 (1996) [9] and ECG 73 (1995) [10] manuals and the "International Survey Energy Management Practices in ISO 50001 Certified Organizations" published by Afnor Energies (2015), modified to fit the context of MSU-IIT.

The survey is divided into three parts. The first part investigates students', faculty, and staff's self-assessment on Energy Management awareness at MSU-IIT. The second part examines MSU-IIT's Energy Management assessment on the following dimensions: policy, organizing, communication, information system, understanding, and investment. This was based on [9] energy management matrix interpreted based on the given criteria below.

The final part, part 3, looks at the self-identified common barriers to Energy Management at MSU-IIT and self-identified/suggested actions to improve Energy Management at MSU-IIT.

III. Results and Discussion

This section discusses the results on the breakdown of major electricity end users, electricity demand profiles, energy saving opportunity, and self-assessment on energy management awareness.

A. *Breakdown of Major Electricity End Users*

The amount of energy used in a university campus depends on many factors. Key factors include the types of buildings, number of facilities, population, the operation efficiency of the electrical appliances, types of lamps and their efficacy, and building operations and maintenance. The first step in breaking down energy use is establishing a list of the significant services or end-users.

TABLE I. Energy Management Matrix [9]

Level	Policy	Organizing	Communication	Information System	Awareness Programs	Investment Programs
5	Formally adopted energy policy with management commitment	The energy manager is integrated into the management structure	Full exploitation of formal and informal channels with all users	Comprehensive system, set targets, monitor consumption, identify faults, etc.	Full marketing of value energy efficiency, both within and outside the organization	Positive discrimination in favor of green schemes
4	Formally adopted but no commitment	The energy manager is accountable to a committee	Energy committee & direct contact with major users	Reports based on sub-meter data	Programs for staff awareness and regular campaigns	Investment in energy efficiency is the same as all other investments
3	Guidelines not formally adopted	Energy manager, but authority is unclear	Contact with users thru an ad hoc committee	Reports based on supply meter data	Some ad hoc staff awareness training	Measures based on short term paybacks
2	Unwritten guidelines	Part-time energy manager	Informal contact with users	Cost reporting based on the invoice	Informal promotion of energy management	Low-cost measures on energy efficiency

TABLE II. Overall Score Interpretation [10]

Level		Interpretation
5	-	Very Good (must be maintained)
4	-	Good (improvement in one or two areas)
3	-	Acceptable (requires strict policy implementation and improvement in most or all areas).
2	-	Poor (energy management needs to be formally adopted, requires thorough attention)
1	-	Very Poor (no energy management is implemented at all)

Figure 2 shows the daily energy consumption at every 12 transformers where various academic buildings are connected. The highest power-consuming location is the COE building, followed by the CASS building. The IDS and Clinic buildings are minor power-consuming locations due to their small size and the absence of high-energy consuming laboratory equipment or machines at these locations. The CSM and COE have the highest power consumption due to the many rooms and laboratories inside the buildings.

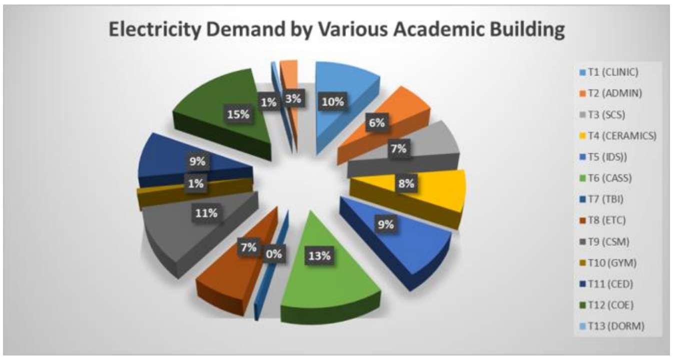

Fig. 2. Electricity Demand by Various Buildings

B. Electricity Demand in MSU-IIT University for Various End Uses

The collected data were analyzed in various ways to investigate and extract different information about electricity demand profiles at MSU-IIT. The demand profiles were analyzed based on various end uses, location, and annual electrical consumption.

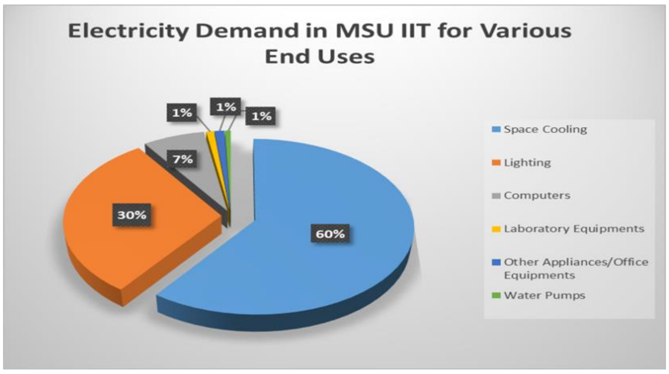

Fig. 3. Electricity Demand in MSU-IIT for Various End Uses

Figure 3 shows the energy demand in MSU-IIT based on various end uses. Available data reveal that space cooling has the highest energy demand at 60%. This is followed by lighting, 30%, then by personal computers and laptops taking 7%. Categories of laboratory equipment, water pumps, appliances, and other office equipment constitute only 1% of energy consumption.

C. Electricity Demand in Academic Buildings

Figure 4 shows the percent energy consumption of various academic buildings in MSU-IIT. The chart shows that transformer 12, which serves the COE building, has the highest demand for usage at 14%, followed by transformer six, which helps the CASS building with 13.04% energy demand.

The slightest accounted need is that of the Academic building in transformer seven which is only 0.42%. These figures are based on the most recent three months of monitoring data that could be made available to the researchers.

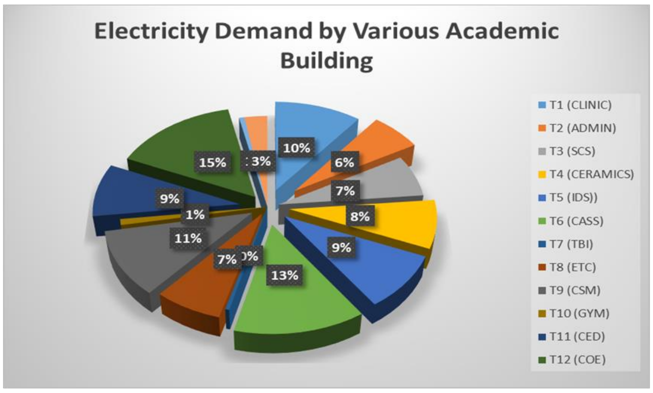

Fig. 4. Electricity Demand by Various Academic Building

D. Annual Electricity Consumption

Table shows the annual energy consumption (kWh) and energy demand (kW) of MSU-IIT from 2000 to 2018. The data show a 7,287-kWh yearly average increase in energy consumption at MSU-IIT.

TABLE III. Annual Electricity Consumption

Year	Energy in kWhr	Demand (Kw)
2000	138,453.00	611.50
2001	151,324.00	698.00
2002	154,850.00	754.00
2003	157,595.00	770.00
2004	163,449.00	808.00
2005	155,375.00	796.00
2006	169,560.50	852.00
2007	181,758.00	881.00
2008	171,046.00	867.00
2009	179,416.50	934.00
2010	184,828.00	949.00
2011	203,868.00	1006.67
2012	203,800.00	1054.10
2013	215,230.00	1120.20
2014	224,750.00	1136.35
2015	238,060.00	1161.60
2016	257,950.00	1232.60
2017	239,840.00	1176.00
2018	236,240.00	1157.60

Table III presents the profile of the annual electricity cost (in millions of pesos) at MSU IIT. The marginal increase in the price of electricity in 2015 is due to scheduled rehabilitation and maintenance works of NPC-managed power plants; during this time, power from other sources, mainly diesel-fired generators, was used to avoid extended inconvenient rotational brownouts. Still, the cost of diesel power was three times the PSALM generation rate.

Apart from this, there was also an increase in industrial investments in the city and consumer demand due to the rise in population. In MSU-IIT, the general increasing trend, compared to the previous years, is attributed to the increase in student population, a growing number of staff, residential and academic buildings, and a reasonably steady power supply within the campus. With the rise in electricity consumption in the university, electricity bills increased from about 1.16 million pesos in 2011 to over 1.48 million pesos in 2018.

The general trend of increasing electricity cost is likely to stay the same in the coming years due to rising energy demand as more people move to the cities, increasing industrial and commercial activities, and steady power rate hikes, which coincidentally followed the privatization of several government-owned power plants. This information is essential, as it will help policymakers and all stakeholders of MSU-IIT University to be aware of the need for the university to adopt energy efficiency measures that will save costs and minimize fallouts from electricity generation as shown in Figure 5.

Let's consider the trend of increasing energy demand and the price of electricity as shown in Figure 5. The above facts of energy consumption at MSU-IIT are alarming. Thus, the electricity consumption at MSU-IIT needs to be brought down. Further, the money intended to cover the surging electricity costs could have improved the university's facilities. Thus, managing electricity usage is quite important.

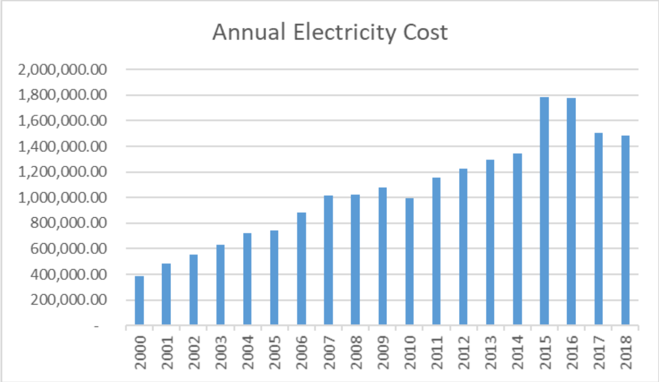

Fig. 5. Annual Electricity Cost Profile

As MSU-IIT's enrolment grows, new buildings are constructed, and new equipment and loads are put in place; hence, there is a significant increase in the use of electrical energy. Therefore, there is a need to take measures to minimize the use of electricity whenever possible to avert unplanned outages and reduce electricity bills.

E. Electricity Consumption of Lightings

As shown in Figure 6, T10 consumes more power in lighting than T9, and the least lighting power consumption is T7. A thorough inspection of illumination using a flux meter to measure the wattage of each illumination.

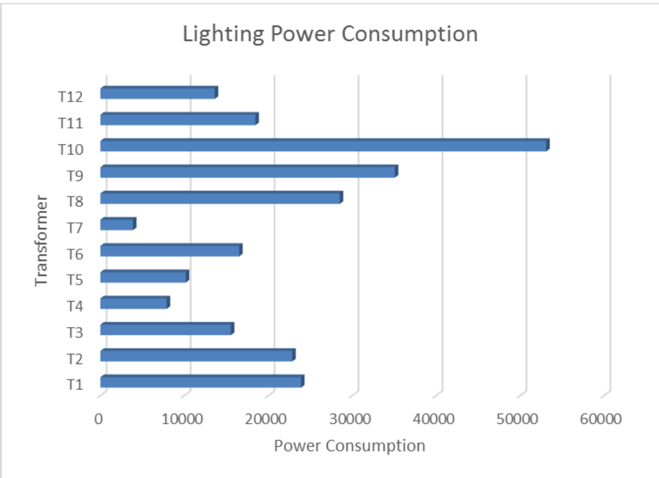

Fig. 6. Lighting Power Consumption

The Gym of the university has the most used of lighting system as expected because it is athletics activities are held in this place. The least uses lighting is the CASS building because the design of the building is well ventilated and most of the classes are held in the morning.

F. Energy Saving Opportunity in Terms in Lighting

In today's scenario, developing nations such as the Philippines face various challenges for saving electricity. Various electric appliances that are not energy efficient, ranging from lighting bulbs to space cooling systems such as fans and air conditioners, have flooded the market. Requiring energy-efficient devices is of utmost importance because of future energy requirements. The necessity for using electricity in office and household appliances like air conditioners, refrigerators, and electric cookers is obvious. If these devices can be made more energy-efficient, a reasonable amount of electricity can be saved in MSU-IIT. In this section, selected areas of intensive energy use are considered for the university's energy-saving potential.

TABLE IV. Table of Illumination Savings

Tranformer	Lighting Power Consumption
T1	23900
T2	22852
T3	15540
T4	7892
T5	10160
T6	16524
T7	3880
T8	28508
T9	35068
T10	53100
T11	18464
T12	13620
Total	249508
Savings	up to 174666

CFL and LED lights would be a good option in decreasing energy consumption since it only requires a small amount of power. Commonly, CFL and LED light bulbs with Energy Star certified can save up to 70% - 90% of energy consumption than incandescent light bulbs. Less energy consumption on lighting can also help reduce CO2 emissions. CFLs have an average lifespan of 6,000 – 15,000 hours, while LEDs have an average of 15,000 – 30,000 hours [11].

A proposed implementing natural light controls and guides in buildings to save energy for electrical lighting and reduce cooling load [12]. A natural lighting system can be a skylight, light shelves, prismatic glazing, Anabolic ceiling, louvers and blinds, and light pipe. To save more from energy consumption, checking lights should be done regularly, and everybody should report busted lights immediately [13].

G. Space Cooling Systems

Inverter-type air conditioning units are becoming popular because of the better energy savings than conventional air conditioning units [14]. Traditional air conditioning needs more power when it starts (and it starts too many times), running at total capacity and requiring a lot of currents. In comparison, an inverter-type air conditioning unit never turns off its compressor or motors. It reduces the electricity it needs and constantly keeps cooling (or heating) the room. When it does start the first time, it begins slowly, so it doesn't require a massive torque current. Thanks to the inversion mechanism, inverter air conditioners can also begin at low voltages. By running in a low power consumption state, inverter air conditioners save a lot of electricity [15].

A study in China shows that the utilization of natural ventilation creates tremendous energy-saving potential, thus reducing the emissions associated with coal-fired power generation [16]. The study revealed that office buildings' aggregated energy savings potential at 35 major Chinese cities reached 112 GWh in 2015.

IV. Survey Resulst and Interpration

A self-assessed evaluation on energy management awareness was conducted among students, faculty, staff, and the management at MSU-IIT. The purpose of this survey is to assess where the university stands at present in terms of its users' willingness to adopt an energy management system, which would require a collective effort from all its stakeholders and evaluate the institution's adoption and implementation of the energy management system.

TABLE IV. Part 1. Students Self-Assessment on Energy Management Awareness at MSU-IIT

(1- Never, 2-Seldom, 3-Sometimes, 4-Often, 5-Always)

	1	2	3	4	5	Weighted Mean	Interpretation
1. Are you interested in energy-related issues?	12	30	118	98	72	3.57	OFTEN
2. Do you believe MSU-IIT has a proactive energy efficiency approach?	20	50	86	126	48	3.40	SOMETIMES
3. Do you take part in energy management practices or feel responsible for your workstation or use of school facilities (e.g., turning off lights and aircon after class)	16	28	78	106	102	3.75	OFTEN
4. Does MSU-IIT provide students with energy training/orientation relevant to school facilities?	40	72	80	72	66	3.16	SOMETIMES
5. Do you think it is crucial to conduct an energy training/orientation for the students (i.e., do you think students need them)?	12	10	58	54	196	4.23	ALWAYS
6. Are you aware of the existing energy management policy at MSU-IIT?	50	78	82	72	48	2.97	SOMETIMES
TOTAL WEIGHTED MEAN						3.51	OFTEN

TABLE V. Part 1. Faculty and Staff's Self-Assessment on Energy Management Awareness at MSU-IIT

(1- Never, 2-Seldom, 3-Sometimes, 4-Often, 5-Always)

	1	2	3	4	5	Weighted Mean	Interpretation
1. Are you interested in energy-related issues?	0	0	17	21	16	3.98	OFTEN
2. Do you believe MSU-IIT has a proactive energy efficiency approach?	0	16	20	18	0	3.04	SOMETIMES
3. Do you take part in energy management practices or feel responsible for your workstation?	0	1	16	21	16	3.96	OFTEN
4. Have you attended any training on energy management?	24	10	11	8	1	2.11	SELDOM
5. Does MSU-IIT provide staff with energy management training?	19	15	13	7	0	2.15	SELDOM
6. Are you aware of the existing energy management policy at MSU-IIT?	20	13	15	6	0	2.13	SELDOM
7. Have you ever observed the conduct of an energy audit at MSU-IIT?	22	14	11	7	0	1.98	SELDOM
8. How often do you observe such practice?	19	18	15	2	0	2.00	SELDOM
TOTAL WEIGHTED MEAN						2.67	SOMETIMES

Overall, the MSU-IIT community welcomes and strongly supports the university's proposal for implementing an energy management policy. The survey shows a strong sense of responsibility among students, faculty, and staff towards energy conservation and management. However, both feel that little if the university administration has provided no opportunity at all towards this end (e.g., there is a lack of formal institutional policy on energy management, no wide dissemination of information, training, and orientation on energy conservation and management) – see Table IV and Table V.

The survey also showed a conservative energy management policy assessment (Table VI), which considering the results of Part 3 of the survey, is points mainly to two things, (1) there is no proper responsibility delegation on energy management and (2) vis-à-vis, a good line of communication and reporting channel for energy management concerns (Table VII).

TABLE VI. Part 2. MSU-IIT's Energy Management Assessment on the following: Policy, Organizing, Communication, Information System, Awareness, and Investment

(1- Very Poor, 2-Poor, 3-Acceptable, 4-Good, 5-Very Good)

MSU-IIT's Energy Management	1	2	3	4	5	Weighted Mean	Interpretation
1. Policy	0	17	22	15	0	2.96	Acceptable
2. Organizing	0	17	25	12	0	2.91	Acceptable
3. Communication	0	20	21	13	0	2.87	Acceptable
4. Information System	0	18	21	15	0	2.94	Acceptable
5. Awareness Programs	0	19	23	12	0	2.87	Acceptable
6. Investment Programs	0	15	20	17	2	3.11	Acceptable
TOTAL WEIGHTED MEAN						2.95	Acceptable

The interpretations are based on the rounded-off weighted mean values. The overall score of 3 (total weighted mean) here is interpreted, based on Table II, as Acceptable and requires improvement in most or all areas.

TABLE VII. Part 3. Identified Common Barriers to Energy Management at MSU-IIT

(1- Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree)

	1	2	3	4	5	Weighted Mean	Interpretation
1. No top management action	0	3	32	15	4	3.37	Neutral
2. Line management problems or lack or reporting channels	0	1	32	19	2	3.41	Agree
3. Department conflicts, complexity/bureaucracy	0	1	36	14	3	3.35	Neutral
4. Apathy from staff/students/building users	1	2	32	15	4	3.36	Neutral
5. No or lack or incentives	0	2	34	16	2	3.30	
6. No delegation of responsibility for consumption	0	2	25	25	2	3.50	Agree
7. Poor data, inadequate metering, lack of monitoring	1	3	31	17	2	3.29	Neutral
8. Poor information system, inadequate analysis	3	3	30	16	2	3.20	Neutral
9. Poor management reporting, energy costs not identified	0	3	26	23	1	3.35	Neutral
10. Lack of time/resources	0	3	25	24	1	3.37	Neutral
11. Lack of knowledge/expertise	3	5	25	16	5	3.27	Neutral
12. Low investments/short pay back/precedence to core budget	2	6	30	14	2	3.15	Neutral
TOTAL WEIGHTED MEAN						3.33	Neutral

Finally, the survey results point to the management and its action towards a well-articulated and vigorously pursued energy management policy for the university. With solid support and commitment from the administration, a formal policy needs to be adopted, followed by broader dissemination of information. Finally, close monitoring of its implementation through a delegated committee or energy management staff is strongly suggested (Table VIII).

TABLE VIII. Part 3. Identified/Suggested Actions to Improve Energy Management at MSU-IIT

(1- Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree)

	1	2	3	4	5	Weighted Mean	Interpretation
1. Gain top management support and commitment	0	0	4	25	25	4.39	Strongly Agree
2. Write and adopt an energy policy	0	0	1	26	27	4.48	Strongly Agree
3. Increase staffing/resourcing of energy management	0	0	5	30	19	4.26	Strongly Agree
4. Involve major users or devolve budgets	0	0	12	22	20	4.15	Agree
5. Form or revitalize a committee or group (for energy management)	0	0	2	27	25	4.43	Strongly Agree
6. Promote achievement of energy management unit	0	0	1	26	27	4.44	Strongly Agree
7. Raise awareness through meetings, training, or publicity	0	0	2	23	29	4.50	Strongly Agree
8. Improve data input analysis and reporting	0	0	0	26	28	4.52	Strongly Agree
9. Engage help/information from outside organizations	0	0	2	26	26	4.43	Strongly Agree
TOTAL WEIGHTED MEAN						4.4	Strongly Agree

V. CONCLUSION

In this study, an energy audit was conducted at MSU-IIT, looking to reduce energy consumption and costs. Over time, as the number of students and the use of new facilities and technology increase, electricity consumption will also increase, and the need for energy conservation measures in the university will continue.

This study reveals that MSU-IIT electricity consumption increased from 138,453 kWh to 236,240 kWh from 2010 to 2018. Moreover, buildings with more functionalities consume more electricity as more appliances are used for different functions. Space cooling and lighting have the highest percentage of electricity consumption of the total demand in the university.

The annual cost of electricity profile for the period under consideration (2011 to 2018) increased from 1.15 million pesos in 2011 to over 1.48 million pesos in 2018. This study shows that the average monthly energy and cost savings for replacing traditional FTL and incandescent bulbs with CFL in student hostels and staff quarters are about 17,075 kWh P150,232.69 pesos. In comparison, replacing LED has cost savings of approximately 11,127.67 kWh, P97,905.67 pesos. The capital cost recovery time for replacing all conventional FTLs and incandescent bulbs is around 1.7 years. Considering the space cooling system (ceiling fans), the monthly energy and cost savings for replacing traditional resistance electric regulator fans with electronic regulator fans is about 17,923 kWh and P157,693.72 pesos. The capital cost recovery time for replacing all resistance electric regulator fans in the university is around 1.88 years.

A self-assessed evaluation on energy management awareness was also conducted among students, faculty, staff, and MSU-IIT management. Overall, the MSU-IIT community welcomes and strongly supports the proposal to adopt and implement an energy management policy. The survey shows a strong sense of responsibility among students, faculty, and staff towards energy conservation and management. However, both feel that little if the university administration has provided no opportunity towards this end. It suggests that a formal policy needs to be adopted with solid support and commitment from the management.

From this study, it can be concluded that adopting energy efficiency measures as part of the overall university developmental policy strategy would substantially reduce peak electricity demand and reduce electric bills and conserve energy. Some of the policy options that the university can take to reduce energy spending include enhancing the efficiency of electrical appliances, utilizing daylighting, maximizing natural ventilation, and improving management practices. Well-articulated and vigorously pursued energy efficiency policy measures in the university can result in estimated annual savings in electricity consumption of about 16%. That can help ensure sustainable development in the university and possibly eliminate the pressure to install additional diesel or gas-electric generators. Energy audits of this type can be replicated at another university campus to reduce electric bills.

VI. OTHER RECOMMENDATIONS

The study suggests implementing the following recommendations: (1) Use of energy management and monitoring systems that will track and control the use of power for the entire institution. These systems are already available and can be installed on existing panel boards. (2) Use of Bureau of Energy Efficiency Star-Rated electrical equipment and other appliances in the laboratories, classrooms, offices, and facilities. (3) Upgrade the ventilation system by installing air vents for high-temperature environments and replacing old ceiling/ventilation fans. This minor and straightforward improvement will have a significant impact on energy savings. (4) Integration of inverter-type air-conditioning units and lightings to an intelligent system for efficient usage. Different sensors and controllers are incorporated with the existing appliances. They can be timed or automated from the primary control linked to class/office schedule or manually operated, thus, minimizing the excessive and unregulated energy use. (5) Conduct seminars and talks that encourage the users/occupants for energy-saving behavior. (6) Constant maintenance check-up for the electrical equipment and wires (cables and ducts) to prevent future power disruptions.

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