Republic of the Philippines

MARIANO MARCOS STATE UNIVERSITY

City of Batac 2906 Ilocos Norte

THE ESTABLISHMENT OF AFFILIATED RENEWABLE ENERGY CENTER (AREC) AT MARIANO MARCOS STATE UNIVERSITY (MMSU)

Funded by the Department of Energy (DOE)

PROJECT TERMINAL REPORT

December 14, 2023

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PROJECT TITLE: **THE ESTABLISHMENT OF AFFILIATED RENEWABLE ENERGY CENTER (AREC) AT MARIANO MARCOS STATE UNIVERSITY (MMSU)**

PROPONENT: **MARIANO MARCOS STATE UNIVERSITY**
National Bioenergy Research and Innovation Center

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EXECUTIVE SUMMARY

The project involves the establishment of an Affiliated Renewable Energy Center (AREC) at Mariano Marcos State University (MMSU) to assist the Department of Energy (DOE) in implementing, promoting, and commercializing renewable energy (RE) programs. The project is funded by the DOE and comprises four (4) main activities: (1) Establish an Energy Self-sufficient RE Center with Solar PV (Off-grid) Systems for demonstration and educational purposes, (2) Review and assess the implemented RE Projects in the area of coverage and facilitate the completion of required documents for the closure of the said RE Projects, (3) Prepare inventory of Non-Commercial RE (NCRE) Systems and develop a database for this purpose, and (4) Perform Information, education, and communication (IEC) campaigns.

MMSU-AREC successfully installed a 15kWp hybrid solar PV system with 30.72kWh energy storage, exceeding the initial plan of an off-grid system. The hybrid system is more flexible and reliable than a standalone off-grid system. With the addition of this system, not only has the MMSU-AREC office become self-sufficient, but, in combination with the existing 10kWp off-grid and 40kWp grid-tied systems, the National Bioenergy Research and Innovation Center (NBERIC) building of MMSU has achieved Net Zero Energy Building (NZEB) status. The system has been demonstrated to various institutions and is currently utilized for educational purposes, including laboratory sessions and educational tours.

Technical and socio-economic assessments was conducted to review and assess the RE projects across six (6) municipalities in four (4) provinces, as well as in four (4) state universities and colleges (SUC). The covered areas include Pangasinan, Nueva Vizcaya, Isabela, and Batanes, where the Household Electrification Program (HEP) of DOE had implemented Solar Home Systems (SHS) and RE demo projects at Benguet State University (BSU), Don Mariano Marcos Memorial State University (DMMSU), Kalinga State University (KSU), former Kalinga-Apayao State College, and Mariano Marcos State University (MMSU).

MMSU-AREC successfully completed the scheduled Focus Group Discussions (FGD) and individual interviews with 405 beneficiaries to monitor and evaluate the condition of SHS units and gather valuable feedback on the technical and socio-economic components of the projects in all the provinces.

The deployed SHS utilized monocrystalline PV modules and lead-acid batteries. Solar panels were installed ground-mounted. It was found that beneficiaries conducted battery replacements to continue utilizing the solar panel and directly connect it. The main uses of SHS were for lighting and a combination of lighting and power generation. A significant number of systems require repair or condemnation, particularly charge controllers and batteries. Key challenges include battery longevity and associated replacement costs.

Currently, MMSU-AREC is developing a Battery Energy Storage System (BESS) to address these battery challenges. The BESS utilizes lithium batteries for an extended lifespan and improved reliability. The design of BESS prioritizes portability for wider accessibility. There are future plans to produce and distribute BESS to beneficiaries and communities in need.

The HEP significantly improved the quality of life for beneficiaries by providing reliable lighting and reducing dependence on kerosene lamps. The SHS units had a positive impact, with many reporting improvements in their household tasks, working hours, family interaction, hygiene, health, and security. However, the project had a limited impact on the community level, with beneficiaries reporting few improvements in social, healthcare, and education services. There were mixed results regarding economic benefits, with beneficiaries reporting reductions in energy expenses but limited increases in income or employment opportunities. The implementation highlighted successes and challenges, emphasizing the need for improved implementation strategies and sustainability measures.

The acquisition of closure documents for the RE project from both the Local Government Units (LGUs) and SUCs was also facilitated. The project involved transferring ownership of the SHS and RE demo projects to the LGUs and SUCs, respectively, through a Deed of Donation and a Certification. However, only two (2) out of six (6) LGUs agreed to sign the Deed of Donation due to difficulties in passing a resolution, inadequate documentation, and the non-operational state of the SHS units. In SUCs, the projects were implemented back in 1997 and 1998 and no longer served any purpose, leading all universities to opt for a Certification instead of a Deed of Donation.

MMSU-AREC developed a multi-platform GIS-based system for gathering, managing, and analyzing data of RE systems. This system is compatible with Windows, Android, and any web browser, and it will soon be available for iOS devices. It has a centralized database on an on-premise server located at NBERIC, ensuring data security and controlled access. The GIS has been tested during the fieldwork inventory of Non-Commercial RE (NCRE) systems in Ilocos Norte. The inventory of NCRE systems in Ilocos Norte was completed within 7 months. The total potential system capacity of the inventory for NCRE systems has accumulated to 3.19MW. The developed GIS is designed to cater to a diverse range of RE projects and initiatives, including the formation of associations among RE producer-consumer private establishments and individuals. It has been rolled out to seven other accredited AREC state universities for their NCRE system inventory. MMSU-AREC aims to establish partnerships with various institutions and private entities to expedite the nationwide inventory of RE systems. This will help achieve the target of DOE of a power generation mix of 35% from renewable energy sources by 2030 and 50% by 2040 by quantifying the contribution of NCRE systems.

In supporting the efforts of DOE to promote renewable energy, MMSU-AREC has spearheaded several Information, Education, and Communication (IEC) campaigns with press releases and social media engagement. These campaigns targeted diverse audiences, including government officials, university students, elementary and high school students, and the general public, encompassed various initiatives:

1. *Renewable Energy Executive Competency Training Program (REECTP):* This program provided LGU executives and representatives with knowledge and skills to plan and implement RE projects in their communities.
2. *Elevating Electrical Engineering Students' Awareness and Understanding of Renewable Energy Systems:* This seminar equipped electrical engineering students with knowledge in RE systems, fostering their understanding of the industry and its potential.

3. *School On-the-Air Program "Solar PV Systems for Household Power Generation":* This program reached a broad audience of farmers, housewives, rural communities, and students, raising awareness about solar energy as a clean energy solution for household power generation.
4. *Affiliated Renewable Energy Centers (ARECs) Knowledge Convergence Forum:* This event brought together representatives from ARECs across the Philippines to share best practices, showcase achievements, and collaborate on initiatives to advance renewable energy development. The convergence resulted in the signing of a Letter of Understanding (LOU) for the formation of a consortium among ARECs.
5. *Information, Education, and Communication (IEC) Campaign Program for Solar Home System and Battery Energy Storage System:* This program targeted elementary and high school students, engaging them in hands-on activities and interactive sessions to learn about renewable energy technologies like SHS and BESS.

In conclusion, the establishment of the Affiliated Renewable Energy Center at Mariano Marcos State University has been a success. By exceeding its initial goals and delivering impactful results across all project activities, MMSU-AREC has demonstrated its commitment to advancing renewable energy adoption in the Philippines. Moving forward, MMSU will continue to play a key role in supporting the goals of the DOE and contributing to a more sustainable future with renewable energy.

PROJECT HIGHLIGHTS

1. Establish an Energy Self-sufficient AREC Office with Solar PV (Off-grid) Systems for demonstration and educational purposes.

MMSU-AREC has successfully exceeded the project objective by establishing a 15kWp hybrid solar PV system with a 30.72kWh energy storage, surpassing the initial plan of an off-grid system. This makes the AREC office energy self-sufficient since the project was commissioned. Also, as a hybrid system, the office can operate during power outages, and all excess generation goes to the National Bioenergy Research and Innovation Center (NBERIC), where the office is housed.

The 15kWp generation system exceeds the energy demand of the MMSU-AREC office to cover instances during rainy days to ensure energy self-sufficiency. During sunny days, all excess would be stored to the battery and absorbed by the NBERIC since the system is integrated with the current RE system of NBERIC.

The completion of this additional system, including the existing 10kWp off-grid and 40kWp grid-tied systems, the NBERIC building has achieved Net Zero Energy Building (NZEB) status. An NZEB is an energy-efficient, grid-connected building enabled to generate energy from onsite renewable sources, meeting or exceeding its annual energy needs.

Figure 1. Objective I Timeline

In Figure 1, the activities undertaken to accomplish this objective are illustrated.

To expedite the process, MMSU-AREC took the initiative to create the schematic diagram (Figure 2) and all necessary plans for the 15kWp solar PV system and proposed the ideal location for the PV modules. These plans were presented to the winning bidder and served as their guide for the electrical modifications, implementation, and installation of materials.

The design was planned not only to meet the energy demands of MMSU-AREC but also to function as an emergency backup power source for the conference room, auditorium, and critical laboratory equipment in the building during power interruptions.

The PV modules were positioned on the west wing roof deck of the NBERIC building (Figure 3). The indoor setup of the system, including the three (3) units of 5kWp hybrid

inverter, three (3) units of 10.24kWh battery, electrical panel etc., is installed inside the AREC office for demonstration purposes and allowing for close monitoring by the team.

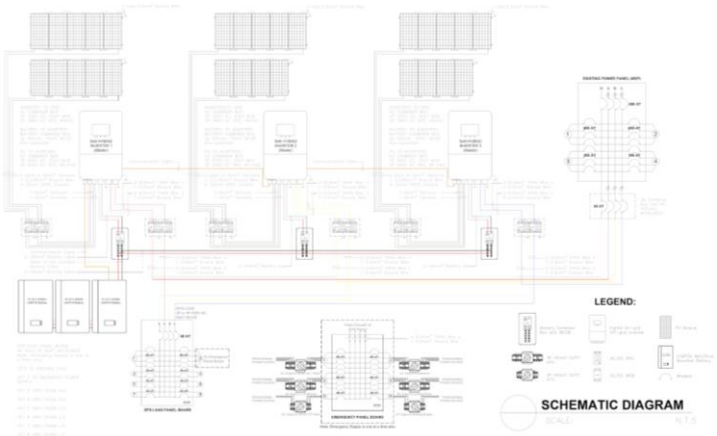

Figure 2. Schematic Diagram

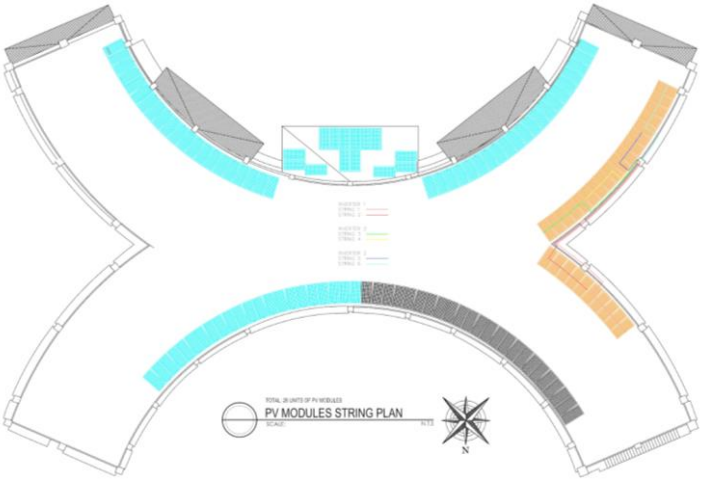

Figure 3. PV Modules String Plan

The Project Procurement Management Plan (PPMP) was prepared to serve as a reference during the procurement monitoring and bidding process. The document listed all the items required for the system, including their detailed specifications, to ensure the quality and within standards. The winning bidder for the materials was also the contractor responsible for carrying out the installation.

Figure 4. Installation of the Inverters

Throughout the installation process, a dedicated project staff member was assigned to closely monitor and supervise the work of the contractor. This ensured that the installation adhered to the approved plans and specifications.

Project staff checked all materials to ensure they met the requirements and communicated effectively with the contractor. This approach helped the objective meet its deadline and make the system ready for demonstration and educational purposes.

Figure 5. Indoor Setup

The installation of the 15kWp hybrid solar PV system was completed on October 23, 2023, and commissioned on October 27, 2023. However, testing and observation of the performance of the system began earlier, on October 17, 2023, when all the necessary components were already installed. The system has passed all required tests and is now fully operational.

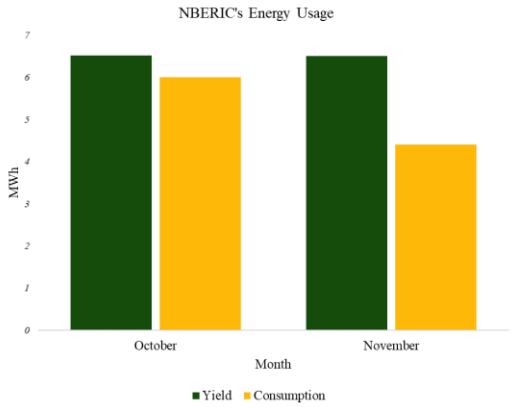

Figure 6. Solar PV System Performance

Based on the yield of the system since the start of its operation, it has consistently generated more energy than its consumption. This excess energy was not wasted, instead, it was supplied to nearby MMSU buildings, given that the MMSU Batac Campus operates as a single grid system. In October and November, the total 65kWp solar PV system generated 6.51MWh and 6.50MWh of energy, respectively. This exceeds the energy consumption of 6MWh and 4.4MWh during the same periods.

The first demonstration of the system was conducted during the *"Affiliated Renewable Energy Centers Knowledge Convergence Center,"* hosted by MMSU-AREC on Oct 24-26, 2023. Six (6) other accredited AREC universities in the country participated in the event. MMSU-AREC also made a presentation during the program on achieving NZEB. The presentation covered the planning and design phase, extending to the implementation of energy efficiency and conservation efforts. It

Figure 7. System Demonstration with AREC Universities

also detailed the components of the 65kWp solar PV system installed in the building and highlighted the journey of MMSU towards becoming a Net Zero Energy Campus (NZEC).

The system is also currently utilized for educational purposes. Electrical engineering (EE) students at MMSU conduct their laboratory sessions on electrical circuits using the setup of the system.

Figure 8. Laboratory Sessions of MMSU EE Students

The NBERIC building is also included in the campus tour for various institutions visiting MMSU, showcasing its commitment to renewable energy. Among the institutions that have visited are Wu-Ling Senior High School (WLSH) of Taiwan, the Philippine Science High School (PSHS), Marinduque State College (MSC), Dr. Emilio B. Espinosa, Sr. Memorial State College of Agriculture Technology (DEBESMSCAT), WCC Aeronautical and Technological College Binalonan, Asian Development Bank (ADB), and De La Salle Araneta University (DLSAU).

Figure 9. Educational Tour with (a) WLSH and PSHS, (b) MSC, (c) DEBESMSCAT, (d) WCC, (e) ADB, and (f) DLSAU

2. Review and assess the implemented RE Projects in the area of coverage and facilitate the completion of required documents for the closure of the said RE Projects.

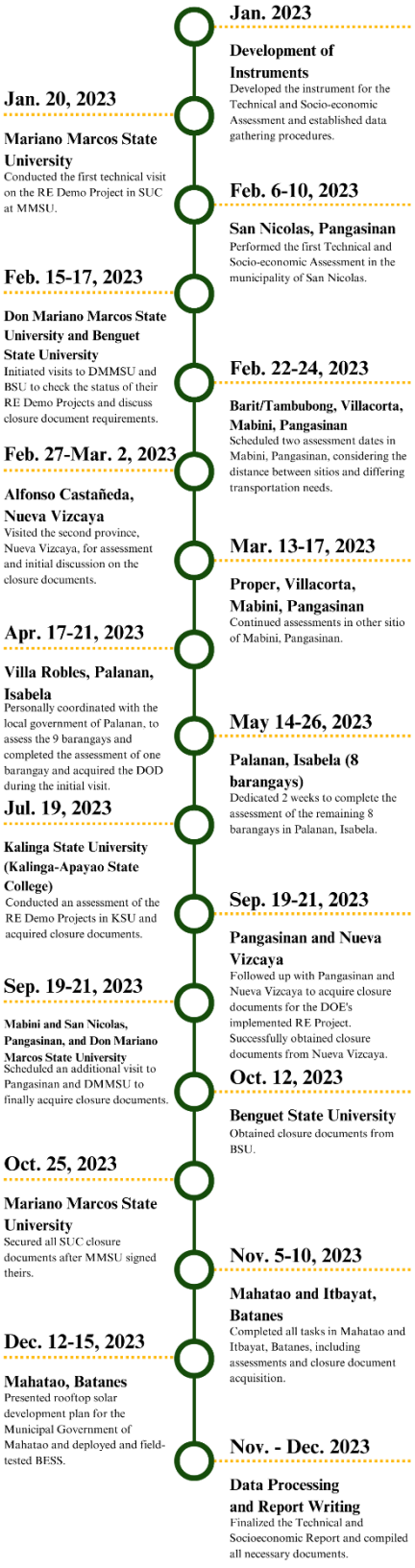

Figure 10. Objective II Timeline

The MMSU-AREC successfully monitored and evaluated the technical and socio-economic components of the RE projects across six (6) municipalities in four (4) provinces and four (4) state universities and colleges (SUC). They also acquired all necessary documentation for project closure.

The assessment of deployed SHSs reveals varying statuses across provinces and municipalities. In Itbayat and Mahatao, Batanes, only 20% of SHS components are operational. Most charge controllers and batteries in these areas are identified as beyond repair, missing due to typhoon damage, or otherwise damaged. In Palanan, Isabela, 44% of SHS components are reported as operational, while 53% are condemned. Alfonso Castañeda in Nueva Vizcaya indicates a majority (94%) of operational solar panels, but a significant number (72%) of charge controllers and batteries are due for condemnation. In Pangasinan, both Mabini and San Nicolas report a mix of operational and condemned systems, with a condemnation rate exceeding 60% for charge controllers and batteries in Mabini.

Beneficiary respondents in Pangasinan felt the RE project had the highest improvements at both household (91.3%) and community (54.1%) levels in their social conditions. Agreement on social indicators were also high in other provinces at the household level: Nueva Vizcaya (80.7%) and Isabela (77.1%). Batanes had the lowest at 32%. At the community level, agreement on social improvements was less pronounced, ranging from 16.7% in Batanes to 54.1% in Pangasinan.

Agreement rates on the economic impact of the RE project were lower than social impact. Community development agreement rates were particularly low in Nueva Vizcaya (27.8%). At the household level, agreement on economic improvements was around half of beneficiaries except for reduction in energy expenses. Average agreement rates were: Pangasinan (53.4%), Nueva Vizcaya (49.4%), Isabela (58.9%), and Batanes (39.3%).

The technical and socio-economic assessment was conducted in the province of Pangasinan, Nueva Vizcaya, Isabela, and Batanes, where the Household Electrification Program (HEP) of Department of Energy (DOE) implemented Solar Home Systems (SHS) on households due to a lack of grid electricity, isolated and remote areas. The technical assessment evaluated the condition of the SHS units and their components, considering that installation occurred 5 to 12 years ago, as indicated in Table 1.

Table 1. Program and Installation Year of the RE Project

Province/ Municipality	Program Year	Installation Year
Pangasinan		
San Nicolas	2010	2011
Mabini	2011, 2015	2014, 2018
Nueva Vizcaya		
Alfonso Castañeda	2015	2018
Batanes		
Mahatao	2013	2015
Itbayat	2013	2015
Isabela		
Palanan	2013	2015

On the other hand, the socio-economic assessment focused on the demographic characteristics of household beneficiaries, their household and economic profiles, energy profile, and perspective on the potential socioeconomic impacts of SHS on their households and communities. The assessment also aimed to evaluate the implementation strategies and sustainability measures undertaken.

Despite the logistical challenges of reaching the remote barangays, both Focus Group Discussions (FGD) and individual interviews were successfully implemented, yielding valuable feedback and insights from the beneficiaries regarding the technical and socio-economic aspects of the RE Project. MMSU-AREC successfully visited the households with SHS installations, gaining information about the implementation process and effectively evaluating the potential socio-economic impacts of the RE project.

Table 2 summarizes the number of beneficiary households from the HEP and those interviewed in each location during the technical and socio-economic assessment. Despite facing challenges like isolated and remote areas, dispersed households, time constraints, and transportation difficulties, the MMSU-AREC team managed to interview 405 beneficiaries and gather valuable information for the assessment. Additionally, the long time since the SHS units were distributed meant some beneficiaries had relocated, passed away, or their units were lost, making them untraceable.

Table 2. Total Beneficiary and Interviewed Households

Province/ Municipality	Beneficiary Households	Interviewed Households
Pangasinan	116	65
San Nicolas	16	
Mabini	100	
Nueva Vizcaya	128	51
Alfonso Castañeda	128	
Batanes	45	21
Mahatao	13	
Itbayat	32	
Isabela	684	268
Palanan	684	
Total	**973**	**405**

A questionnaire was prepared for the interviews, along with guide questions focusing on the implementation process and sustainable measures undertaken. Interviews were conducted in either Ilokano or Filipino, or both languages.

Figure 11. MMSU-AREC conducting the FGDs and Individual Interviews in (a) Pangasinan, (b) Nueva Vizcaya, (c) Isabela, and (d) Batanes

The assessment commenced in San Nicolas, Pangasinan, the most accessible location. While most beneficiaries were relocated near accessible roads, some remained in their original,

remote locations, reachable only by foot. The team then proceeded to Alfonso Castañeda, Nueva Vizcaya, which, though the barangay is accessible by any type of vehicle, is still distant from the town center, and the households of the beneficiaries are widely dispersed. Next, the team returned to Pangasinan, visiting two sitios within one barangay in the municipality of Mabini. Despite being within the same barangay, the sitios are far apart and have no road connection. The MMSU-AREC team reached one sitio on foot, while in the other sitio, difficult terrain necessitated pickup trucks or their mode of transportation, which they call *"pugpug,"* to access the area on different scheduled dates.

Figure 12. MMSU-AREC Traveling to Assessment Locations in (a) San Nicolas, Pangasinan, (b) Mabini, Pangasinan, and (c) Alfonso Castañeda, Nueva Vizcaya

Palanan, Isabela, with nine (9) beneficiary barangays, posed the most significant logistical challenge. Due to the Sierra Madre Mountain Range, the municipality is isolated from others, and no roads connect it to neighboring municipalities, so travel by plane is necessary to reach the area. The MMSU-AREC team planned an initial visit to evaluate the best option to complete the assessment efficiently. Since the barangays are separated by rivers, the team had to rent motorcycles and ride "*balsa"* or small boats to travel across the waterways and reach the other side. Within the barangays themselves, motorcycles served as the primary mode of transportation, with the team resorting to foot travel when necessary due to underdeveloped roads.

Figure 13. MMSU-AREC Traveling to Assessment Locations in Various Barangays in Palanan, Isabela

The last monitoring and assessment were conducted in Batanes, a province composed of three inhabited islands located at the northernmost part of the Philippines. Due to its distance from the main island of Luzon, the team traveled from Manila to Basco, Batanes, by plane. One barangay in each of the municipalities of Mahatao and Itbayat were the beneficiaries of the HEP. However, these municipalities were located on separate islands. While Mahatao and Basco were on the same island, the MMSU-AREC team needed to take another plane from Basco to Itbayat.

In Mahatao, the beneficiaries were gathered at the municipal hall for the FGD and individual interviews. The team also visited a household with functioning SHS units, and households with still had components from the units. The beneficiaries recalled that most of them lost their units when a typhoon hit in 2021.

Meanwhile, in Itbayat, the team personally visited the beneficiaries, most of whom had relocated to the center of the island due to the typhoon damaging their homes and the SHS units in 2016, only one year after the provision of the SHS. Some were still located in their original remote locations, requiring a tricycle ride and a hike up a highland area to reach their homes.

Figure 14. MMSU-AREC Traveling to Assessment Locations in Batanes

To promote renewable energy (RE) development among Local Government Units (LGUs), during the first visit to Mahatao, Batanes, a meeting was scheduled with the Mayor, accompanied by a presentation on the potential for solar energy in the municipality. The presentation included estimated costs, returns on investment, and different implementation

options. Recognizing the significant benefits of RE, the Mayor expressed willingness and support to partner with MMSU-AREC for implementing RE projects in Mahatao.

To further solidify this partnership and move towards concrete implementation, MMSU-AREC scheduled a follow-up visit. This visit focused on presenting a more detailed proposal, including a comprehensive plan for installing a solar PV system specifically on the roof of the Mahatao Municipal Hall. This targeted approach demonstrated the commitment of MMSU-AREC to provide tailored solutions aligned with the specific needs and priorities of the local government.

Figure 15. Presentation of Potential Rooftop Solar PV System with Municipal Mayor of Mahatao, Batanes

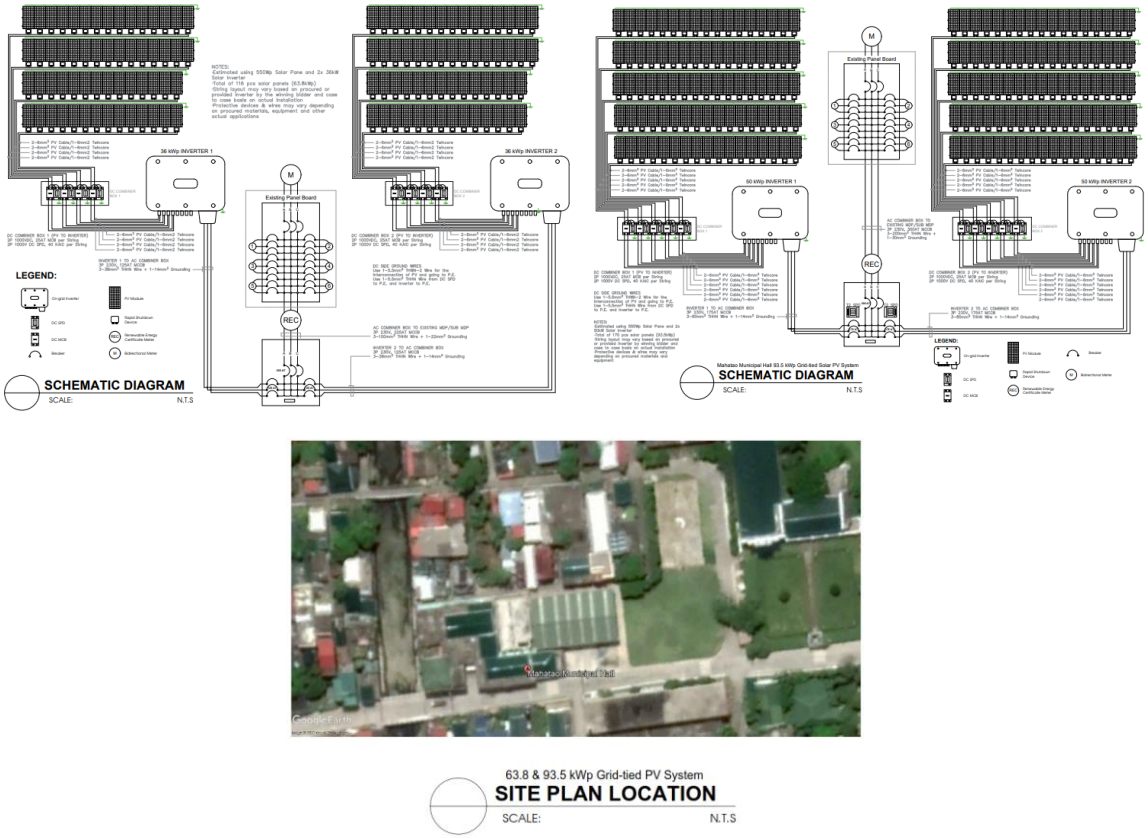

Figure 16. Proposed (a) 63.8kWp and (b) 93.5kWp Grid-Tied Solar PV System

A. Technical Assessment Report Summary

The Home Electrification Program (HEP) brought reliable electricity in remote areas across the Philippines. The technical characteristics of Solar Home Systems (SHS) deployed to the beneficiaries in municipalities of Itbayat and Mahatao in Batanes, Palanan in Isabela, Alfonso Castañeda in Nueva Vizcaya, and Mabini and San Nicolas in Pangasinan was determined. The project exclusively relied on solar energy, installing individual off-grid systems in each home. These systems, measured in primarily had a capacity of 30 watts peak (Wp), granting basic electricity needs. A few systems in Alfonso Castañeda were even smaller, operating at 10Wp.

Monocrystalline photovoltaic (PV) modules were chosen for all the solar home systems, primarily due to their superior efficiency compared to other types of PV modules. The decision to use them was influenced by the varying efficiencies of different PV modules, with monocrystalline modules demonstrating the highest efficiency. It is also widely used by other consumers nowadays. All solar panels installed were ground-mounted, specifically using a pole-mounted type, as opposed to being roof-mounted. The factor behind choosing this type is by several factors. Firstly, the height of the pole-mounted systems is greater than that of the roofs, providing an elevated position for optimal sunlight capture. Secondly, pole-mounted systems offer versatility, allowing for adjustments to ensure proper alignment of the solar panels. This is crucial for receiving maximum sunlight throughout the day, which enhances energy production. Lastly, roof-mounted solar panels are limited by the orientation of the roofs on which they are installed. Roof-mounted have advantages but due to several conditions required for its installation, pole-mounted types were used and more applicable in the area.

Lead-acid batteries were predominantly used in all the provinces due to their lower cost, availability, and suitability for homes with lower energy consumption. The frequency of battery replacement varied significantly across regions. In Batanes, Itbayat and Mahatao reported no instances of battery replacement, largely due to damage to the units from Typhoon “Ferdie” in 2016 and Typhoon “Kiko” in 2021. Alfonso Castañeda reported 14 instances of no replacement and 8 instances of 1-3 replacements. Mabini in Pangasinan showed a mix of replacement frequencies, while Palanan in Isabela had the widest range, with most batteries having 1-3 replacements. Overall, 118 batteries had never been replaced, 104 had 1-3 replacements, 56 had 4-6 replacements, 10 had 7-10 replacements, and one had more than 10 replacements. Frequent replacements were attributed to corrosion and the discharge-recharge cycle of batteries, worsened by direct connection of solar panels to batteries due to non-functional charge controllers.

The primary use of SHS across various provinces and municipalities, categorized into lighting, power generation, a combination of both, and other uses. In Batanes, Itbayat and Mahatao predominantly used SHS for lighting. In Palanan, Isabela, 192 systems were used for lighting, six for power generation, and 70 for both. Alfonso Castañeda in Nueva Vizcaya reported varied uses, with 38 systems for lighting, five for power generation, and eight for both. In Pangasinan, Mabini and San Nicolas also reported mixed uses. Overall, 292 systems were used for lighting, 15 for power generation, and 98 for both across all provinces and municipalities. No data was reported for other uses of SHS.

The current status of SHS components across provinces and municipalities is outlined in Table 3. In Batanes, specifically Itbayat and Mahatao, a limited number of SHS components are operational. In Itbayat, 4 solar panels, 2 charge controllers, and 3 batteries are operational, while 11 solar panels, 11 charge controllers, and 11 batteries are marked for condemnation and beyond repair. In Mahatao, 2 solar panels, 1 charge controller, and 1 battery are operational, and 4 SHS units are nowhere to be found due to Typhoon "Kiko." In Palanan, Isabela, a significant number of solar panels remain operational, with 257 solar panels. However, 256 charge controllers and 258 batteries are marked for condemnation. Alfonso Castañeda in Nueva Vizcaya reports most operational solar panels (48) but highlights a significant number of charge controllers (44) and batteries (43) that are due for condemnation. In Pangasinan, both Mabini and San Nicolas present a mix of operational and condemned systems, with a considerable number of charge controllers (29) and batteries (34) in Mabini marked for condemnation.

Table 3. Current Status of SHS Components

PROVINCE/ MUNICIPALITY	STATUS															
	SOLAR PANEL				CHARGE CONTROLLER				BATTERY				WIRINGS			
	Operational	For Repair	For Condemn	Nowhere to be Found	Operational	For Repair	For Condemn	Nowhere to be Found	Operational	For Repair	For Condemn	Nowhere to be Found	Operational	For Repair	For Condemn	Nowhere to be Found
Batanes																
Itbayat	4	-	11	-	2	2	11	-	3	1	11	-	4	-	11	-
Mahatao	2	-	-	4	-	1	1	4	-	-	2	4	1	1	-	4
Isabela																
Palanan	257	-	11	-	7	3	256	2	5	3	258	2	206	12	48	2
Nueva Vizcaya																
Alfonso Castañeda	48	-	2	1	5	1	44	1	6	1	43	1	44	1	5	1
Pangasinan																
Mabini	48	-	1	-	20	-	29	-	15	-	34	-	43	-	6	-
San Nicolas	15	-	-	-	-	-	10	5	-	-	10	5	15	-	-	-
Total	374	-	25	5	34	7	351	12	29	5	358	12	313	14	70	7

Based on the technical assessment, one of the identified challenges is the longevity of the battery and the associated cost of replacement. Beneficiaries may be concerned about having to bear these expenses themselves. In response to this prevailing battery problem, MMSU-AREC has developed a Battery Energy Storage System (BESS). Two initial sets of BESS have been deployed in Mahatao, Batanes on December 12, 2023, to revive the only two SHS in which solar panels survived the strong typhoon in the area, the year after its installation. Initial testing has yielded positive results, demonstrating the potential of the BESS to address the battery-related challenges identified in the assessment. The capacity

of the 150Wh BESS is found suitable for the 30W SHS. Lithium batteries were chosen for the BESS, known for their reliability, and extended operational life, similar to their use in cellular phones, electric vehicles, and other devices. This choice aims to mitigate the battery lifespan issues observed in the assessed SHS.

Figure 17. Developed Battery Energy Storage System (BESS)

The design of the BESS prioritizes both reliability and portability. MMSU-AREC aims to produce and distribute BESS to beneficiaries and communities in need across their area of coverage.

Figure 18. Distributed two (2) units of BESS with Led Bulbs and USB Lights in Mahatao Batanes

B. Socio-Economic Assessment Report Summary

The socio-demographic characteristics of the beneficiaries in the RE Project were determined in four provinces: Pangasinan, Nueva Vizcaya, Isabela, and Batanes. The household profile of the beneficiaries shows that most of the families are nucleus, with

parents and children forming the main household composition. Although most of the beneficiaries across the provinces are adults, Batanes stands out with an older average age of 45 compared to the other provinces with average of 29 and 31. Males are more prevalent than females in all four provinces. The results reveal that single civil status comprises the largest percentage in all the provinces. Educational attainment showed that many beneficiaries completed only elementary education, except in Batanes, where most had finished high school. In terms of school attendance, Pangasinan had the lowest rate, with 3 out of 10 children and youth not attending school, while Nueva Vizcaya had the highest attendance rate.

Farming is the primary source of income for most households, with Nueva Vizcaya and Batanes having the highest percentage of farmers. The mean monthly income varies across the provinces, with Batanes having the highest (PhP 6,381) and Nueva Vizcaya having the lowest (PhP 4,418). Despite the implementation of the RE Project, the income of household beneficiaries in the provinces remains low, with the majority falling into the poor category.

The implementation of the RE project has significantly impacted the energy profile of beneficiaries in the four provinces, with many of them purchasing replacements or additional RE systems for their households. Before the project, kerosene served as the primary lighting source. Currently, except in Batanes, SHS units are mainly used for lighting. In Nueva Vizcaya, some households newly connected to the grid use them as an alternative due to frequent power interruptions. In Batanes, most units were damaged and could not be located due to typhoons experienced by the province. The responsibility for maintaining and repairing the units lies with household members themselves in all the provinces, despite having no prior knowledge and training about the technology.

The social impact of the RE project has been mixed, with some positive improvements in the households observed but limited to the community. At the household level of Pangasinan, Nueva Vizcaya, and Isabela, beneficiaries generally perceived improvements in efficiency in carrying out household tasks, working hours, longer family interaction at night, hygiene and health situation, and household/personal security. However, the perceived improvements in children's learning conditions and entertainment opportunities were lower but still significant. In Batanes, fewer respondents agreed with the social indicators because most SHS units were used for a relatively short time.

Table 4. Social impacts at the household level of the RE project by province.

SOCIAL IMPACT AGREEMENT RATING (%)	PROVINCE			
	PANGASINAN	NUEVA VIZCAYA	ISABELA	BATANES
Social Impacts at the Household Level				
Working hours for household tasks have risen	95.4	81.4	89.6	33.3
Efficiency in carrying out household tasks improved	98.7	90.7	93.8	47.6
Longer family interaction at night	92.8	83.7	75.0	33.3

Children's learning conditions had improved	91.5	83.7	60.4	23.8
Hygiene and health situation of the household has improved	96.7	76.7	70.8	23.8
Household/Personal security has improved	90.2	72.1	97.9	33.3
Entertainment opportunities increased	73.9	76.7	52.1	28.6
Mean	91.3	80.7	77.1	32.0

At the community level, the perceived improvements were less pronounced, with the lowest mean level of agreement among beneficiaries observed in Batanes. However, there were some positive perceptions in Pangasinan regarding social, healthcare, and education services. In Nueva Vizcaya, positive perceptions were noted for social gatherings and education services, while in Isabela, positive perceptions were related to healthcare services.

Table 5. Social impacts on the development of the community of the RE project by province.

SOCIAL IMPACT AGREEMENT RATING (%)	PROVINCE			
	PANGASINAN	NUEVA VIZCAYA	ISABELA	BATANES
Social Impacts on the Development of the Community				
Healthcare services were improved.	62.0	50.0	60.4	19.0
Education services were improved.	62.0	58.1	33.3	14.3
Social services were improved.	73.9	47.6	35.4	19.0
Safety services were improved.	28.9	42.9	35.4	19.0
Social gathering has increased.	58.5	59.5	31.3	14.3
Spiritual related activities have increased.	39.4	52.4	20.8	14.3
Mean	54.1	51.8	36.1	16.7

The economic impact of the RE project demonstrates a more reserved response from the beneficiaries. At the household level, reduction in energy expenses is experienced by most of all the households, but the increase in income and employment opportunities is relatively low across all provinces.

Table 6. Economic impacts at the household level of the RE project by province.

ECONOMIC IMPACT AGREEMENT RATING (%)	PROVINCE			
	PANGASINAN	NUEVA VIZCAYA	ISABELA	BATANES
Economic Impacts at the Household Level				
Energy Expenses are reduced.	100.0	85.7	97.9	90.5
Household income has increased.	50.3	45.2	50.0	23.8
Increased employment in the household.	28.1	23.8	29.2	19.0

Received more livelihood assistance.	35.3	42.9	58.3	23.8
Mean	53.4	49.4	58.9	39.3

In the community, the establishment of sari-sari stores led to local enterprise growth in Pangasinan and Isabela, but limited growth was perceived in Batanes. Agricultural activities were somewhat affected in Pangasinan and Batanes. In Nueva Vizcaya, the agreement among economic indicators in community development is low, with minimal perceived improvement in infrastructure and agricultural activities.

Table 7. Economic impacts on the community development of the RE project by province.

ECONOMIC IMPACT AGREEMENT RATING (%)	PROVINCE			
	PANGASINAN	NUEVA VIZCAYA	ISABELA	BATANES
Economic Impacts on the Development of the Community				
Establishment of local enterprises.	52.1	21.4	43.8	9.5
Agricultural activities have increased.	50.7	38.1	43.8	61.9
Improvement on infrastructure.	22.5	23.8	41.7	14.3
Mean	41.8	27.8	43.1	28.6

The implementation of the RE project revealed both successes and challenges. Inconsistency in the installation process of SHS, particularly in Nueva Vizcaya and Batanes, led to beneficiary discrepancies, and the lack of official documentation raised transparency concerns. The financial arrangements of the projects, including installation and monthly fees, hindered widespread SHS adoption, with inconsistent arrangements across provinces. The intended establishment of SOPA faced organizational issues and discontinuation in certain areas, impacting the operation, maintenance, and repair of SHS units. Despite expressed satisfaction from beneficiaries, limited training on RE technology and the absence of sustainability measures, such as maintenance support and follow-up monitoring, present significant gaps. Going forward, addressing these challenges, and ensuring strong collaboration between government entities and communities will be essential for the sustained success of similar RE projects.

C. CLOSURE DOCUMENTTS OF THE RE PROJECTS

For the closure of the RE project, MMSU-AREC facilitated the acquisition and signing of necessary documents with both Local Government Units (LGUs) and State Universities and Colleges (SUCs) in the coverage area. For LGUs, a combination of Deed of Donation (DOD) and Certification documents were obtained, while for SUCs, all secured documents were Certifications. The breakdown of these documents is presented in Table 3.

Table 3. RE Project Closure Documents

LGU/SUC	RE Project	Document
San Nicolas, Pangasinan	(16) 30-Wp SHS	Deed of Donation
Mabini, Pangasinan	(100) 30-Wp SHS	Certification
Alfonso Castañeda, Nueva Vizcaya	(36) 30-Wp SHS; (92) 10-Wp SHS; (1) 75-Wp Communal SHS	Deed of Donation*, Certification
Palanan, Isabela	(684) 30-Wp SHS; (6) 75-Wp Communal SHS; (6) 75-Wp PV Streetlight	Deed of Donation
Mahatao, Batanes	(13) 30-Wp SHS	Certification
Itbayat, Batanes	(32) 30-Wp SHS	Certification
Kalinga State University (KSU)/Kalinga-Apayao State College	(1) Biogas System	Certification
Don Mariano Marcos Memorial State University (DMMSU)	(2) Biogas System; (2) Solar PV Systems/Components	Certification
Mariano Marcos State University (MMSU)	(1) Biogas System; (6) Solar PV Systems/Components; (2) Wind Systems/Components	Certification
Benguet State University (BSU)	(1) Biogas System	Certification

** Opted to proceed with certification due to the Sangguniang Bayan's involvement in passing Resolution No. as requirement in the DOD, despite the DOD having been signed by the Mayor.*

In LGUs, a courtesy meeting with the Mayor was scheduled to discuss the closure document for the provision of SHS. Prior to the meeting, a copy of the Deed of Donation (DOD) was sent, which also included a request to conduct assessments of the RE projects. The DOD specified that all SHS units are to be transferred, conveying ownership to the LGU.



Figure 19. Courtesy Meetings in Municipal Government of (a) San Nicolas, (b) Mabini, (c) Palanan, (d) Mahatao, and (e) Itbayat

Conditions included in the DOD is the strengthening the Solar Power Association (SOPA) in the community for operating and managing the SHS. The LGU is tasked with designating personnel to coordinate with the DOE and implementing sustainability measures in both the technical and social components of the project.

In these conditions, only 2 out of 6 municipalities agreed to sign the DOD and provided a Resolution No. authorizing the local chief executive by the Sangguniang Bayan to enter a DOD with the DOE for the donation of SHS in their respective municipalities, Palanan and San Nicolas. In Alfonso Castañeda, the Mayor signed the DOD, however, the Sangguniang Bayan was unable to pass a resolution, a necessary requirement for the DOD. Nonetheless, Alfonso Castañeda and the remaining municipalities signed a Certification as a valid alternative for closure requirement.

The Certification states that the SHS units were already non-operational and unserviceable due to wear and tear, with the DOE not providing any allocation for repair and maintenance funds. Presented below is summary explaining the reasons why other mayors refrained from signing the DOD:

1. The implementation of the RE Project commenced prior to the start of their respective terms.
2. The difficulties in passing Resolution No. as it requires the involvement and consensus of the Sangguniang Bayan.
3. Inadequate documentation and an unclear transfer of responsibilities during project implementation.
4. The completion of the project occurred a considerable number of years ago.
5. The responsibility of sustaining the project primarily rested on the non-functional SHS units, with the solar panel being the sole operational component at present.
6. The DOE and LGU was not allocated any funds to support the maintenance and repair of the SHS.
7. The SOPA has been discontinued due to operational and management challenges, including difficulties in fee collection and personnel-related issues in all municipalities.

In SUCs, all the RE projects listed in Table 3 were implemented back in 1997 and 1998. The current administration of each university collaborated with MMSU-AREC in conducting technical assessments for each RE project and accompanied the team in

the installation sites. MMSU-AREC determined that none of these systems were operational and no longer served any purpose. Unfortunately, no records of data and documents were available as they had exceeded the retention period, and the personnel who oversaw these projects are no longer affiliated with their respective universities. Therefore, the universities opted not to consider signing a DOD and chose to proceed with a Certification.

Figure 20. Technical Assessment and Courtesy Meetings in (a) DMMSU, (b) KSU, (c) MMSU, and (d) BSU

3. Prepare inventory of Non-Commercial RE (NCRE) Systems and develop a database for this purpose.

MMSU-AREC has developed a GIS-based system that can gather, manage, and analyze data of RE systems, named ARECGIS. The system is a multi-platform application now compatible with Windows and Android operating systems on any device and any web browser. The future update of the application will include iOS operating system compatibility.

The development of the system followed an *Agile Software Development Life Cycle* as the framework, consisting of six phases: requirement gathering and analysis, system design, coding, testing, deployment, and operation and monitoring of the system. This framework emphasizes iterative development, allowing for flexibility and adaptation to changing requirements and feedback.

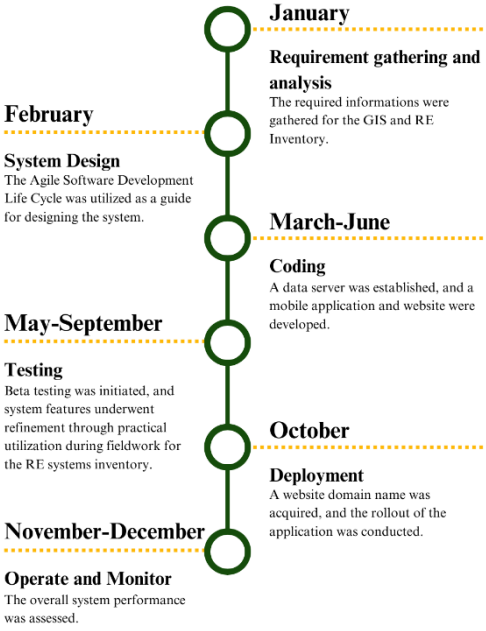

Figure 21. Objective III Timeline

The platform was built with following technologies:

1. **MongoDB:** A *NoSQL* database was chosen for its flexibility, scalability, and ease of use. It offers geospatial indexes and operators to handle geospatial data and provides backup and restore tools for data security.
2. **Flutter:** Used for mobile application development with the *Dart* programming language. *Dart* was chosen for its strong typing, productivity, and performance.

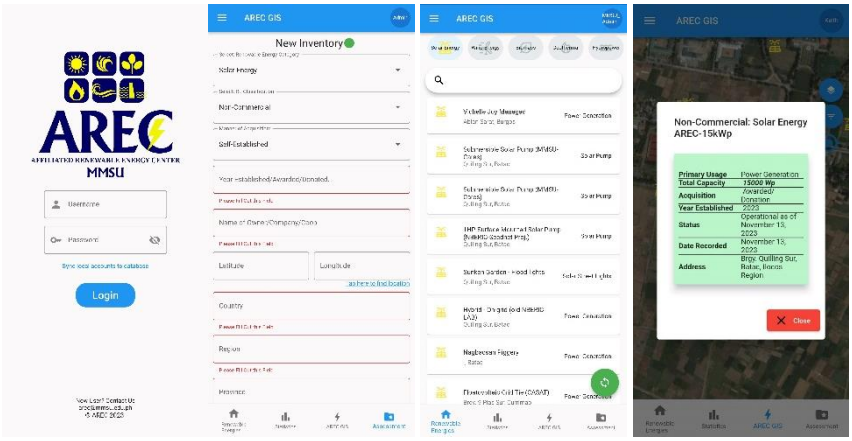

Figure 22. ARECGIS Mobile Application User Interface

3. **MERN Stack:** Employed for web application development, consisting of the following components:
    a. *MongoDB:* A *NoSQL* database that stores data in *JSON*-like documents.
    b. *Express:* A web application framework for *Node.js*, providing features for building web applications, including routing and middleware support.
    c. *React:* A *JavaScript* library for constructing user interfaces, following a component-based approach for creating reusable user interface (UI) elements.
    d. *Node.js:* A server-side *JavaScript* runtime enabling developers to execute *JavaScript* on the server side.

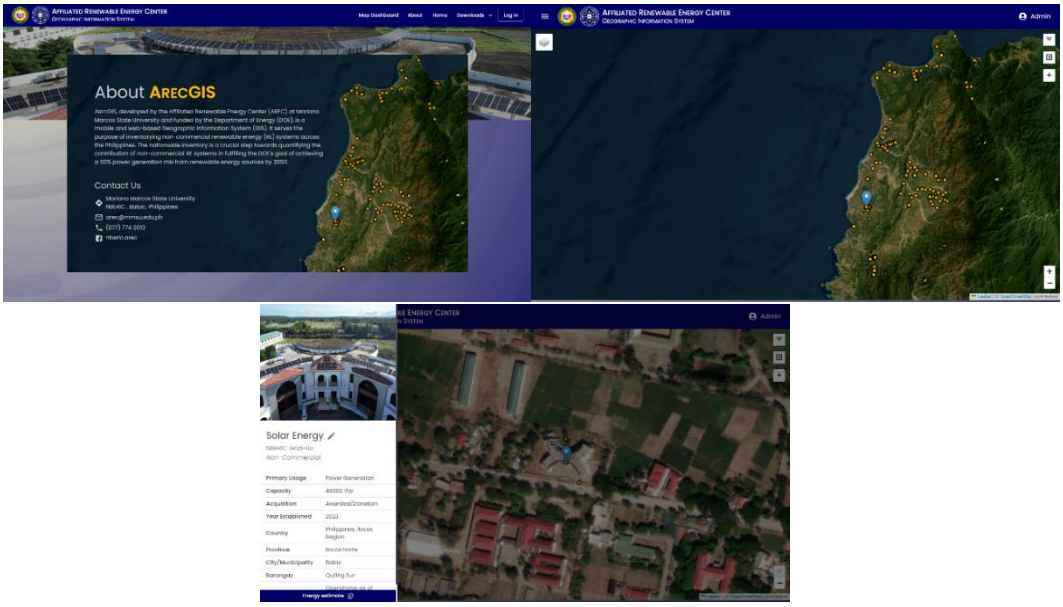

Figure 23. ARECGIS Website User Interface

The centralized database for all the inventory of RE systems resides on an on-premise server located at NBERIC. This centralized approach ensures higher security, controlled data, and services solely under the implementor. The management of this server is overseen by the IT staff of both MMSU-AREC and NBERIC.

The multi-platform GIS can be accessed through https://arec.mmsu.edu.ph/. The Android Application Package (APK) for the mobile application can be downloaded directly from the website. To maintain data integrity and controlled access, adding or updating information about the RE systems requires specific authorization. However, mapped RE systems remain publicly viewable.

The GIS underwent testing during the fieldwork inventory of Non-Commercial RE (NCRE) systems in Ilocos Norte. This testing phase led to significant enhancements such as web and mobile debugging, image upload and exporting functionality, total capacity calculation, generation and yield projection, and enhanced data visualization. Table 4, presented below, highlights the advantages of the developed GIS compared to the traditional approach to inventory.

Table 4. Traditional and ARECGIS Comparison

Traditional	ARECGIS
Limited coverage, with registration limited to net metered systems. Non-commercial systems are excluded.	Comprehensive coverage, ensuring the inclusion of all types of renewable energy systems.
Manual inventory followed by data transfer to Excel, a time-consuming and error-prone process.	Onsite inventory conducted with geotag pictures, capable of working offline. Data is automatically saved and uploaded once connected online to a secure on-premise server. This process is efficient and reduces errors.
Database stored on a local hard drive, potentially vulnerable and lacking accessibility.	Secure database management on an on-premise server, ensuring higher data security and controlled access. On-premise server storage is stackable to ensure the capacity can handle nationwide inventory and future developments.
Difficulties in obtaining information, contributing to delays.	Accessible via user-friendly mobile and web applications. Additional features include reporting summary of total capacity and units, and other inventory information, enhancing usability and efficiency.

Over the course of seven (7) months as shown in Table 5, MMSU-AREC successfully accomplished the inventory of Non-Commercial Renewable Energy (NCRE) systems across all 23 towns of Ilocos Norte.

Table 5. Ilocos Norte NCRE Systems Inventory

Month	Municipality/City
June	Nueva Era, Adams, Carasi, and Solsona
July	Piddig and Dumalneg
August	Pagudpud, Bangui, and Burgos
September	Bacarra, Pasuquin, and Dingras
October	Laoag City
November	San Nicolas, Vintar, Marcos, Sarrat, and Badoc
December	Banna, Pinili, Currimao, Paoay, and City of Batac

Figure 24. Fieldwork for the Inventory of NCRE Systems

In Ilocos Norte, the total potential system capacity of the inventory for NCRE systems has accumulated to 3.19MW. The highest accumulated total capacity is attributed to power generation with 3.11MW, comprising 153 units. Power generation is gaining popularity, with households setting up their solar energy systems, and government establishments incorporating solar energy systems into their buildings. The Department of Agriculture and the National Irrigation Administration are also implementing RE projects, including water pumps in Ilocos Norte. Solar lights are widely utilized for street lighting and serve as alternative lighting in households. The installation of streetlights of Department of Public Works and Highways and local government units contributed a high number of units and households are purchasing solar lights as alternative source of lights in their homes. On the other hand, other RE sources have a lower presence compared to solar.

Table 6. NCRE System Breakdown in Ilocos Norte

RE Source	No. of Units	Total Capacity
Solar		
Streetlights/lights	3,105	315.98kW
Power Generation	153	3.11MW
Water Pumps	89	446.98kW
Wind		
Water Pumps	17	-

The developed ARECGIS is designed to cater to a diverse range of RE projects and initiatives. This includes but is not limited to, Local Government Unit (LGU) RE projects, residential installations, agricultural projects, and initiatives in Public and private establishments. The team has conducted direct interviews and gathered information from government agencies, local communities, and private entities. This data collection ensures an accurate assessment of existing RE systems within the region.

Figure 25. NCRE Systems in Ilocos Norte

As part of the NCRE systems inventory, the team conducted a survey to assess the interest of individuals with residential RE systems in joining an association of RE producer-consumers. The association aims to integrate these individuals into the GIS developed for real-time update of private owned SHS and other RE systems. The survey revealed that 88% of respondents are willing to be part of such an association and believe it would be beneficial for them as producer-consumers of RE. They see the association as a platform for sharing good practices, supporting each other, and collectively advocating for their interests.

While the survey revealed a significant willingness to participate in an RE producer-consumer association, it also highlighted several challenges faced by individuals who have already installed RE systems in their homes. These challenges can be categorized into three main areas:

a. Net-Metering:

Numerous Requirements: Applying for net-metering often involves a complex and lengthy process with numerous administrative difficulties. This can lead to delays, frustration, and higher costs for consumers.

Lack of Transparency: In some cases, a consumer did not receive a copy of the net-metering contract, leaving unaware of the terms and conditions agreed to.

b. After-Sales Services:

Poor Quality Services: About 43% of consumers experiencing poor after-sales services from contractors who install and maintain the RE systems. This may result into impeding the adoption of RE among private individuals.

c. Assistance Needed:

14% of the consumers express a need for assistance with various aspects of owning and operating an RE system. These include:

Cost Estimation: Consumers need accurate and reliable information to estimate the upfront cost of installing an RE system. This can be

challenging due to the complex factors involved, such as system size, technology, and installation requirements.

Electrical Design and Planning: Proper electrical design and planning are essential for ensuring the safe and efficient operation of an RE system. Many consumers lack the technical expertise to do this themselves and require assistance from qualified professionals.

Maintenance and Repair: RE systems require regular maintenance and occasional repairs to ensure optimal performance. Consumers need access to reliable and affordable maintenance services to keep their systems running smoothly.

In addition to Ilocos Norte, DOE projects such as Solar Home Systems under the Household Electrification Program in isolated and remote areas have also been incorporated into the database by MMSU-AREC. These areas include Pangasinan, Isabela, Nueva Vizcaya, and Batanes. During the visit to Batanes, the NCRE system on the island of Batan has also been completed.

The ARECGIS has been rolled out, and user accounts have been provided to seven other accredited AREC state universities, both existing and to be awarded AREC status by the DOE during the ARECs convergence forum. It was introduced, and hands-on training was conducted to enable them to initiate the inventory in their respective areas of coverage. The Western Mindanao State University-AREC is already using the application for fieldwork, and some NCRE systems in their area of coverage, the Province of Zamboanga, have already been inputted into the system with total of 10 inventory entries. This initiative is part of goal to map and inventory non-commercial RE systems nationwide using the developed GIS.

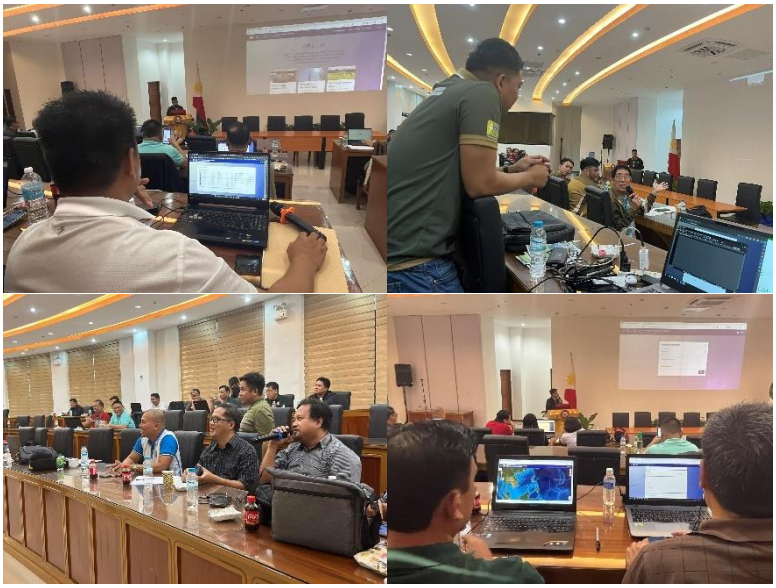

Figure 26. Presentation and Rollout of the GIS

The nationwide inventory seeks to quantify the contribution of non-commercial RE systems and assist local electric cooperatives in determining the amount of RE production from these systems for their share of electricity distribution. In this manner, the power generation mix contributed by these non-commercial systems will be accounted for as part of the DOE's target to achieve a power generation mix of 35% from renewable energy sources by 2030 and 50% by 2040.

To expedite the inventory of RE systems, DOE and ARECs aims to establish partnerships with various institutions and private entities like the ERC, local cooperatives, LGUs, and NGOs. These collaborations will not only accelerate the process but also enhance existing partnerships. Given the nationwide scope of the inventory, MMSU-AREC acknowledges that achieving this objective requires the support of all government agencies and other stakeholders.

4. Perform Information, education, and communication (IEC) campaigns.

MMSU-AREC has successfully organized five (5) information, education, and communication (IEC) campaigns in Ilocos Norte. These campaigns engaged a diverse audience, including government and university professionals, students from elementary, secondary, and colleges, farmers, and the general public.

To achieve this success, MMSU-AREC partnered and communicated with various agencies and institutions, including:

- *Department of Energy (DOE)*
- *Global Environment Facility - United Nations Development Programme (GEF-UNDP)*
- *Research Directorate*
- *Extension Directorate*
- *National Bioenergy Research and Innovation Center (NBERIC)*
- *Professional Science Masters in REE Program (PSM-REE)- Graduate School*
- *Institute of Integrated Electrical Engineers (IIEE) – Ilocos Norte Chapter*
- *Divine Word College of Laoag*
- *Northwestern University*
- *DWFB Radyo Pilipinas, 103.5 MHz, FM Band*
- *DWCI FM, 105.1, Radyo Adjo Piddig*
- *DWNI FM, 91.1, Radyo Karruba Burgos*
- *MMSU University Laboratory School*
- *All AREC nationwide*
- *Local Government Units of Ilocos Norte*

Figure 27. Objective IV Timeline

Important details about the campaign goals, activities, and achievements were shared through press releases with local media such as The Manila Times and Bannawag. Additionally, social media, particularly Facebook, was utilized to connect with the community and promote the campaigns. This included utilizing pages and websites like MMSU and NBERIC, as well as sharing posts from others. The main goal is to increase awareness and support for renewable energy in the region, contributing to its development.

A. Renewable Energy Executive Competency Training Program (REECTP)

The Renewable Energy Executive Competency Training Program (REECTP) is designed to provide LGU executives and representatives with a general understanding of renewable energy and the relevant laws in the Philippines. The program also aims to help participants develop the skills necessary to plan, implement, and evaluate community-based renewable energy programs.

Figure 28. Launching of REECTP

Launched on January 24-25, 2023, the program included training module writing workshops held from April to May, a trainers' training conducted on March 9-10, 2023, and a four-week intensive blended learning and exploratory activities for participants from May 22 – June 21, 2023, serving as the training program proper. The sessions took place through a hybrid format, combining virtual and face-to-face interactions in the NBERIC Auditorium and on Zoom App.

Figure 29. Writing Workshop and Trainer's Training

By the end of the program, participants were tasked with drafting their local energy development plans, preparing them for leadership roles in project and organizational management. The training program covered the following modules:

Module 1: Understanding the Power and Energy Sector including the Renewable Energy Development
Module 2: Rediscovering the Energy Policies, Laws, Mechanisms and Guidelines
Module 3: Shaping and Getting Ready for a Sustainable Renewable Energy-Based Communities
Module 4: Planning and Programming of Local Renewable Energy Development Program
Module 5: Financial Management of Renewable Energy Development Program
Module 6: Management and Operation of the Local Renewable Energy Development Plan and Program.

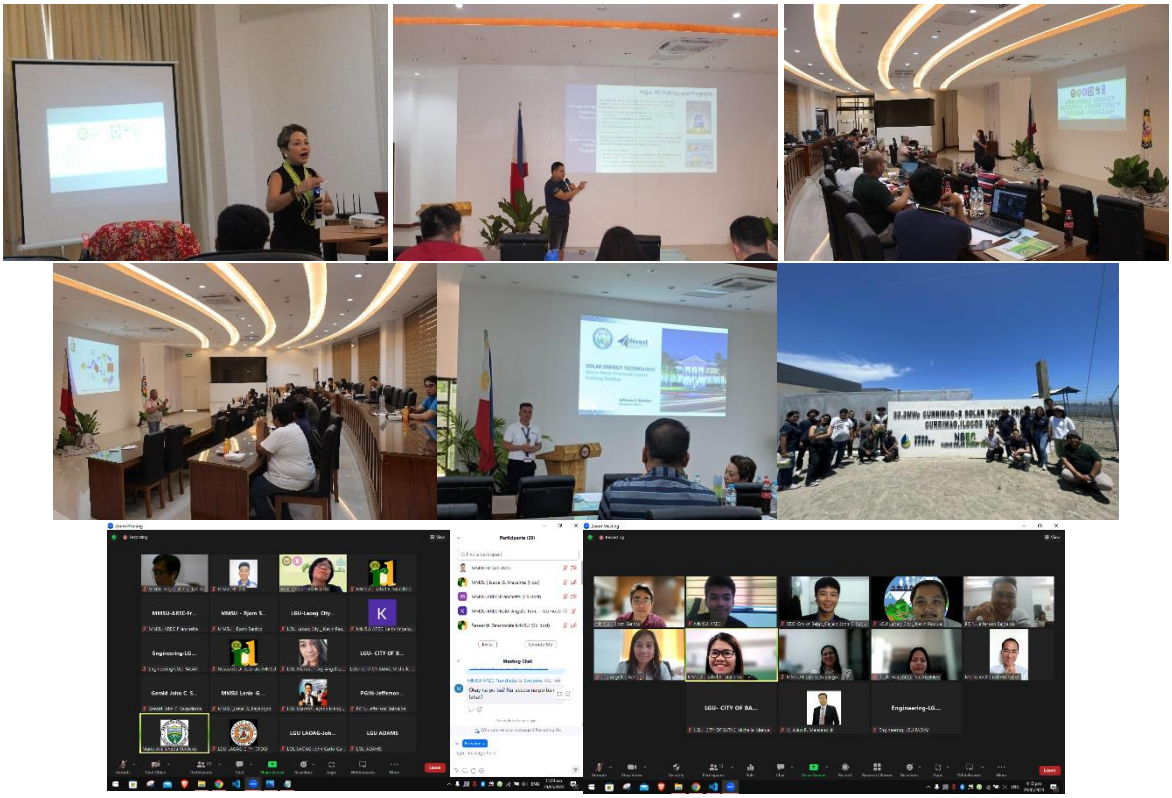

Figure 30. Training Program Proper

The REECTP was open to LGU representatives from the 21 municipalities and 2 cities of Ilocos Norte. Participants were involved and committed to the development and implementation of their respective local energy development plans. A total of 16 participants registered for the training. Participants, comprising diverse backgrounds, held roles such as municipal councilor, engineer I, project development officer, administrative aide, general electrical foreman, and consultant.

Overall, the REECTP provided participants with a comprehensive understanding of renewable energy and equipped them with the necessary knowledge and skills to contribute

effectively to the development and implementation of renewable energy projects in their communities in Ilocos Norte.

Figure 31. REECTP Awarding and Closing Ceremony

B. Elevating Electrical Engineering Students' Awareness and Understanding of Renewable Energy Systems in Ilocos Norte

MMSU-AREC, in collaboration with the Institute of Integrated Electrical Engineers Ilocos Norte Chapter, organized a relevant RE seminar on September 23, 2023, at MMSU Teatro Ilocandia. The seminar aimed to equip student-participants with valuable knowledge, practical skills, and insights into industry trends and innovations, fostering a broader understanding of the significance of RE systems.

The seminar discussed RE topics, including:

Topic 1: RE Systems
Topic 2: Energy Storage Systems in RE
Topic 3: Trends and Potential of Biomass in Power Generation
Topic 4: Potential of Wind Generators for Household Applications
Topic 5: Net Zero Energy Building
Topic 6: Microgrid

The seminar attended a total of 136 participants, comprising 4th-year electrical engineering students from three universities and colleges in Ilocos Norte: Northwestern University, Divine Word College of Laoag, and Mariano Marcos State University. Additionally, invitations were extended to students of the PSM-REE program and faculty members of the engineering departments of each institution.

Figure 32. Seminar Proper

To approach an interactive learning experience, each topic presentation was followed by engaging question-and-answer sessions. This approach encouraged critical thinking and stimulated discussions among participants, allowing them to delve deeper into the practical applications of the presented concepts.

Figure 33. Photo Opportunity and Awarding Ceremony

C. School On-the-Air Program "Solar PV Systems for Household Power Generations"

Mariano Marcos State University (MMSU) has consistently utilized radio to reach its target audience. Through its radio program, Rimat ti Ilocandia, and its School-on-the-Air (SOA) program/Eskuela iti Tangatang, MMSU has effectively disseminated valuable information to communities across Ilocos Norte.

The SOA program is implemented in partnership with the Provincial Government of Ilocos Norte, Local Government Units, and National Government Agencies. It is broadcast through three local radio stations: DWFB Radyo Pilipinas, Laoag; DWCI Radyo Adjo Piddig; and DWNI, Radyo Karruba, Burgos. Additionally, the program is live-streamed via Radyo Pilipinas and cross-posted on the MMSU Extension Directorate Facebook Page. To further expand its reach, the FB live is shared by the enrollees.

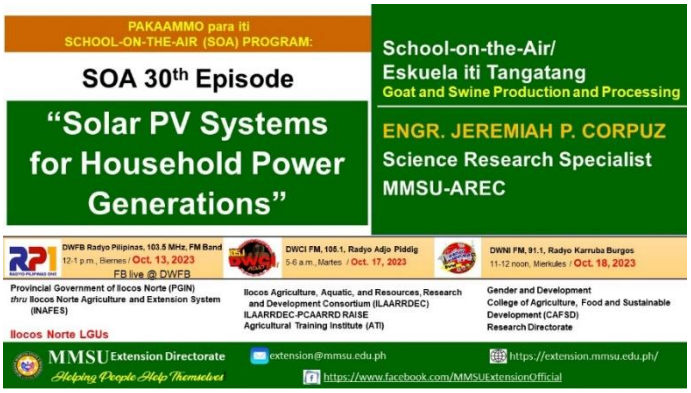

Figure 34. Promotional Poster

The SOA program has enrolled a total of 1,500 participants from various local government units in Ilocos Norte. These enrollees include farmers, housewives, zanjera organizations, rural improvement club members, and students from MMSU and the Ilocos Norte Agricultural College (INAC) in Pasuquin, Ilocos Norte.

Recognizing the potential of renewable energies to help communities combat climate change and provide households with power generation, the SOA incorporated a topic on "Solar PV Systems for Household Power Generation". This topic aimed to raise awareness about the different energy sources available and promote the adoption of clean energy solutions.

Engr. Jeremiah P. Corpuz, Science Research Specialist of MMSU-AREC, served as the speaker for this topic, delivering a series of presentations broadcasted on three radio stations on Oct 13, 17, and 18, 2023. Additionally, the sessions were live-streamed on Facebook through Radyo Pilipinas Laoag's Facebook page and co-posted with the Facebook page of the Extension Directorate. The SOA program was hosted by MMSU-AREC Researcher, Mercy Ramos Gaño. In addition to the live presentations, a 2-minute video plug was aired on Facebook from October to November. This short video provided a brief overview of RE sources and applications.

Figure 35. SOA Program Facebook Live

The topic covered the application of solar energy on households, specifically solar home systems (SHS) and various types of renewable energy (RE) systems. It provided detailed costings and return on investment (ROI) calculations, helping viewers and listeners gain an overview of the costs involved in adopting SHS for power generation. The SOA aimed to reach a broader audience, promoting renewable energy sources to the general public.

D. Affiliated Renewable Energy Centers (ARECs) Knowledge Convergence Forum

The "Affiliated Renewable Energy Centers Knowledge Convergence Forum," held from October 24 - 26, 2023, marked a significant milestone in advancing the role of ARECs in shaping the renewable energy landscape in the Philippines. This hybrid event, hosted by MMSU-AREC in collaboration with the DOE and the NBERIC seamlessly integrated face-to-face interactions at the NBERIC Auditorium with virtual participation via Zoom.

Figure 36. ARECs Convergence Opening Ceremony

The primary objective was to expedite progress towards the goals of ARECs by fostering collaboration, showcasing achievements, and introducing innovative tools such as the ARECGIS— multi-platform GIS for the Inventory of Non-Commercial Renewable Energy Systems developed by MMSU-AREC.

Key activities included an AREC Showcase, where seven (7) universities (Northern Iloilo State University (NISU), Negros Oriental State University (NORSU), University of Science and Technology of Southern Philippines (USTP), University of Eastern Philippines (UEP), Pangasinan State University (PSU), Western Mindanao State University (WMSU), and hosting university, MMSU, presented their accomplishments, challenges, and initiatives.

Figure 37. AREC Showcase with (a) NISU, (b) NORSU, (c) USTP, (d) UEP, (e) PSU, and (g) MMSU

The introduction and rollout of ARECGIS, a Geographic Information System designed to map and visualize renewable energy data, was also conducted. The hands-on training on ARECGIS to other ARECs provided participants with a comprehensive understanding of its functionalities. Also, showcasing of the NBERIC as Net Zero Energy Building (NZEB) was done enriched with a presentation on how to achieve NZEB status.

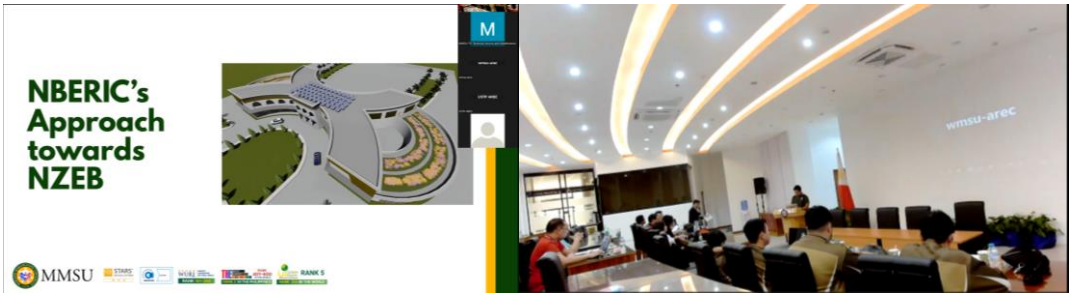

Figure 38. Presentation on NZEB

The forum's highlight was the discussion on the formation of a consortium among AECs, including NISU, NORSU, USTP, UEP, PSU, WMSU, and MMSU. A panel discussion on consortium formation brought together AREC directors and representatives, emphasizing the benefits of collaborative efforts in shaping a unified identity and efficiently sharing resources. A Letter of Understanding (LOU) was collaboratively formulated to solidify these commitments.

Figure 39. Discussion on AREC Consortium

The decision to start with a Letter of Understanding (LOU), with the potential to elevate it to a Memorandum of Agreement (MOA), ensures a structured and formalized collaboration. Mariano Marcos State University will play the role as the lead collaborator, ensuring effective organization and execution of the consortium's initiatives.

The event concluded with an insightful tour of renewable energy sites in Ilocos Norte. The closing ceremony, featuring Mr. Jeffrey Cotoner of the DOE, emphasized the government's commitment to renewable energy targets and acknowledged the vital role of AECs in this journey.

Figure 40. RE Tour and Closing Ceremony

E. Information, Education, and Communication (IEC) Campaign Program for Solar Home System and Battery Energy Storage System

Recognizing the importance of educating and involving young people in sustainable energy practices, Mariano Marcos State University (MMSU) launched a crucial initiative to establish an Information, Education, and Communication (IEC) Campaign Program for Solar Home Systems and Battery Energy Storage Systems (BESS) targeting elementary school students and Grade 11 and 12-Science, Technology, Engineering, and Mathematics (STEM) students.

The two-day campaign, held in collaboration with the University Laboratory Schools, MMSU, Laoag City, on November 30 for 38 elementary school students and December 01, 2023, for 92 high school students, was designed to encourage active participation among the students through a series of hands-on activities, demonstrations, and talks. As a result of this IEC campaign, these elementary and high school students will visit the NBERIC building for an actual educational tour of the RE facility. Moreover, some senior high school students signified their interest in undergoing an internship at NBERIC/MMSU-AREC.

Figure 41. Two-day IEC Campaign

The topics presented during the campaign were carefully chosen to fit the different needs and learning abilities of elementary and high school students. By having separate

sessions for each group, the program ensured that the educational activities were tailored to specific age groups, making sure they were relevant, engaging, and had the most impact.

The topics covered during the campaign included:

Topic 1: Basics of Electricity
Topic 2: Renewable Energy Sources
Topic 3: Renewable Energy Electrical System (High school only)
Topic 4: Solar Home System (SHS) (Elementary only)
Topic 5: Battery Energy Storage System (BESS) (Hands-on activity)
Topic 6: Operation & Maintenance of 20kWp Solar Photovoltaic (Hands-on activity)

Figure 42. Presentation of Topic and Hands-On Activities

The use of question-and-answer sessions throughout the campaign proved to be a valuable strategy, encouraging students to actively participate, think for themselves, ask for clarification, and get involved with the subject matter. Additionally, to reinforce learning beyond the immediate context of the campaign, IEC materials were given to students, emphasizing the importance of providing resources to support ongoing education. These materials served as valuable tools for students to revisit the concepts learned and continue their exploration of renewable energy technologies. By providing students with the knowledge and skills they need, we can help them create a more sustainable future.

Figure 43. Distribution of IEC Materials

ENDORSEMENTS

This is to certify that the information presented in this report is true and correct.

Submitted by:

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