Case study of the Marubay rural renewable energy technology

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Renewable Energy Access for off-grid Communities and Households

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Research Team
People In Need

I.0 Introduction

The case study of the Marubay water supply system rural renewable energy (hereafter RE) initiatives (solar energy) demonstrates it can be a potential strategy to promote rural development. The Marubay water system is a Level III service facility that began ten (10) years ago.

The purpose of the study is for the Renewable Energy Access for off-grid Communities and Households (REACH) Project to promote renewable energy technology. The REACH Project team will organize advocacy initiatives, business fora, and other events to showcase innovative renewable technology and stimulate investments and active participation in the sector. The water system is a model—by far the only reported renewable energy in Northern Samar that is functional—having worth of special attention and emulation. Lessons and best practices can be taken from the experiences, successes, and narratives of its beneficiaries and shared with interested groups.

In light of this, the case hopes to inspire, guide, and prompt action among municipal and barangay officials to explore the potentials of renewable energy now, and provides a venue for multi-stakeholder dialogue to identify challenges to renewable energy deployment and to come up with solutions to existing barriers to entry. The report briefly presents and describes Marubay solar-powered water system experiences and best practices that have proven to accelerate the deployment of renewable energy technology and their implication on the long-term social, economic, and good governance benefits that such system can generate for the community as a whole.

2.0. Background

2.1 Marubay Water Supply System in Context

The antecedent of the Marubay water supply system initiative came to be, as residents struggled for convenient access to clean, drinking water. A household that wants access to water must pay PhP7.00 per container, which hikes up to PhP15.00 per container during the barangay fiesta. The source of water is in the barangay center; downstream through deep wells; one is for drinking and the other is for washing only. For quite a decade the barangay had no form of centralized water distribution; rather, Marubay residents had to collect water from these wells situated downstream. Because the water is obtained from shallow wells, the water quality is poor and creates a high-risk situation for the community's health as the water they acquire could lead to water-borne illnesses.

The Marubay water system is an example of a barangay-managed water supply system model in Northern Samar (Philippines) that has documented the lessons and best practices in taking rural renewable energy initiatives. This design project involved supplying clean water to Marubay residents, a small barangay with a household of 298 in Batag Island, Laoang (inset). The degree to which the water system initiative has benefited from outside support for operation and maintenance before and after construction has been completed.

In 2010, Mr. Pepe Mendoza was elected as Barangay Chairman of Marubay; former President of the Association of Barangay Captains (ABC) of Laoang. When Mr. Mendoza assumed office along with the new set of barangay council members, they decided to convert and put to use the Photovoltaic panels (PV modules) donated by the Australian government through the Samar Integrated Rural Development Project (SIRD) into a water system using the eight panels with a capacity of 17 watts each. Other beneficiaries of the PV modules were Cabadiangan and Napotiocan. Altogether, there were seventeen (17) PV modules, including rechargeable batteries of which six households in Marubay were recipients for a rural electrification project. The PV modules were intended to put energy into batteries by forcing an electric current through them. The community's battery charging fee was PhP5.00 per battery for rechargeable lights.

To address the barangay rural electrification and the lack of access to clean and potable water, the Marubay Barangay Council invested in the eight (8) PV modules for street lightings, and to power the submersible water pump for the barangay-managed water supply system Level 1 project. Later, the system was upgraded under Phase 1 Level 3 project with thirty-one (31) beneficiaries for a project cost of PhP300,000.00. The construction of Phase 1 water storage tank was funded by the DILG Provision for Water Supply (Sagana at Ligtas na Tubig Sa Lahat Program). Apart from this assistance, Marubay made use of their Barangay Development Projects (BDPs) fund towards the provision of water facilities. They also invested additional funding derived from the users' fees. The storage tank was mounted behind the Barangay Hall using renewable energy technology for the water supply system.

For the Phase 2 water supply systems project, Malteser International provided funds to construct a storage tank placed on the east side of the barangay center delivering and supplying a Level 3 water system to twenty-six (26) households. The project cost was PhP400,000.00 to include a submersible pump (drilled), PV modules, PVC pipelines, and a control system.

The combined households being served by the water supply systems are fifty-six (56), with a users' fee of PhP52.00 per cubic meter, or PhP1.00 per container. It was the community that determined the users' fee of PhP1.00 per container. Barangay officials were afforded the privilege of a reduced users' fee of PhP25.00 per cubic meter. To avail of the water services, a household pays about PhP2,000 for the PVC pipe and water meter, including the service charge of PhP300.00.

As of 2021, the reported average income gained from the Marubay water supply systems operation ranged from PhP12,000.00 to PhP15,000.00 per month. Marubay water supply systems face the challenge of how they can adequately deliver water to households at the right time when they need it most. The storage tanks in Phase 1 and 2 have a limited capacity to store water that they cannot supply sufficient amounts to the households for 24/7. It takes a long period to fill the storage tanks as the rechargeable batteries to power the pump has to be recharged at night through AC power from NORSAMELCO. NORSAMELCO only supplied energy from 4:00 pm to midnight where the solar batteries were recharged anew using AC power.

3.0 Objectives

The case aims to document the Marubay water supply system project's rural renewable energy development and deployment.

Specifically, it aims to:

1. Gain a better understanding of renewable energy for water system operation and maintenance;
2. Determine improvement in social, economic, and good governance; and
3. Identify issues, determine the solution, and communicate the benefits.

4.0 Significance of the Case

The findings characterized and provided documentation of the lessons and best practices of the Marubay renewable energy water supply systems. This paper will provide policymakers, decision-makers, potential funders, and other interested groups with a clear view that outlines the operation and maintenance, as well as risk factors associated with renewable energy's initial cost of investment. There is a need to get its head around the fact that the only long-term sustainable energy solution is solar energy and other green technologies. This is simply borne out by the immense amount of energy potential that the sun can provide.

The case would be important as it contribute to the government's planning processes. The water supply system delivers water from sources to households, and provides services vital to the function of the community and important to emergency response and recovery after typhoons. Further, the findings will also serve as an eye-opener to recognize the potential for renewable energy as a small utility power generation that could replenish itself without depleting the resources. The impacts of water supply for both municipal and barangay would encourage them to explore, develop, and adopt renewable energy to minimize the environmental impacts of climate change.

5.0 The Renewable Energy in Brief

Renewable energy technologies are on the verge of a new era, and Marubay is by far the trailblazer of the renewable energy water systems in Northern Samar. Koch (2012)[1] wrote, "in many countries and regions, renewable energy is already responsible for meeting a substantial share of energy demand." "The rapid and substantial progress of renewable energy in recent years has been driven by policies of local, national and regional authorities, in close cooperation with the business community, as well as continued technological innovation and cost reductions in energy generated with renewable sources."

Progress in building new energy systems is already considerable. But issues like energy independence, eradicating energy poverty[2], combating climate change, and improving the crisis-robustness of energy systems are asking to accelerate the deployment of renewables. Recent events that have had large impacts on societies around the world, e.g., the financial crisis, the nuclear accident in Fukushima, large oil spills, new findings in climate change science—have further highlighted this need[3].

However, some trends disguise the opportunity of accelerating renewable energy growth. For instance, the promising—short-term—benefits from exploring new fossil sources like oil in arctic regions or shale (i.e. sedimentary rock formed by the deposition of successive layers of clay) gas are mobilizing powerful forces that tend to disregard the long-term disadvantages[4]. Meanwhile, the real costs of renewables are often misperceived, and the reality of integrating decentralized renewable sources in grids is often misperceived as a hurdle that cannot be taken[5].

One should acknowledge the real challenges of large-scale deployment of renewable technologies, which requires institutional, technological, and societal change. But the challenges of a business-as-usual strategy outweigh a renewable route by orders of magnitude: dealing with increased and volatile oil prices, insecurity of energy supply, climate change, air pollution, major accidents, etcetera[6].

[1] https://www.world-nuclear.org.
[2] The Canadian Observatory on Homelessness (2015) defined energy poverty as individuals, households, or communities that are unable to access and afford adequate energy/fuel for necessities of life, such as heating and cooling.
[3] ibid
[4] https://www.sciencedirect.com/topics/engineering/renewable-energy-technologies.
[5] Op. cit.
[6] Op. cit.

The challenge therefore for policymakers and decision-makers: how to pass the threshold in the short term to prepare for the longer term? Achieving energy systems that will meet tomorrow's increasing energy demand in a sustainable, responsible way is possible, as some countries already have proven. But further deployment requires a large effort on the part of policymakers and business leaders. The International Energy Agency's Implementing Agreement on Renewable Energy Technology Deployment (IEA-RETD)[7] advocates a significantly higher utilization of renewable energy technologies. RETD believes international cooperation and public-private partnerships are crucial means to establish a more rapid and efficient deployment, and that it is important to step up or accelerate to the scale today.

UN (2009) reported that about 884 million people lack access to improved water sources, and 84% live in rural areas. Rural areas are typically remote, have small and dispersed populations, and few resources. The particulars vary greatly from place to place—there can be no one-size-fits-all solution—but the essential problem is the same: no access to a reliable source of clean drinking water.

The Sustainable Development Goals (SDG) 2015-2030 emphasize the importance of energy access, particularly clean energy, in improving development indicators and driving economic development. SDG 7 on ensuring affordable and clean energy is intertwined with the achievement of other goals on good health and well-being (SDG 3), quality education (SDG 4), clean water and sanitation (SDG 6), to cite a few. The 2018 figures estimate that at least 780 million people lack access to electricity, while in some developing countries, 1 to 4 health facilities are not energized (https:www.un.org/goals/goal 7). UNESCO (2017) estimates that only 35.1% of primary schools in Sub-Saharan Africa and 50.7% in Southern Asia had access to electricity. In East Asia and the Pacific, this number is close to 100%, although no data is available for the Philippines. The growing rate of urbanization and demand for greater access to social services such as education, health, and water serves, will lead to a greater demand for energy. Sustainable energy can power these developments while contributing to a low carbon, resilient economy.

The Philippines has developed the Philippine Energy Plan (2017-2040), whose key aims include: increasing energy security, expanding energy access through affordable, reliable, and modern energy sources, and promoting a low carbon future. The plan also aims to strengthen cooperation among government agencies, encourage multisectoral collaboration, and enhance consumer welfare and protection. The share of renewable energy has grown to one-third of the energy mix in the Philippines, and this is expected to increase in the coming years. Renewable energy is also a crucial tool in helping the government meet its target of providing electricity for all by 2030. 2018 data showed that out of 106.5 million Filipinos, 24.5 million–nearly one-quarter of the population – still do not have access to electricity. Among those who do, 82.3% get their electricity from the grid, 3.3% from mini-grid access, and nearly 3% from stand-alone solar power. The use of clean fuels for cooking has increased (53%), but improved cooking stoves remain low at 0.9%. The share of renewable energy to final energy consumption, however, is still quite low at 23%.

Through its Access to Sustainable Energy Program (ASEP), the EU has allocated over PHP 3 billion in grants to help the Department of Energy (DOE) address some of its gaps. The Renewable Energy Access for Off-grid Communities and Households (REACH) is an ongoing initiative to reduce the vulnerability of poor rural communities to the adverse impact of climate change, through renewable energy. It does so by enhancing social welfare, disaster resilience, and economic growth in the remote communities

[7] https://www.sdg.iisd.org/news/iea-retd-policy-brief/

of Northern Samar through innovative, scalable, and sustainable renewable energy technologies and systems.

With that in mind, the strategy taken by the government to address the barangay drinking water problem for the past few decades is known as the "demand-responsive" approach. The basic principle of this approach is to treat water as an economic good. The idea of "water as an economic good" has value to users, who are willing to pay for it. Consumers will use water so long as the benefits from the use of an additional cubic meter exceed the costs hence incurred. In addition to the role the government is required to play in providing water services, the demand-responsive approach has also been seen as a solution to increasing the sustainability of water services by increasing community participation in and ownership of the water services.

6.0 Methodology

This is a case study involving small samples to systematically investigate; describe and characterize the Marubay water supply system to look into the household water use patterns of 'representative' case study families. However, these households were not randomly selected and the small sample size (a total of 16 families) do limit the conclusions that can be drawn. The survey and data collection methods employed are in Annex A: structured questionnaire.

The study begins with a review of related literature, a review of recent studies, and reports by People In Need (PIN) through the REACH Project to assess what has already been done. These studies identified challenges and deficiencies affecting the renewable energy sector and outlined interventions to relate such to resolve concerns relating to the operation and maintenance (O&M) of the Marubay water supply system's renewable energy development and deployment.

Key Informant Interview (KII) using a 'structured interview' at the sample's home was initiated alongside the PIN enumerators for the specific purpose of obtaining research-relevant information on the study's research objectives. The KII consisted of qualitative in-depth interviews that would shed light on patterns in responses and the range and nature of the samples regarding their water use and perception, performance which focuses on select variables. The five thematic areas were the following: 1) socio-demographic information, 2) existing water source for the household, 3) existing sanitation facilities and hygiene practices of the household, 4) operation and maintenance of water facility, and 5) economic status of the household. The independent variables are socio-demographic information, existing water sources for the household, existing sanitation facilities, and hygiene of the household. The dependent variables are related to the water operation and maintenance, scheme, modes of water supply, causes of water insufficiency, etc.

To complement the KII, a focus group discussion (FGD) involved fifteen (15) barangay officials having homogeneous characteristics, and shared their individual views (Annex B: FGD Guide Questions). The researcher made sure to keep the discussion going and would intersperse with probes whenever necessary to elicit insightful responses. These responses helped uncover patterns, trends, relationships, and structure in the information that may otherwise be difficult to capture; see or hear differences as raw responses from the questionnaire.

7.0 Data Processing and Analysis

Descriptive or qualitative analysis was used to identify and count the presence of a certain characteristic, e.g. finding out households' frequency of water use, satisfaction, contribution to social, economic welfare, and good governance. The responses were subsequently transcribed verbatim. After transcription, responses were grouped by the question and then collated to identify common answers.

Collected data included manual cleaning, editing/cross-checking from the encoded results of questionnaires. The data was tabulated, collated, categorized, and analyzed. It was then classified into patterns to arrange and conclude results. The data was summarized in a meaningful way to show patterns that might emerge from the data; analyzed to detect common responses and interpreted together to determine trends and tendencies in the answers of the respondents. In this case, only descriptive statistics were performed. Triangulation was likewise employed to compare data using different methodologies that hopefully will converge, resulting in answers that reinforced each variable that will ensure reliability and validity of data. After encoding and verifying the results, the statistical tables generated summarized the data in a meaningful way using frequency counts, averages, and percentages to show patterns that might emerge. Finally, the tables were analyzed to detect common responses which were then collated and interpreted together to determine trends and tendencies in the answers of the respondents.

8.0 Ethics statement

Participants were informed about the background information of the research, giving special emphasis on the rationale of the survey and their rights to refuse participation without consequences.

9.0. RESULTS AND DISCUSSION

9.1 The Project Area

Batag is an island in the Philippines under the jurisdiction of Laoang in the province of Northern Samar. The island lies within the Philippine Sea (see map). The island has an approximate area of 33.96 square kilometers, or 13.11 square miles, and roughly has a coastline length of 42.09 kilometers or 26.15 (httpa://www.philatlas.com).

Batag is best known for the lighthouse at its northeastern point, built-in 1905 during the early part of the American colonial period. The lighthouse is historically significant because along with the Capul Island lighthouse, it guided sea vessels coming into the archipelago from the Pacific Ocean via the San Bernardino Strait, one of the most traveled waterways in the archipelago. However, the lighthouse is in a state of disrepair and dysfunctional but the 30.8-meter lighthouse is still complete and undamaged. For the most daring and brave, one can ascend its steps providing a commanding view of the San Bernardino Strait and the surface area of the Pacific Ocean.

Marubay, with 298 households, is one of the six Barangays in Batag Island (Cabadiangan, Candawid, Pangdan, Binaganbangan, and Napotiocan) has a natural pool (inset, below) that is just a few minutes walk from the barangay center. The lagoon has crystal clear spring water that flows from a source into a nature pond before flowing off in the adjacent mangrove forests and into the sea. The spring in vernacular is called *Tina*-e (entrails) as the lagoon was used to clean slaughtered cattle in the olden days.

The spring (inset) served as an alternative that provides the native Laundrette, where residents gather to do the week's wash while youngsters play and swim around. Aside from its pool, Marubay has a water service facility and street lights from solar energy.

Barangay Napotiocan—gateway to the Batag island—has a church where the image of Our Lady of Salvation is enshrined and is regularly visited by worshippers. The image is believed to be miraculous, and an increasing number of devotees testify to the numerous favors granted by the Virgin Mary whose image is depicted with two young children by her side.

9.2 Characteristics of the case study samples

The case study families were summarized, including the age, education, sources of income, household or component members, monthly water fees, and access to water sources **(Table 1).**

Table 1. Key socio-demographic characteristic of case study samples

Sample	Age	Education	Source of income	House hold size	Monthly water fee (Php)	Types of water sources
1	58	Teacher	Teaching	3	700.00	Water system, deep well, purified water
2	61	Elementary	Farming	6	400.00	Water system, deep well, purified water
3	31	High School	Labor	4	104.00	Water system, deep well, purified water
4	45	High School-level	Farming	8	500.00	Water system, deep well, purified water
5	41	High School	Labor	5	300.00	Water system, deep well, purified water
6	24	College-level	Farming	6	0	Water system, deep well, purified water
7	54	Elementary	Farming	9	900.00	Water system, deep well, purified water
8	66	No formal training	Farming	6	240.00	Water system, deep well, purified water
9	63	High School	Farming	7	0	Water system, deep well, purified water
10	77	Teacher	Pension	3	312.00	Water system, deep well, purified water

11	51	High School	BHW	6	400.00	Water system, deep well, purified water
12	69	Elementary	Kagawad	0	150.00	Water system, deep well, purified water
13	59	High School	Store/BHW	8	262.00	Water system, deep well, purified water
14	50	College	Housewife	5	75.00	Water system, deep well, purified water
15	73	Elementary	Kagawad	7	0	Water system, deep well, purified water
16	68	Elementary	Teacher	5	0	Water system, deep well, purified water

The unit of analysis included the Housewives, Barangay Kagawads (Barangay Councilmen), Barangay Health Workers, and Teachers. Eighty-seven (87%) percent of samples claimed to live in own-land and house, while 13 percent had no housing of their own. The age of the study population was between the age group of 24 to 60 years old and 61 to 77 years old, with an average of 55 years old. Regarding marital status, most of the samples were married; a widower and one sample (6.25%) separated. Worthy of notice was 25% of family members were teachers; college graduates (50%), college-level (25%), and the least were in high school and elementary.

9.3 Water source of the sample households

Traditionally, the samples have indicated that they obtained water from an unprotected deep well in the barangay: one was used for drinking and the other for washing purposes. These water sources were frequented daily for collecting drinking, cooking, washing clothes, bathing, livestock washing, etc. Since 2010, the samples (93.75%) reported that they had access to the water service facility that was owned and operated by the barangay. The samples (62.5%) rated the quality of water as “good” source for drinking and washing. A noteworthy fact was that the sample population (100%) claimed that the schedule of water supply was “seasonal”, i.e. water delivery to the households was not 24/7 due to the limited capacity of the storage tanks. The samples (100%) reported that the scheduled water supply to the residents was between 6:00 am to 9:00 am **(Table 2).**

Table 2. Existing water source for the household

Code	Variable	Frequency	Percent %
B-1	Household access to drinking water		
	Yes	15	93.75%
	No	1	6.25%
B-2	Ownership of the main water source		
	Community	16	100%
B-3	Quality of water		
	Good	10	62.5%
	Acceptable	6	37.5%
B-4	Time for water to reach home		
	Before 6.00 am	16	100%
B-5	Where to get water for gardening and livestock		
	Distance	1	6.25%
	Time/convenience	15	93.75%

B-6	Drinking water are stored in containers	16	100%
B-7	The quantity of water enough for drinking and cooking purposes		
	Yes	13	81.25%
	No	3	18.75%

At the barangay hall, the barangay secretary announced through a public address system (inset) that was strategically set up in the community to inform the households of the availability of water.

Most of the samples described that they buy drinking water from the water purifying station owned by a resident in the barangay. It should be noted that the barangay allowed other residents without water connections to buy or share water from their neighbors with access to the barangay water service facility. The samples reported that the community water system was only used for cleaning, washing, cooking, and toilet flushing. Further, the samples argued that there was no regular or fixed time of water supply by the barangay water supply system. They had to store in containers such as plastic pails or drums so that they can use water anytime they need it. The sample population (100%) has no taps or water faucets inside the house, rather the water meter was connected to a long flexible hose to supply water to the containers.

9.4 Barangay sanitation facilities and hygiene practices

Sanitation was being promoted by the Barangay Health Workers (BHWs) as a public health condition related to clean drinking water and adequate treatment and disposal of human excreta and sewage. Preventing human contact with feces was part. As in handwashing, all the sample population (100%) reported handwashing with soap after going to the latrine and before eating. The rating (100%) was not necessarily in that order but was done in the basin or using the hose connected to the water meter. Containers were used to store drinking water inside the house, and water in the storage tanks was chlorinated **(Table 3)**.

Table 3. Existing facilities and hygiene practices of the household

Code	Variable	Frequency	Percent %
C-1	Type of sanitation facility in the household		
	Pit latrine		
	Pit latrine with concrete slab	16	100%
	Pour flush latrine		
	Flush septic tank		
	Nothing		
C-3	The household practice of handwashing	16	100%
	Before the start of cooking		
	Before start eating		
	After going to the latrine		
	After working outside		
	After handling children’s feces		
C-4	How is done		
	In the tap		
	In the basin	16	100%

	Outside the basin		
	How does the household keep drinking water in the house?		
	In a bottle inside the house with cover	16	100%
	In a bottle inside the refrigerator		
C-5	Is tap water treated in the main tank?	16	100%
C-6	If yes, how is it treated		
	Putting chlorine in the tank	16	100%

The most common (100%) reported sanitation technology and approach that existed among the samples was a pit latrine. A pit latrine collects human feces in a hole in the ground. Urine and feces enter the pit through a drop hole in the floor, which is connected to a squatting pan.

9.5 Barangay solid waste management

Solid waste was practiced by the residents. The most common form of solid waste management was segregation. The sample population (100%) reported that they were required to divide solid waste into dry and wet. The barangay collected all dried solid waste (non-biodegradable) while wet (bio-degradable) were retained at home for the household to dispose of. In keeping with the Ecological Solid Waste Management Act, or R.A. 9003 and the R.A. 8749 or the Clean Air Act, the barangay strictly adhered to the law that prohibits and penalizes open burning. The barangay maintained and practiced good sanitation to protect the community's vulnerability to waterborne diseases by collecting non-biodegradable solid wastes every end of the month.

However, it was noted that the natural lagoon was cluttered on the sides with empty shampoo plastic wraps, used plastic bottled water, plastic cups, and polyethylene products (inset). These are non-biodegradable materials that will pollute and contaminate the pristine waters of the lagoon and feed into the shoreline.

The surveyed families (100%) reported having energized homes that come in from the power lines of the NORSAMELCO. However, the supply of energy was only from 4:00 pm to 12:00 midnight—this is typical for off-grid communities. A large proportion of the samples owned appliances such as a refrigerator; television; radio emergency lights. A small proportion of the sample population owned electronic gadgets such as laptops, cellular phones, motorboats, and motorcycles. The motorcycle was ranked as the most common form of transportation.

9.6 Operation and maintenance of water facility

The operation and maintenance of a water supply system describes the activities needed to run the system in order to ensure that it continues to provide the necessary service. The overall aim of operation and maintenance was to ensure an efficient, effective, and sustainable water service facility. The barangay water service facility charged water users' a 'rateable' value using a water meter installed in individual homes. The water user was billed for the amount of water they consumed. The samples' calculated average monthly bill was PhP267.00 per month. The sample population (100%) expressed gratification that the average amount they paid was significantly lower compared to their previous expenses for hiring labor to collect water from deep wells **(Table 4).**

Table 4. Operation and maintenance of water facility

Code	Variable	Frequency	Percent %
D-1	How much does the household pay for the connection of the water systems?		
	Php267.00 per month	16	100%
D-2	Who usually maintains the water facility which your household uses for drinking water?		
	Barangay water committee	16	100%
	Nobody		
D-3	Who is responsible for repairs of the water facility when it breaks down?		
	Water committee	16	100%
	Nobody		
D-4	Do you see a need for the present water supply conditions to get improved?		
	Yes	12	0.75%
	No	4	0.24%
D-5	Which option is desirable for you if the present water supply conditions are improved to obtain a community water supply system?		
	Water committee	16	100%
	Purok leaders		
D-6	Would your household be willing to pay a user fee for the improved facility?		
	Yes		
	No	16	100%
D-7	Are you aware of the role of renewable energy in the local government of the water system?		
	Yes	16	100%
D-8	Where did you learn about renewable energy solutions for water systems?		
	Barangay officials	16	100%
D-9	What do you think are the potential benefits of renewable energy for the barangay water service facility?		
	Environmental benefits	5*	31.0%
	Local socio-economic benefits	16*	100%
	Reduce greenhouse gas emissions	2*	12.50%
	Improve energy security	16*	100%
	Cut energy costs for households	16*	100%
	Help alleviate energy poverty and contribute to growth in jobs	14*	87.50%
D-15	Overall assessment of the water supply system		
	Very satisfied	14	87.50%
	Somewhat satisfied	2	12.50%
	Total	16	100%

*multi responses

The connection fee for the barangay-managed water supply systems was PhP 2,000.00, with a reconnection fee of PhP 300.00. The sample population reported a rare case that a water user was unable to pay for the monthly dues. The samples argued that they made sure to apportion money for their monthly water dues to avoid default.

The operation and maintenance of the water facility falls upon the barangay utility workers who are tasked by the barangay council to be responsible for the repairs. If the system needs repair and it is not within the ambit of the barangay utility workers, none less than the barangay chairman undertakes the work.

Moreover, the sample population was asked to rate the potential benefits of rural renewable energy for the barangay water service facility (Table 4). They all rated (100%) on the following variables: a) improved local socio-economic benefits, b) helped alleviate energy poverty and contribute to the growth of jobs, and c) improved energy security. The lowest rating was on environmental benefits (31%), and greenhouse gas emissions (12.50%).

Overall, the barangay water service facility was rated “good” (87.50%) by the samples. A small proportion (12.50%) stated that they were “somewhat dissatisfied” because the supply of water was done by schedule.

9.7 Economic status of the household

The sample population (100%) interviewed reported self-employment, and employment as an economic activity. Common challenges to unleashing the potential of the community included low productivity (no livelihood opportunities); under-investment in agriculture and fisheries which was the resource of the community, lack of off-farm rural employment; lack of adequate infrastructure; and limited or no access to services, including financial services **(Table 5)**.

Table 5. The economic status of the household

Code	Variable	Frequency	Percent %
E-1	Main sources of income		
	Farming	7	43.75%
	Labor (construction)	1	6.25%
	Salary from employment	6	37.5%
	Pension	1	6.25%
	Housewife	1	6.25%
E.2	The costliest thing in the household expenses in a month		
	Food	16*	100%
	Medicines	16*	100%
	Other daily expenses	16*	100%
E-6	Is there good governance in the water supply system		
	Yes	16	100%
	No		

*multi responses

Forty-four (44%) samples maintained that they were engaged in farming; followed by employment (37.5%) as a teacher, barangay council member, and barangay health worker. The costliest things the household must cover was discovered to be medicine and other living expenses. Finally, the samples expressed or manifested approval of the good governance demonstrated by the barangay in the water system management.

9.8 Water and poverty impact the social and rural livelihoods

Water is an essential element for human health, nutrition, and agricultural production, and enables job opportunities in numerous key sectors across the community. People require water for a wide range of activities essential to their livelihoods, including both domestic (drinking, washing, cooking, and sanitation) and productive needs (vegetable gardening, livestock, etc.) Supplying water for these different needs has contributed to poverty alleviation in the barangay. There is either too much rainfall in a short period resulting in flood and loss of property, or too little rainfall resulting in drought. In these myriad ways, water is directly linked to poverty–making access to water a means to ending poverty.

Before the Marubay water supply systems, the sample population claimed that their livelihoods were often dependent on adequate water supply, and their experience before the supply of water has affected their livelihoods. Access to water is vital to ensure the community obtains sufficient, clean, and easily accessible water sources. Local demand for water may continue to increase, as the number of residents increases. Sustained operation of the water supply will allow residents to open opportunities for social and economic welfare. As an offshoot of the water service facility, a barangay resident has opened a water purifying business sourced from this facility. This suggests that there is an increasing demand for water in the community in the future.

10. Main Solar Water System Component

The Marubay water supply system solar energy pumping system is composed of several PV (photovoltaic) modules. Solar cells are the building block for solar panels. Each solar cell has two or more specially prepared layers of semiconducting material that produce direct current (DC) electricity when exposed to sunlight. The DC is collected by the wiring in the panel. This DC is converted to AC by using an inverter and this AC is used to run the AC submersible pump that pumps water whenever the sun shines, stored in overhead water tanks. The output of the solar power system varies throughout the day, and with changes in weather conditions. The photovoltaic module, the power source for solar pumping, has no moving parts, requires no maintenance, and lasts for decades. A properly designed solar pumping system will be efficient, simple, and reliable.

Marubay's main components of the solar water systém are the following:

1. **The Source**: The water sources were deep wells (drilled) below the storage tank using submersible AC motor pumps. The pump can recharge at a rate that is equal to or greater than three gallons per minute (inset photos).

2. **The pump**: This is the heart and soul of the solar water pumping system. The submersible AC motor pump set was drilled onto the source. The pump produced a unique combination of flow and pressure; with a combination of performance characteristics.

3. Photovoltaic (PV) panels: The photovoltaic modules or panels made up most (up to 80%) of the cost of the system. The size of the PV system was directly dependent on the size of the pump, the amount of water that was required (m³/d), and the solar irradiance available. A panel was rated in watts of power it can produce with a sufficient number of modules in series and parallel producing the required PV array power output.

4. Mounting structures and tracking system: To enhance the performance of the water pumping systems, the PV modules were mounted next to the storage tank on steel structures and appropriate design, which can withstand a load of modules and high wind velocities. The support structure is fixed and welded.

5. Controller: The controller matches the input power available from the solar panels, and was set up below the storage tanks. It provides low voltage protection, where the system was switched off if the voltage was too low or too high for the operating voltage range of the pump thus increases the lifetime of the pump and reducing the need for maintenance. The control panel included an inverter, which changes the DC from the solar panels into AC for the pump. The panel and inverter were sized accordingly to accommodate the inrush characteristic of the AC motor.

6. The water distribution system: PVC pipes in combination with black polyethylene piping were used (1.5 diameters) to connect to the metered water system of households. This component used a conduit that conveys water from the deep well to the storage tanks and from the storage tanks to the access points, households.

7. Water meter: Measures the amount of water consumed by the household that passed through a certain point per unit of time using this device. It will be read off by the barangay water utility attendant and used the readings to determine the bill to be paid by the water users.

8. Battery charger. An additional device has been added to the basic components to provide electricity to convert into stored chemical energy for storage in batteries by running an electric current through it. The battery charger is beside the batteries in the control panel.

Photovoltaic modules should last 20–25 years. This is dependent on being maintained (keeping it clean from bird droppings, or debris, and securely mounted), and protected from strong winds, lightning, and storms, and falling objects such as tree branches.

The submersible pump should be expected to last about 10 years more or less, while the maximum life of the rechargeable batteries is a one-year plus. The other electronics and controls with little electrical maintenance. The system is inspected at least once per week checking the pumping rate, operation of the controller, condition of PV modules, tanks, wires, and pipes (for leaks/corrosion). Another important aspect to consider is system security. Can the PV modules be secured properly or will they be stolen? It is obvious that without a functioning PV module, the whole system is worthless. The PV modules are one of the most expensive components of the system and should be protected from theft. The PV modules in Phase 1 were located behind the Barangay Hall while Phase 2 was on the east side of the barangay.

Figures 1 and **2** show the mechanism of the solar-powered pumping working system.

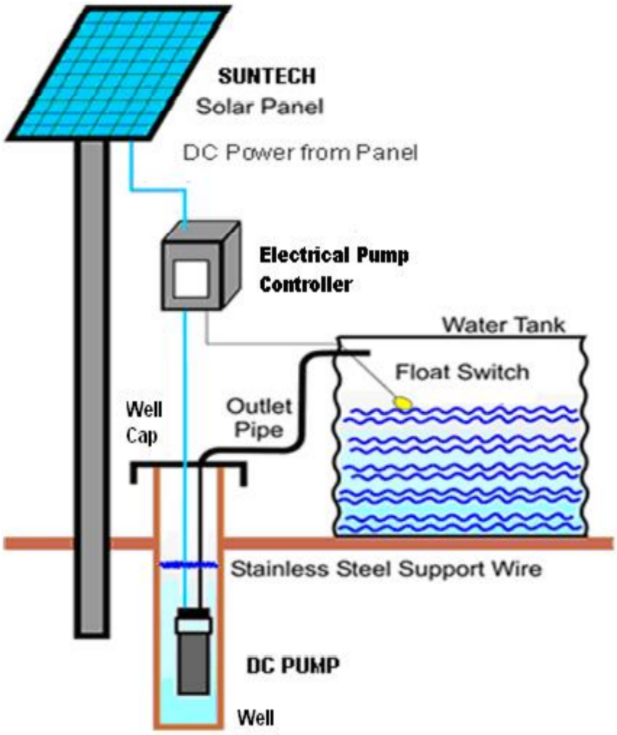

Fig. 1. Mechanism of the solar energy pumping system

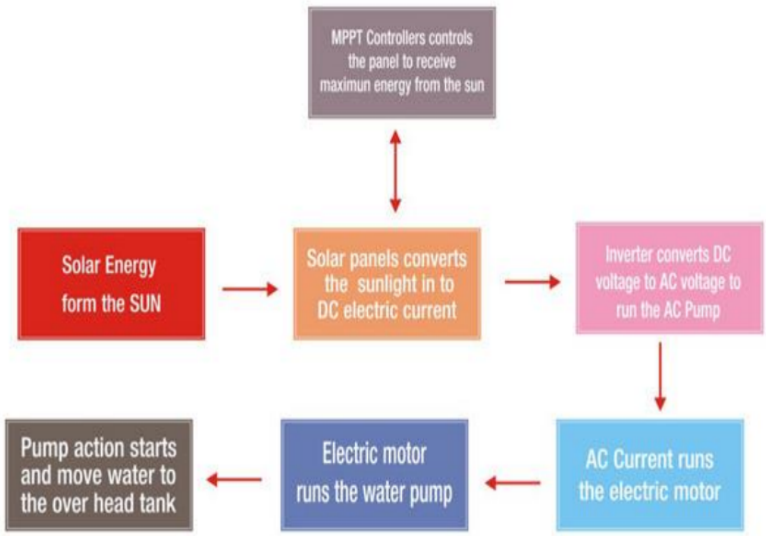

Fig. 2. Solar energy pumping working system

Source: Adopted from Ratterman W., and Cohen J., Garwood A.

10.1 Benefits of Solar Water Pump

- Use for community water supply system
- No fuel costs
- Simple, reliable and easy to install, and low maintenance
- Unattended operation with low operating cost compared to diesel pumps
- Where there are cloudy weather solar water pump systems have a storage tank to store excess water constant maintenance.

10. The leadership of Marubay community-managed water system

The Marubay rural renewable energy model for water supply projects has been in service for 10 years. It is the only renewable energy initiative in Northern Samar that employs a solar energy water pumping system. The challenge is "how one perceives and defines the performance and sustainability of the water system projects is somewhat more complicated than one might imagine". The current status of the water system is its capacity to deliver clean water service to water users. "There are several approaches used to determine which factors are most critical to water supply systems' sustainability", said Whittington (1993)[8], arguing "this approach will provide insight into the many factors during renewable energy planning, design, installation, operation, and maintenance that affect the sustainability of the water system, as well as the actions taking place during the ongoing operation and maintenance stage of the water project", he added.

The Marubay water supply system is an engineered solution that operates through the social cooperation of the community. This contributes to better outcomes for each resident that would not be achieved through entirely individual efforts. Barangay Chairman Mendoza's expertise and knowledge in the area of solar energy allowed him to establish a strategic reliable network of equipment suppliers (in Manila) that was difficult to replicate by anyone in the barangay. The barangay chairman developed this network long before setting off the Marubay water service facility. He managed a private rural renewable energy water system in Marubay, as well as in Cabadiangan, Batag (as claimed by one sample during the household interview). According to Mr. Mendoza, "developing a network of suppliers was one critical factor for the sustainability of the renewable energy". The focus group interview remarked that there exists a link between technical adequacy (i.e. embodied by the barangay chairman), community support and participation, and the involvement of councilwomen members who played significant roles in the success of the Marubay water service facility. Addressing these factors during the project process and taking advantage of the potentials of rural renewable energy have increased and improved the supply and delivery of water to the community.

The concern facing the Marubay water system is leadership succession, at which point there is a need for the barangay council to come to the realization that current and future success is heavily based on having the right leaders in the right roles at the right time and with the right skills. With the barangay chairman's last term of office, they desperately need to identify, select and train people who could be proactive and disciplined about orchestrating succession processes to continue the water system and yield sustainable results. Leadership succession planning is an "urgent" or "important" priority to sustain the projects. It is mandatory for the trained barangay utility workers to have some understanding of the solar water system and its components, the electrical system and plumbing, and how all of these function together in order to determine what the real cause of a problem is, and make repairs that solve that problem so it does not happen again.

[8] Water resources issues in the developing countries. Water Resources Research 29 (7):1883-1888

By its very nature, succession takes years to bear fruit. At this point, it is imminent the barangay chairman identifies and trains existing barangay utility workers who embody his skills as part of a transition—a period in which such a change or shift is happening. The potential gains from doing leadership succession in the barangay council for new leadership to succeed would go far beyond the obvious result of having a reliable, steady pipeline of leaders ready to step into new roles.

11.0 Water Governance

11.1 Water Governance Challenges

11.1.1 Economic, political, and environmental change

Water governance, according to Rogers & Hall (2003), "relates to the range of political, social, economic, and administrative systems that are in place to develop and manage water resources and the delivery of water services at different levels of society". Moench (2003), supports the view of Rogers (2003) that "water governance is much more about how decisions are made (i.e. how, by whom, and under what conditions decisions are made) than the decisions themselves". Simply put, water governance is the set of systems that control decision-making about water resource development and management.

Water governance challenges are invariably complex. The barangay's fundamental challenge is to continually establish systems of water governance that take account of and adapt to the community, socioeconomic, and environmental conditions that are characterized by uncertainty, variability, and change. It is just not possible to have functional operation and maintenance strategies and plans that will solve all water management problems now and well into the future. Instead, the water governance capacity of the barangay must be developed (i.e. information systems, water users' platforms, and local regulatory mechanisms, capabilities, and conflict resolution systems) to enable the community to respond to and adapt to uncertainty, variability, and change that could be local, short or long term, political, economic or environmental.

The achievement of effectiveness and efficiency in the delivery of barangay water services should be given greater importance by the barangay council. The conservation of the integrity of barangay water ecosystems using good governance principles that also impact positively on levels of poverty and take explicit account of the risks and uncertainties of climate change is an even greater challenge for the barangay. It is reasonable to assume that Marubay's improvements to water governance are a necessary part of the solution to the specific challenges that fall within this link of water ecosystem management and poverty reduction within the context of climate change.

To govern the water resources and services of the barangay has profound impacts on people's livelihood and the sustainability of water resources. Convenient access to water is, for many rural people, a matter of daily survival, or can help to break the vicious circle of poverty. Improving water governance is therefore essential to alleviating poverty, which the barangay has made good progress.

The following five principles of good governance were adopted to measure Marubay water supply system's good governance[9]. The participants of the focus interview were asked to give their view on the following principles:

[9] https://www.pubs.iied.org.

1. **Community Participation**. The barangay council revealed there was direct participation of stakeholders in decision-making, represented by the community in the planning stage of the water system. The decision to ask users' fee of PhP1.00 per container or PhP52.00 per cubic meter was a determination by the community. This decision was reached without third-party facilitators (INGOs) to help them identify, mobilize, organize and inform stakeholder groups.

2. **Responsiveness.** The barangay council averred that they attended to the needs of the community whenever concerns were brought to the fore. Along with this, efficiency was treated invariably to produce desired results with little or no waste of time and resources as a reaction over issues of the community. For instance, when a repair is undertaken on the system they make sure there is the optimal usage of the equipment and time to reduce or avoid buying new parts if it could be repaired or remedied.

3. **Effectiveness & Efficiency**. The Barangay Council was quick to act to make an immediate effect on community needs about the water system. It was worthy of attention that the barangay chairman and the council find a way to improve outcomes, by doing something very differently to improve the delivery of the water system. Efficiency was demonstrated by the Council's exertion to ward off wastage of materials, efforts, money in order to produce the desired result. A case in point, the barangay chairman claimed that he attended to do the work whenever a problem arises with the water system. This assertion was supported by the water users.

4. **Open and transparent**. All transactions that the barangay committed, in particular, the water system operation and maintenance were legitimate and open. The barangay treasurer maintained that individual records of all transactions of the water systems were kept. Collection from water fees was deposited in the bank for safekeeping. The treasurer provided the Council with a monthly financial report of transactions. The barangay council has stated that the barangay treasurer was authorized to deposit and/or withdraw barangay funds associated with the barangay development.

5. **Rules-based**. The barangay council, particularly the barangay chairman revealed that they adhered to rules-based decision-making. Local water good governance was tied to prescribed regulation in detail adhering to a set of policies, or rules. The council further abided by the principles of morality; about right and wrong in barangay dealings and accordance with the standards for right conduct.

12.0 Socio-Economic Alleviation

Water and poverty are inextricably linked. Lack of safe water and poverty are mutually reinforcing; access to consistent sources of clean water is crucial to poverty reduction. According to the World Health Organization (WHO), safe drinking water from a source less than 1 kilometer (.62 miles) away and at least 20 liters (5.28 gallons) per person per day[10].

The operation of the Marubay water supply system has provided residents access to water which played an important role in ensuring equitable, reliable, and productive community. In addition to being an essential element for livelihoods such as agricultural production, nutrition, and human health, water enabled job opportunities such as the setting up of one water purifying station in the community

[10] Health through safe drinking water and basic sanitation," World Health Organization, last accessed October 2, 2014, http://www.who.int/water_sanitation_health/mdg1.

which the water used comes from the barangay water service facility. In addition to being an essential element for livelihoods such as agricultural production, nutrition, and human health, water has provided appropriate occasions for an enterprising resident to set up a water purifying station in the community in which the water used comes from the barangay water service facility. The water quality test for Phase 1 and 2 was in 2017 and was not carried on. Records of the test result from the Rural Health Unit (RHU)—Laoang and the barangay was damaged during previous typhoons. The RHU claimed that the quality testing was done only for the water refilling station.

13.0 Community Involvement & Ownership

Water is recognized as a human right that "entitles everyone to sufficient, safe, acceptable, physically accessible and affordable water for personal and domestic uses". The Marubay residents' acceptance of the water project was an important factor in the reliable operation and maintenance of the water system. In the planning phase, community consultations were held to determine their willingness to embrace rural renewable energy technology. Community participation is a quintessential factor in rural renewable energy development and encourages the furtherance of more-human centered approaches in rural energy planning practice.

For other barangays inclined to develop and deploy renewable energy, it is necessary to conduct an "inventory of technical know-how" to consider local skills, materials, and labor to estimate how the community could be involved in the installation, operation, and maintenance of the water system. It is also generally a good idea to contact the local government officials and make sure that they are accepting of the solar system and aware of what it is being used for. Solar-powered water systems are gaining ground, particularly in the country, but rarely are they installed without the funds and supervision of INGOs. REACH and Malteser International are just a few of the INGOs advocating for renewable energy. There are significant upfront costs and community training required for the successful implementation of the system. International NGOs will usually be involved in the initial phases of the project, including design, installation, and training needed to operate and maintain the systems. One best practice that has been the driver for rural renewable energy development is the acknowledgment of the indispensable role of the INGOs in this case.

In Marubay, the community ownership was key to the longevity of the water system—which has been 10 years in operation. The community takes pride in its water system and gained a sense of ownership from the service it provides. The fees collected from water users were used to maintain the facility and to upgrade the system as needed, with funding assistance from an INGO for Phase 2 of the barangay water supply project. To strengthen policies and processes on rural water, the barangay may explore the possibility of creating a Barangay Water and Sanitation Association (BAWASA). BAWASA is a local organization of water supply and sanitation beneficiaries whose objective is to own, operate, and maintain (Level I, II, or III) water system and sanitation facilities in the barangay. BAWASA falls under the Localized Customer Service Code (LCSC)[11], a document that serves as a binding social contract and agreement between the BAWASA and its members for the provision of water service to its members. The Code will serve as the guide of the association in operating and managing the water system. In 2007, Philippine-Australia Community Assistance Program (PACAP) facilitated the creation of BAWASA in several rural barangays in San Antonio.

Marubay water system may not go through a consequence of conflict between off-farm livelihoods with water users for agricultural production. The community has no rice fields (predominantly

[11] https://www.ombudsman.gov.ph/UNDP4

coconut-based farming system) that may compete with the use of water for household consumption. The water service facility was not designed for irrigation, but largely for household use. A scenario that would cause water conflicts can be divided into two groups of controllable and uncontrollable factors. The conflict in the studied area may arise from 'water scarcity, and 'mismatched' size of the water tanks capacity as uncontrollable factors. Furthermore, the conditions that may result in consequences of water conflicts can have socio-economic and agro-environmental aspects. To anticipate these potential causes of water conflicts in the studied area in the future, the most logical solution is to further toughen the barangay's good governance in water resources management.

Water systems and livelihoods are entwined as water plays an important role in people's livelihoods. Capability, equity, and sustainability are the fundamental means and ends of sustainable rural livelihoods. Thus, water plays an important role in many aspects of a community's livelihoods. Access to an adequate water supply has enhanced a wide range of community assets, both tangible and intangible.

14.0 Sustainability of Renewable Energy System

The long-term costs and ability of the Marubay renewable energy systems conformed to local changing demands and were considered into the feasibility of the systems. This process was also significantly related to the ability of the barangay to adapt to changing demands. And more importantly, the greatest concern for the barangay that shifted to renewable energy water systems was the availability of a skilled person (Pepe Mendoza) who designed, installed, and maintained the systems; otherwise, the facility will not last long. The barangay chairman was taking action to train barangay utility to operate and maintain the renewable energy systems; the barangay treasurer controls and manages the income from the water service facility which they could raise themselves. The profit earned from selling systems can be reinvested in new systems.

15.0 Summary, Conclusion, Challenges, and Lessons Learned

The Marubay rural renewable energy technologies have created considerable opportunities for promoting rural development. Such systems have directly improved the social and economic welfare of the community. Thus, contributing to achieving the Sustainable Development Goals 6 ("clean water and sanitation for all") of providing rural people with safely managed drinking water.

Sustainable project replication is a project's ultimate measure of success or failure. Local institutions (i.e. the local government), including the barangay, should continually seek to explore the dynamics of rural renewable energy technologies for water application which has demonstrated it can operate reliably with minimum maintenance. For replication to be substantial, several factors must be adequately addressed: the local population must know the technology and what it can provide; quality equipment and services must be available locally, and must be able to pay for the technology. For the last reason, access to applicable financing mechanisms is the key. The barangay water service facility is a tailor-made approach unique to this barangay with community participation that has ensured an efficient sense of accountability and ownership of the initiated project for sustainable and convenient access to the water supply system.

The rural renewable energy systems are technically reliable and economically viable with the support of the community. Renewables are more capital intensive than a conventional system, but conventional systems have higher operating costs than renewables. The National Renewable Energy Program (NREP) outlines the policy framework under Republic Act 9513 for the strategic building blocks to help the country achieve the goals in developing renewable energy resources, stimulating investments in the renewable energy sector, developing technologies, and providing the impetus for national and local renewable energy planning that will help identify the most feasible and least-cost renewable energy development options. Reliability, often associated with low investment in PV, maintenance costs, must also be considered. Small island grids, for instance, in San Antonio, and Capul, are an opportunity for investors in renewable. With investors setting up development and deployment of renewables would lead to the eventual shift of outdated infrastructures and of outmoded conventional forms of electricity generation that powers energy supply systems that rely on diesel. Off-grid islands in Northern Samar can potentially deploy renewable energy to secure, cheaper and cleaner power.

Institutional factors and the local infrastructure need to be considered in the use of renewable energy technologies. The Department of Energy (DoE), Department of Finance (DoF), National Economic and Development Authority (NEDA), provincial government, local government units, and barangays must collectively provide support in planning, funding, deployment, local capacity building, and institutional arrangements.

The 2018-2023 Provincial Development and Physical Framework Plan (PDPFP) of the Provincial Government of Northern Samar included several renewable energy-related programs and projects. The PDPFP strategy is to invite local, national, private investors, including international NGOs supporting renewable.

Preventive maintenance steps should be included in project planning from the start. Maintenance activities can often be funded with revenues from proceeds of users' fees. However, the lack of attention to institutional issues often leads to inadequate system maintenance and eventual system degradation to the point of failure. To avoid failure, a renewable energy water supply system must include realistic system sizing (projected demand) and proper institutional controls from the start. Barangay planners must allow for an anticipated rise in water demand, a reasonable and realistic water fees structure acceptable to the users for water consumption, and a means to meet future maintenance requirements. Only then can rural renewable energy deliver long-term and reliable service to the community it serves. With proper attention to institutional details, these systems can provide many years of reliable service. Rural renewable energy also offers the potential to generate new and important business activity in the barangay by creating jobs through local retail sales and services.

As cited in Output 2 of the REACH project, it aims to achieve PIN's extensive experience with the application of the Market system development approach in different Asian countries, including the Philippines. REACH will support the creation of new value chains as well as the strengthening of existing business models in promising sectors of the local economy. By removing constraints that impede the poor from participating in markets (e.g. developing and introducing sustainable solutions to help lower the financial barriers households and businesses face in accessing these technologies), the project will contribute to lasting and systemic changes in the market system for RE technologies and target communities ability to participate and benefit from these. Through the capacity building workshops, coaching, marketing and application of innovative renewable energy appliances and systems, the project will promote inclusive growth, job creation, and sustainable livelihood opportunities".

Finally, key lessons learned from these renewable energy experiences were:

The sample families (100%) asserted they were aware that solar energy for water systems contributed to climate change. In 2015, typhoon Nona (international name: "Melor") made landfall in Batag island, bringing about devastation to the community and nearby barangays. Marubay, with its solar energy water system, recovered readily from adversity as water services were instantaneously restored. This event allowed the community to adapt more successfully than others to that adverse event, prompting them to 'bounce forward' and continue their activities even to this day.

Below is a summary of main points from the study:

- Marubay renewable energy initiative was mainly driven by local opportunities and concerns mainly oriented to serve local demand for water.
- The application of renewable energy products, equipment, and systems at the barangay conserves the natural environment and resources because solar energy consumption is a better alternative to using fossil fuels.
- The solar energy for the water system produces low greenhouse gas (GHG) emissions which is safe for use and promotes a healthy and improved environment for all forms of life; and helps conserve the use of energy and natural resources.
- Barangay support and training are crucial, particularly leadership succession.
- System ownership and responsibilities need to be established early on.
- Maintenance is critical for long-term system survival.
- The local government should strive to work with the industry sector to conduct project installations while developing local skills' capability and infrastructure for system maintenance.
- RE works best when it develops functional linkages with core rural businesses (in agriculture, forestry, green tourism, etc.). RE has to "have a job" within the rural economy to create new employment opportunities.
- Capacity building and community empowerment have accumulated skills in the new industry, their capacity to learn and innovate was enhanced.

The research found that the barangay water service facility has three main factors that contributed to the success or failure of the project. These are Community, Technology, and Economics. Marubay demonstrated that solar energy technology (a clean, simple and indigenous source of energy) is appropriate to any community, especially off-grid island communities that can respond to, or solve the need for energy. The light and heat harnessed from the sun's energy using PV cells convert sunlight into electricity; thus, the solar thermal is used to produce energy to power the water pump and/or light bulbs. Renewables are pollution-free and cause no greenhouse gases (GHG) to be emitted with far-ranging environmental and health effects; reduced dependence on foreign oil. This appeared to imply that renewable energy may have a connection to provide a reducing disaster vulnerability and impacts, tackling climate change by reducing GHG emissions and safeguarding economic growth and development.

16.0 Recommendation

The study yields general recommendations to enhance capacities for relevant institutional development affecting renewable energy. The recommendations are directed at the provincial (Northern Samar), municipalities, and barangays, as follows:

1. Creating an enabling environment in the municipality of Laoang by providing an incentive to barangays that will gradually shift for small-scale renewable energy technology; investment advisory and business support services; and facilitation or assistance to barangay officials in navigating corporate or commercial transactions with equipment suppliers, to stimulate renewables development and deployment.

2. Setting up desks at the local government units to assist barangays that will shift to the development and deployment of renewable energy technologies. The local government units

should develop a webpage as a platform to answer Frequently Ask Questions (FAQs) from local government units and other interested groups.

3. Develop communications messages that are compelling. Messages (through radio plugs, brochures, tarpaulins, etc.) about renewables should be carefully differentiated by segment, i.e. public officials, the general public, communities, including school children. An identified barrier to the widespread use of renewable energy technologies is the lack of understanding in the public, at a political level, and within the industry sector about the benefits, opportunities, and capabilities of renewable energies.

4. Use of social marketing to ensure commitment by local government officials to the Renewable Energy Act No. 9513 that provides a legislative framework for renewable energy development and deployment in rural communities. A strong commitment is a factor for nurturing a healthy and sustained market for renewable energy development in the countryside.

5. Identifying and developing internal people (RE technicians in the municipal, and barangay) with the potential to fill a technical position in the management, operation, and maintenance of renewable water energy systems. The provincial and local government units appear to lack know-how in the area of renewables. For Marubay, which has demonstrated the application of renewable energy, a leadership succession strategy must not be overlooked by the barangay council. Trained successors must be able to continue and be fairly ready to do the job (short-term successors) or seen as having longer-term potential (long-term successors) to assist other barangays that will develop and deploy renewable technology.

6. The implementation of the Barangay Ecological Solid Waste Management Project through the collection of non-biodegradable solid wastes from households should transcend beyond households. The barangay needs to protect the lagoon by reminding people who frequent it to avoid the disorderly accumulation of rubbish in the lagoon to protect this biodiversity resource of the community, as well as the mangrove forests.

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