SOLAR PHOTOVOLTAIC (PV) HOME SYSTEM: ADAPTABILITY AND TECHNOLOGY AWARENESS AMONG USERS IN OFF-GRID AND ON-GRID AREAS IN NORTHERN SAMAR

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Abstract: *This study was conducted to come up with baseline information on how users from on-grid and off-grid areas in the province of Northern Samar response with the use of Solar PV Home system technology. A descriptive correlational research design was employed to analysed data from 93 randomly selected respondents coming from off-grid and on-grid areas of Northern Samar. Results revealed that user respondents in this study has high level of awareness to the operation and maintenance of the solar PV system, has high level of satisfaction and adaptability to the technology. Regression analysis revealed a significant relationship exists between the user's level of awareness and profile on educational attainment as well as monthly family income. The level of satisfaction was found to be significantly related to the users attendance to trainings/seminars related to PV system and the location. Level of user's adaptability to the technology revealed a significant relationship with the age and the number of PV trainings/seminars attended. Operational problems on replacement parts, poor battery performance, high battery cost as well as the non availability of local technician and to include the poor quality materials were the experiences encountered by the user's respondents with the use of solar PV home system. It can be concluded as a whole that using PV system offers significant benefits and advantages to the part of the users as manifested by the high level of satisfaction and adaptability.*

Key Words: *Solar PV Home System, awareness, satisfaction, adaptability.*

1. INTRODUCTION:

Renewable energy systems have been increasingly utilized in most developing countries as means to rural electrification. Solar Photovoltaic System took advantage as it uses solar energy which is virtually free and supply is unlimited. With these characteristics, and with the massive global campaign in climate change mitigation, solar Photovoltaic (PV) technology grew faster than any other fuel in 2016 (IEA, 2017).

A Solar Home System (SHS) is a type of PV system, typically a small standalone solar electrical system with a solar panel, a charge controller/regulator, a battery, and belt-in load applicability for simple, low powered electrical appliances such as lights, small radio, mobile phone charger, portable DVD player and a small TV. Its basic function is to utilize the sun's energy to provide electricity for various electrical applications in a household.

Province of Northern Samar has four (4) island municipalities with a limited power supply. These municipalities were dependent on NPC-Small Power Utility Group power plant that operates on a limited hours of operation per day. To add the fact that the province is constantly experiencing power interruption, this scenario serves as a driver for the local residence to invest in solar technology for home use. In addition, it was late in the year 2010 when the Philippine Department of Energy (DOE) in partnership with University of Eastern Philippines Affiliated Renewable Energy Center for Samar Island started promoting SHS by way of energizing un-energized barangays in the province of Northern Samar (UEP-AREC). As of to date, the DOE and UEP-AREC had energized one thousand one hundred seventy one (1,171) households using SHS technology in the province. With these existing PV installations, the researchers believed that it helped a lot in technology diffusion more so that many households in the adjacent areas who do not qualify as a DOE's program-beneficiary provided their own solar home system.

In the study conducted by Farhar and Coburn (2000) revealed that main barriers of PV adoption is that residents are not willing to install PV systems until they receive more information (e.g. how it works, how they reduce electricity costs and other users' experience). Result of this study will encourage future users to adopt and patronize solar PV technology as Wamukonya N. and Davis M. (2001) mentioned that satisfied households may also encourage others to acquire SHS. Conversely, low user satisfaction may also discourage other residents who have not adopted SHS from purchasing the equipment. In view of the previous studies and with the researchers' desire of attaining at

least majority of households in the province utilizing SHS as a supplemental source of electricity, this study documents the current adaptability level and degree of satisfactions of SHS users as well as identify the problems encountered by the current users to serve as a guide for the future SHS adopters. Specifically this study aimed to:

- determine the profile of Solar PV Homes system users in Northern Samar in terms of Age, Educational Attainment, Monthly Income, Mode and Cost of system Acquisition, Number of Solar PV technology Trainings attended;
- determine the profile of the users' Solar PV systems in terms of Size/ Capacity of PV system, Number of years of utilization, Degree of Utilization(Primary Source , supplemental, standby), Location(off-grid or (on-grid Areas), Completeness of Installation;
- determine the Users' level of awareness on Solar PV Home System (SHS) operation, management and maintenance;
- determine the level of users' satisfaction and adaptability on Solar PV Home System technology;
- determine the relationship between the PV-SHS users' profile, PV-SHS profile and the level of technology awareness;
- determine the relationship between the PV-SHS users' profile, PV-SHS profile and the level of PV User's satisfaction;
- determine the relationship between the PV-SHS user' profile, PV-SHS profile and level of users adaptability to PV technology; and
- identify problems encountered with the use of PV-SHS technology.

2. METHODOLOGY:

2.1. Research Design & Variables

A descriptive correlational research design was employed to realize the objectives of the study. Awareness, satisfaction and adaptability to the Solar PV Home system technology of the user respondents were the dependent variables considered in this study. Independent variables include profile of the respondents and the profile of the owned PV system. PV User-respondents profile includes age, educational attainment, monthly family income, mode of PV system acquisition, acquisition cost and number of PV seminars and trainings attended. PV systems profile includes PV size/capacity, date of installation, degree of utilization, location and completeness of installations. It was conceptualized that the above mentioned independent variables affect the user levels of awareness, satisfaction and adaptability to the solar PV home system technology.

2.2. Population and Sampling

The Solar Home System (SHS) users-respondents considered in this study was taken from two separate groups. Updated numbers and names of SHS adopters in the province were taken from the UEP- AREC database (result of previously conducted inventory on RES users). User adopter includes PV user coming from on-grid areas or areas where NORSAMELCO is available and respondents from off-grid areas where government's SHS beneficiaries and other private individual who owned SHS can be found. Using Slovens' Formula, at 10% margin of error, a sample size of ninety three (93) respondents was computed as sample of this study. Eventually, users-respondents in this study were randomly selected.

2.3. Research Instrument

The interview instrument utilized in this study consisted of four parts. The first part gathered information on respondents' personal profile and Solar PV systems' profile; the second part was used to gather information on respondents' level of awareness on solar PV technology operation, management and maintenance; the third part gathered information on respondents' satisfaction and adaptability in using solar PV technology and the fourth part were information on respondents' problems encountered with the use of PV-SHS.

2.4. Scoring and Interpretation of Data

Level of awareness. The categories of PV technology awareness were coded as, Very Much Aware - 5 points; Aware - 4 points; Undecided- 3 points; Unaware- 2 points; and Very Much Unaware- 1 point. Each statement was also categorized using the weighted mean and interpreted as follows:

Range	Interpretation
4.20 – 5.00	Very High
3.40 – 4.19	High
2.60 - 3.39	Moderate
1.80 – 2.59	Low
1.00 – 1.79	Very Low

Level of Satisfaction. Level of Solar PV Technology user-respondents' satisfaction depends on their agreement to the statements provided. For each statement, a five point scale was provided for indicating whether the statement applies to the respondent. There were five options which were scored as: Strongly Agree – 5; Agree – 4; Neutral – 3; Disagree– 2; and, Strongly disagree – 1. Further, each statement was categorized by computing the weighted mean and was interpreted as follows:

Range	Interpretation
4.20 – 5.00	Very Satisfied
3.40 – 4.19	Satisfied
2.60 – 3.39	Moderate
1.80 – 2.59	Unsatisfied
1.00 – 1.79	Very Unsatisfied

Adaptability. Level of adaptability to the technology of user-respondents depend on their agreement to the adaptability statements provided. For each statement, a five point scale was provided for indicating whether the statement applies to the respondent. There were five options which were scored as: Strongly Agree – 5; Agree – 4; Neutral – 3; Disagree– 2; and, Strongly disagree – 1. Further, each statement was categorized by computing the weighted mean and was interpreted as follows:

Range	Interpretation
4.20 – 5.00	Very High
3.40 – 4.19	High
2.60 – 3.39	Moderate
1.80 – 2.59	Low
1.00 – 1.79	Very Low

2.5. Data Gathering Procedure

Data gathering was performed with the use of the interview instruments made. Prior to the actual data gathering, the said instrument was pre-piloted in adjacent province to test the content validity and consistency. The said instrument was presented to other solar PV experts for comments and suggestions.

3. RESULTS AND DISCUSSION:

3.1. Profile of the Respondents

Table 1 presents the profile of the Solar PV user- respondents considered in this study. The user profile includes: age, educational attainment, monthly family income, mode of solar PV system acquisition, acquisition cost and number of solar PV Trainings/seminars attended.

Survey results showed that majority of the respondents have ages between 30 to 60 years. Most number of respondents representing twenty-nine percent or 27 belongs to an age bracket of 40 to 49 years of age. This was closely followed by respondents belonging to age brackets of 30 to 39 and 50 to 60 years of age with twenty three respondents each representing 24.7% of the total.

Distribution of the PV user-respondents according to their educational attainment revealed that most number of user respondents have college degrees represented by 31 respondents or 33.3 % of the total. The least number of respondents representing 7.5% of the total has elementary degree. The respondents' monthly family income of the PV user respondents considered in this study showed that most number of the respondents appeared to have a monthly family income of 5,000 pesos to 9,999 pesos represented by 33 respondents or 33 percent of the total. This was followed by 22 respondents or 23.7% of the total, with less than 5,000 pesos of monthly income. This means that majority of the respondents have monthly family income of less than 10,000 pesos reflective of the fact that these respondents were able to acquire PV Home system only through government interventions. They were just required to put up a required amount as force savings for the maintenance of their systems. On the other hand, there were 14 respondents or 15.1% of the total that has a monthly income of 20,000 or over.

The mode of PV systems acquisition revealed that 47 or 50.5% of the respondents acquired their PV system through government grant. They were just required to put up a required amount that will serve as savings for the maintenance of their individual system. Results further showed that 46 or 49.5% of the respondents acquired their PV system through personal resources.

Table 1 further showed the respondents acquisition cost of their PV home system. The data showed that 68 or 73.1 percent of the total respondents spent less than 20,000 pesos to acquire their PV home system. Sixteen (16) or 17.2 percent spent 20,000 to 39,999 pesos while only 5 and 4 respondents spent 40,000 to 99,999 pesos and over 100,000 pesos, respectively.

As to the number of PV home system seminars or trainings attended by the user respondent , results revealed that majority of the respondents represented by 58 or 62.4 percent were not able to attend any seminar/trainings related

to solar PV home system. Only 33 or 35.5 percent of the total were able to attend once or twice and only 2 respondents attended more than 3 seminar/ trainings related to solar PV home system.

Table 1. Profile of the PV-SHS Users – Respondents

Respondent's Profile	Frequency	Percent
AGE		
less than 20	1	1.1
20 to 29 year old	4	4.3
30 t0 39 years old	23	24.7
40 to 49 years old	27	29.0
50 to 60 years old	23	24.7
Over 60 years old	15	16.1
Total	93	100.0
EDUCATIONAL ATTAINMENT		
Elem. Level	10	10.8
Elem. Grad.	7	7.5
High School Level	15	16.1
High School Grad.	13	14.0
College Level	17	18.3
College Graduate	31	33.3
Total	93	100.0
MONTHLY INCOME		
less than 5k	22	23.7
5k to 9999	33	35.5
10k-14999	8	8.6
15k to 19999	16	17.2
20k and over	14	15.1
Total	93	100.0
MODE OF ACQUISITION		
Govt Grant	47	50.5
Privately Owned	46	49.5
Total	93	100.0
ACQUISITION COST		
less than 20K	68	73.1
20k to 39999	16	17.2
40k to 99999	5	5.4
100k and over	4	4.3
Total	93	100.0
NUMBER OF PV TRAININGS/SEMINARS ATTENDED		
0	58	62.4
1 to 2	33	35.5
3 or More	2	2.2
Total	93	100.0

3.2. Profile of the Solar PV Systems

Table 2 presents the profile of the Solar PV Home Systems owned by the respondents considered in this study. As shown in table, the distribution of the respondents according to the capacity of their installed solar PV system revealed that majority of the respondents represented by 52 or 55.91 percent of the total has an installed PV capacity of less than 100 watts. Twenty nine or 31 percent of the total respondents has a PV capacity ranging from 100 to 300 watts and only 12 respondents or 12.9 percent of the total with an installed PV capacity of greater than 300 watts.

The distribution of the user-respondents according to year of PV systems installations was also presented. Data showed that majority of the respondents represented by 65 or 69.89 percent of the total had their PV system installed between year 2014 to 2015. Fourteen respondents or 15 percent of the total had their PV systems installed between years 2012 to 2013 and year 2011 or earlier, respectively. The table further showed that majority of the respondents represented by 50 or 53.76 percent utilized their PV system as primary source of electricity. Thirty four or

36.56 percent of the total respondents used their PV system as supplemental source while only 9 or 9.68 percent of the respondents utilized their PV home system as a standby source of electricity.

Table 2. Profile of the PV System

Profile of PV System	Frequency	Percent
SIZE/PV CAPACITY(Watts)		
Less than 100	52	55.91
100 to 300	29	31.18
greater than 300	12	12.90
Total	**93**	**100.00**
YEAR INSTALLED		
2014-2015	65	69.89
2012-2013	14	15.05
2011 or earlier	14	15.05
Total	**93**	**100.00**
DEGREE OF UTILIZATION		
Primary	50	53.76
Supplemental	34	36.56
Stand-by	9	9.68
Total	**93**	**100.00**
LOCATION		
Offgrid	59	63.44
Ongrid	34	36.56
Total	**93**	**100.00**
COMPLETENESS OF INSTALLATIONS		
Complete	80	86.02
Partially Complete	11	11.83
Incomplete	2	2.15
Total	**93**	**100.00**

Data on the location of the respondents installed Solar PV Systems showed that majority comes from off-grid areas represented by 59 or 63.4 percent of the total respondents. Thirty four or 36.56 percent were in on-grid areas.

Completeness of solar PV system installations was categorized as complete, partially complete and incomplete. PV system installation is considered complete if the heart of the PV system, the charge controller, is present and it can be used for other appliance aside from lightings. It is considered partially complete if charge controller is present but it can only be used for lighting applications. On the other hand, PV system is considered incomplete if charge controller is missing. As shown in table 2, majority of the PV system user-respondents considered in this study have complete PV systems installations or set up. Only 2.15 percent, represented by 2 respondents have an incomplete PV system and 11 or 11.83 percent have a partially complete PV system.

3.3. Level of Awareness to Solar PV Home System Technology

Table 3 presents the level of awareness to the solar PV technology operation and maintenance of the user-respondents. Generally, results revealed that a grand mean of 3.70 interpreted to have High level of awareness.

Among the areas on solar PV technology, awareness on "The solar panel converts sunlight into electricity" had the highest weighted mean of 4.39 interpreted as very high. This was followed by "The brighter the sunlight, the more electricity is produced" with a weighted mean of 4.32 interpreted to have a very high level of awareness. This means that the PV user-respondents in this study have higher level of understanding on the technical know-how of PV system operation. However, moderate level of awareness was found out on the correct orientation and tilt angle of the Solar PV module with weighted mean of 3.23 and reflected to be the lowest. This means that the installer-supplier failed to orient the user on the benefit of correct position of the solar PV module or the installer itself lacks the knowledge on the correct PV module installation *("incorrect PV module orientation will result to under utilization of the power generated by the system").*

This further implied that the user-respondents have not been taught or oriented on the overall installation of the PV System, knowledge acquired was mainly on the operation and maintenance of the PV system. This result reflected the practice that the supplier/installer conducted technical training of the PV system only after complete installation of the system focused on the operation and maintenance of the PV system. Only the designated technicians were trained on the Design, Installation, Operation and Maintenance of PV Solar Home Systems.

Table 3. Users' Level of Awareness to Solar PV Home System technology

Statement	Weighted Mean	Interpretation
1. The solar panel converts sunlight into electricity	4.39	Very High
2. The brighter the sunlight, the more electricity is produced. Clouds and shade reduce the amount of sunlight.	4.32	Very High
3. Controller makes the batteries last longer and the system safer.	4.12	High
4. The system is provided with a safety protective devises/fuse to protect against fires.	4.08	High
5. Batteries lose their capacity if they are discharged too much too often.	4.03	High
6. White LED (WLED) lamps are used in the solar lighting system. They provide a lot of light without using a lot of Electricity.	4.01	High
7. Keep the insulated battery box in a safe place where children can't reach them	3.98	High
8. When a battery is overcharged it may be damaged because it can get too hot and it loses water rapidly.	3.97	High
9. Trees, bushes and plants grow and thus can cause shadows or full shading of the solar panel, reducing system power generation.	3.94	High
10. More electricity is produced if the panel is pointed directly at the sun. The sun moves from east to west each day, and also moves north and south with the seasons.	3.94	High
11. Hazardous chemicals in the batteries. These chemicals may cause poisoning of people and animals.	3.91	High
12. A charge controller works like a valve on a rainwater collection system that prevents the water tank from overflowing.	3.86	High
13. Batteries lose water and capacity if too much electricity is passed to it from the solar panels.	3.81	High
14. Batteries may lose charge by itself if there is a lot of dust on the top cover between the terminals.	3.75	High
15. Batteries contain acid. This liquid can burn clothing and skin, and can cause blindness.	3.75	High
16. Batteries lose their capacity the hotter it is. They also lose capacity if it is very cold.	3.72	High
17. Explosion. Batteries produce hydrogen gas which Catches on fire easily.	3.65	High
18. Flooded type batteries must be filled by distilled water to replace the lost electrolyte during charging.	3.44	High
19. The hotter the panel/PV Module, the less electricity is produced.	3.40	High
20. The recommended PV Module orientation is due North facing south with a tilt angle of 10 to 15 degrees	3.23	Moderate
Grand Mean	**3.70**	**High**

3.4. User's Satisfaction

Table 4 presents the level of satisfaction of PV user-respondents included in this study. It was measured based on the respondent's agreement to the statements provided. Generally, results revealed that the user-respondents were satisfied on the performance of their Solar PV home system. This is manifested by the computed overall grand mean of 4.021 and is generally interpreted as "satisfied".

Data further showed that the respondents in this study posted a strong agreement on the statements: " *I am happy with what I am currently using for lighting; Solar PV home system is safe to use; Solar PV system can be considered as dependable energy source; and The amount invested with solar is justified with the benefits derived."* Strong agreement on the above mentioned statement indicated that they were very satisfied. On the other hand, respondent were found to be undecided on the statement *" Local technicians are easily available".* This was interpreted as moderate or neither satisfied nor unsatisfied reflective of the unavailability of local technician when needed as the primary concern of the user.

Table 4. Users' Level of Satisfaction to Solar PV Home System

Statement	W. Mean	Interpretation
1. I am happy with what I am currently using for lighting	4.65	Very Satisfied
2. Solar PV Home system is safe to use	4.51	Very Satisfied
3. Solar PV Home system can be considered as dependable energy source	4.32	Very Satisfied
4. The amount invested with solar is justified with the benefits derived	4.20	Very Satisfied
5. Solar Powered Lightings provide enough light to meet my needs	4.19	Satisfied
6. The installer/supplier has satisfactory after-sales service	4.06	Satisfied
7. My existing technical set up is excellent	4.00	Satisfied
8. I am proud that I use a solar powered lightings / my neighbours are impressed with me	3.70	Satisfied
9. The installer /supplier shows his technical skill and expertise	3.66	Satisfied
10. Local Technicians are easily available	2.92	Moderate
Grand Mean	**4.021**	**Satisfied**

Result of this study particularly corroborated with the findings of Aziz et al.(2009) that investigated and measured the satisfaction level of the consumers in eight areas of the SHS service namely: number of appliances supported, stability of electricity, quality of electricity, frequency of breakdowns, helpful information from the company, financing facilities of the company, and troubleshooting services. The responses indicated that most of the consumers were either satisfied or highly satisfied with the SHS they use in their homes or rural small businesses. It further implied that utilization of solar PV system is one of the highly dependable and satisfying renewable energy systems as corroborated by Aziz et.al. (2009), Linguet (2009) and Komatsu (2013) in their studies.

3.5. Adaptability

This section presents the level of user-respondent's adaptability to the solar PV technology. The level of the respondent's adaptability to the solar PV technology was determined based on their agreement to the provided adaptability statements. Table 5 showed that respondents generally have high level of adaptability to the PV technology. Very high adaptability was manifested by the respondent's willingness to learn more on solar PV technology with a weighted mean of 4.58. This is followed by the willingness to invest more on solar for possible upgrading and expansion. On the other hand, user respondents responded undecided on the statement "*Sometimes system troubles can easily resolved by the user itself*" was interpreted as moderate or neither high nor low level of adaptability. This means that owning a solar PV system requires assistance from technical people who will do trouble shooting, repair and maintenance. As a whole, user-respondents in this study became adjusted to the PV system operation even in a limited capability to manage its system as manifested by their strong willingness to learn more on solar PV technology and invest more for possible upgrading of the system.

Table 5. Users' Level of Adaptability to the Solar PV Home System technology

Statement	W. Mean	Interpretation
1. If I will be given a chance, I am willing to learn more on solar PV technology.	4.58	Very High
2. I am willing to invest more on solar for possible upgrading and expansion	4.33	High
3. I have plans for the possible battery replacements as scheduled.	4.06	High
4. I consider solar PV system to be expensive but not as expensive in using diesel/gasoline powered generator set	4.05	High
5. Load management is practiced during rainy and cloudy days to avoid systems shutdown.	4.04	High
6. Sometimes system troubles can easily resolved by the user itself.	3.31	Moderate
Grand Mean	**4.06**	**High**

3.6. Relationship between User Profile, User PV Profile and Level of Awareness to the Solar PV Home System Technology

The findings revealed a significant relationship between a respondent's profile on educational attainment, monthly family income and their level of awareness to the solar PV Home System technology operation and maintenance. Educational attainment of the respondents revealed to be highly significant as manifested by a 0.001 significance level and a beta coefficient of 0.347. This implied that for every positive unit increase in educational attainment of the respondents, there is a corresponding 0.347 increase in the level of awareness.

The monthly family income of the user-respondents revealed to have a significant relationship with the level of technology awareness as manifested by significance level of 0.002 and a beta coefficient of 0.478, implying that for every positive unit increased in monthly family income there will be a corresponding 0.478 increase in the respondents' level of awareness to the solar PV home system technology.

Results revealed that awareness of PV user on the system's operation and maintenance has something to do with the educational attainment as well as on their financial capacity. Moreover, access to internet and other source of information will surely increase the level of awareness to the technology. This finding corroborated with Vagela (1993) who concluded that people who are educated and have high income were aware of Solar products. Further, the results of this study also confirmed the results of the study conducted by Claudy et al (2010) on consumer awareness of distributed renewable energy in Ireland which stressed that men, older people, educated people and fully employed people were significantly more likely to have heard of such technologies and have higher awareness of renewable energy technologies.

Table 6a. Analysis of Variance for the test of Relationship between Users' Profile, PV System Profile and Level of Awareness

	Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**	**Interpretation**
Regression	13.406	11	1.219	3.415	.001[a]	Significant
Residual	28.905	81	.357			
Total	42.311	92				

Table 6b. Beta Coefficients for the test of relationship

Predictors	B	Sig.	Interpretation
Age	.013	.902	Not Significant
Educational Attainment	.437	.001	Highly Significant
Monthly Income	-.478	.002	Significant
Mode of Acquisition	-.212	.345	Not Significant
Acquisition Cost	.241	.089	Not Significant
Number of PV Training/Seminars Attended	.175	.127	Not Significant
PV System Capacity	-.125	.512	Not Significant
Date/Year of Installation	-.169	.121	Not Significant
Degree of Utilization	.124	.369	Not Significant
Location	-.076	.636	Not Significant
Completeness of Installation	.179	.095	Not Significant
a. Dependent Variable: AWARENESS			

Table 6b showed that there was no significant relationship existed between solar PV systems profile, namely: size of PV system, year of installation, degree of utilization, location and completeness of installation and the level of respondent's awareness to the Solar PV technology. This finding has partial disagreement with Vagela (1993) who mentioned other more important parameters from consumer point of view for solar products profile: product cost, awareness and availability, especially after sales service and number of service center.

3.7. Relationship between User Profile, User PV Profile and Level of Satisfaction to the Solar PV Home System Technology

Table 7b showed that among the user-respondents profile, only the number of PV trainings/seminars was found to have a significant relationship with the level of satisfaction to the Solar PV Home system Technology as manifested by a 0.012 significance level and a beta coefficient of 0.321. This implied that for every positive unit increase in the number of solar PV trainings/seminar attended by the respondents, there will be a corresponding 0.321 increase in the level of satisfaction. Reflected further that attendance to solar PV related seminars/training has a

significant relationship to the level of satisfaction by increasing the level of understanding on how a PV system works, knowing its capability, limitations and its maintenance.

Table 7b further showed that only location revealed to have a significant relationship with the level of PV user satisfaction as manifested by significance level of 0.047 and a beta coefficient of 0.355 implying that for every positive unit increased in the location of the PV system there will be a corresponding 0.355 increase in the respondents' level of satisfaction to the solar PV home system technology. It further revealed that the level of satisfaction of the user can be associated with the off-grid or on-grid locations of the PV systems. Solar PV system user in off-grid areas might have a more positive response and strong appreciation to the technology considering the absence of the power grid, considering solar being more appropriate than standby generating set and other conventional source of power supply in the off-grid areas.

Table 7a. Analysis of Variance for the Test of Relationship between Users' Profile, PV System Profile and Users Satisfaction

Model		Sum of Squares	df	Mean Square	F	Sig.
	Regression	6.176	11	.561	1.494	.150[a]
	Residual	30.441	81	.376		
	Total	36.617	92			

Table 7b. Beta Coefficients for the test of Relationship

Predictors	B	Sig.	Interpretation
Age	.066	.562	Not Significant
Educational Attainment	-.111	.443	Not Significant
Monthly Income	-.325	.053	Not Significant
Mode of Acquisition	-.019	.937	Not Significant
Acquisition Cost	.149	.338	Not Significant
Number of PV Training/Seminars Attended	.321	.012	Significant
PV System Capacity	.011	.957	Not Significant
Date/Year of Installation	-.145	.227	Not Significant
Degree of Utilization	-.176	.249	Not Significant
Location	.355	.047	Significant
Completeness of Installation	.140	.233	Not Significant
a. Dependent Variable: SATISFACTION			

Result of this study also strengthen the findings of Komatsu et al (2013) that households that achieved reduction in dependency with kerosene because of PV systems have higher user satisfaction. On the other hand, several independent variables do not show any statistically significant relationship with user satisfaction. SHS size has no impact on user satisfaction. This implied that if households have reasonable expectations and experiences associated with SHS size, then size may not be a determinant of user satisfaction. Furthermore, the year of use is not also a significant determinant of user satisfaction, which implies that the level of satisfaction neither deteriorates nor improves over time. The completeness of installations or the presence or the ability of the system to be used with other appliances other than lightings does not influence the user level of satisfaction. This finding corroborated with the result of study conducted by Komatsu et.al (2013).

3.8. Relationship between User Profile, User PV Profile and Level of Adaptability to the Solar PV Home System

Table 8b presents that among the PV user's profile, only the age and the number of solar PV trainings/seminars attended showed a significant relationship with the user's adaptability to the solar PV home system technology. The age of the respondents showed to have a 0.017 level of significance and a beta coefficient of 0.277. This implied that for a positive increase in age of the respondents, the level of adaptability to the PV technology would increase by 0.277. The numbers of PV trainings/seminars attended showed a significant relationship with the level of adaptability as manifested by the significance level and a beta coefficient of 0.344 implying that for every positive increase in the number of PV seminar/trainings attended, the level of user's adaptability to the technology would increase by 0.344. It further manifests that age of an individual as well as his/her attendance to trainings or seminars related to the solar PV technology has something to do with his/her becoming adjusted to the use of PV technology.

On the other hand, PV systems profile of the user respondents, namely: PV system capacity, year of installation, degree of utilization, location and completeness of installations, were found to be not significantly related to the adaptability to the solar PV home system.

Table 8a. Analysis of Variance for the Test of Relationship between Users' Profile, PV System Profile and Users Level of Adaptability to the Technology

	Sum of Squares	df	Mean Square	F	Sig.
Regression	7.284	11	.662	1.492	.150[a]
Residual	35.940	81	.444		
Total	43.224	92			

Table 8b. Beta Coefficients for the test of Relationship

Predictors	B	Sig.	Interpretation
Age	.277	.017	Significant
Educational Attainment	-.040	.783	Not Significant
Monthly Income	.000	.999	Not Significant
Mode of Acquisition	.111	.652	Not Significant
Acquisition Cost	-.179	.251	Not Significant
Number of PV Training/Seminars Attended	.344	.008	Significant
PV System Capacity	-.006	.979	Not Significant
Date/Year of Installation	-.006	.963	Not Significant
Degree of Utilization	-.088	.562	Not Significant
Location	0.085	.263	Not Significant
Completeness of Installation	0.105	.190	Not Significant
a. Dependent Variable: ADAPTABILITY			

3.9. Problems Encountered by Solar PV Home System Users

Table 9 presents the problems encountered by solar PV Home System users-respondents considered in this study. Results showed that the *availability of the replacement parts* revealed to be the most common operational problem of 38 or 40.8 percent user-respondents. This was followed by *limited power supply* being complained by 27 or 29 percent respondents. *The lack of knowledgeable technician* was the complaint of 24 respondents and 23 respondents complained for the *Power interruption during rainy days* as well as for the *difficulty in trouble shooting.* This finding corroborates with result in the study conducted by Linguet et al (2009) that stressed of the major drawback highlighted by the user client on low capacity batteries, poor performance of the system during rainy days and the lack of system maintenance.

Furthermore, for the problems on PV system component parts, 34 and 30 PV user-respondents complained on battery, and problems on lamps and other accessories, respectively. On system load management, 31 respondents were unable to practice load management and 24 of them lack of the basic knowledge on basic load management for PV system. For the maintenance of the PV system 21 of the respondents have problems on the very high maintenance cost of the replacement battery. Notably, it was also found out that low quality solar PV system materials/components were among the other problems encountered by 13 user-respondents in the study.

Table 9. Problems encountered with the use of Solar PV Technology by the user-respondents

Problem Statements	**Frequency**	**Percent**
OPERATIONAL PROBLEMS		
Power interruption during rainy day	23	24.7
Lack of available and knowledgeable PV technician	24	25.8
Limited power supply	27	29
Availability of replacement parts	38	40.8
Difficulty in trouble shooting	23	24.7
PROBLEMS ON SYSTEM COMPONENTS		
PV Module/Panel	3	3.22
Charge Controller	7	7.22
Battery	34	36.6

Lamps and other appliances	30	32.25
SYSTEM LOAD MANAGEMENT		
Users inability to practice load management	31	33.33
Lack of Knowledge on load management	24	25.8
MAINTENANCE		
Very high maintenance cost for Battery Replacement	21	22.58
OTHER PROBLEMS, please specify		
Low Quality Solar Components/Materials	13	13.97

4. CONCLUSIONS AND RECOMMENDATIONS:

Based on the findings of this study, the user-respondents were mostly of age bracket 40 to 49 years of age, with college degree, have monthly family income of 5,000 pesos to 9,999 pesos. Majority of the respondents acquired their PV system through government grants, spent less than 20,000 pesos to acquire their PV home system and were not able to attend any seminar/trainings related to solar PV home system.

Data on PV profile revealed that majority of the respondents have installed PV capacity of less than 100 watts that were installed between year 2014- 2015, utilized their PV system as primary source of electricity, and were located in off-grid areas and with complete solar PV systems set up.

Generally, user-respondents have high level of awareness on PV system operation and maintenance, highly satisfied with the system performance and with high level of adaptability to the PV SHS technology.

Tests of relationship between PV user level of awareness, satisfaction, adaptability and PV user profile and PV system profile were performed. Results revealed that there were significant relationship between respondent's profile on educational attainment, monthly family income and their level of awareness to the Solar PV Home System Technology operation and maintenance. On the other hand, profile of the PV system was not significantly related to the level of awareness of the respondents.

The number of PV trainings/seminars was the only user profile that found to have a significant relationship to the level of satisfaction to the Solar PV Home system Technology. Data further revealed that only location showed to have a significant relationship with the level of PV user satisfaction.

Among the PV user's profile, only age and number of solar PV trainings/seminars attended showed significant relationship with the user's adaptability to the solar PV home system technology. On the other hand, PV systems profile of the user respondents, namely: PV system capacity, year of installation, degree of utilization, location and completeness of installations, were found not significantly related to the adaptability to the solar PV home system technology.

For the problems encountered by the user-respondents, " *availability of the replacement parts*" appears to be the most common operational problem of complained by user respondents. This was followed by "*limited power supply"* and the "*The lack of knowledgeable technician"* . "*Power interruption during rainy days*" as well as for the "*difficulty in trouble shooting".*

The results suggest several policy implications for improving user satisfaction with SHS and adaptability with its operational features, thereby contributing to expanded SHS coverage in the long run. A reduction in battery replacements could be achieved not only through improvements in battery quality but also by providing households with better instructions on battery use. System load management must be properly introduced to the user. Furthermore, if SHS providers can provide brief guidelines for maintaining battery life and periodically monitor the pattern of battery use by SHS households, dissatisfaction with battery use will decrease. Wijayatunga PDC, Attalage RA(2005) shared experiences in Sri Lanka and stressed that providing households with training by service provider is helpful for maintaining the system.

Trainings and certification for a service provider be given attention by the concerned agency, e.g. TESDA and other institutions to encourage future adopters to go into solar PV technology competency skills training through a Competency Assessment and Certification System in the installation and maintenance of solar PV energy/power system. Availability of local competent and reliable solar PV technicians will surely improve the level of satisfaction and a much higher technological adaptation among users for sustainable operation, to further encourage individuals to take their part in saving the environment with the use of renewable energy technology.

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