A Report on

"Outcome Analysis of Pico PV Distribution in Sunamganj District, Bangladesh"

Submitted to

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Preface and Acknowledgements

This report is written for the academic internship of Department of Urban and Regional Planning (URP) and the United Nations of Development Programme (UNDP). The motivation behind the topic is based on our common interest for the intersection between the energy sectors and sustainable development allowing us to combine and utilize knowledge obtained through our coursework. Access to sustainable energy has emerged as an important topic on the global level, and it is often highlighted as essential for social and economic growth in developing countries. We wanted to shed light on this topic. Using the solar systems located in Sunamganj district as a key input for our analysis allowed us to gain insight into the renewable energy programme in Bangladesh. The work was interesting, but also challenging in terms of data collection and establishing a dialogue with Pico PV owners. There are a number of people that have contributed and supported our work.

Firstly, we would like to sincerely thank our supervisor, Nusrat Jahan Imu, for constructive feedback throughout the writing process. She was always available with advice and provided us with guidance and direction along the way. Secondly, we would like to express our great appreciation to Dr Md. Taibur Rahman, Project Manager, SREPGen Project, UNDP for invaluable insights into the sustainable renewable energy in Bangladesh. In this regard, we would like to extend our gratitude to all of our interviewees for their time and valuable input, which allowed us to incorporate first-hand insight into our report. Lastly, our gratitude goes to Professor Dr Shafiq Ur Rahman, Chairman, Department of URP, Jahangirnagar University for linking us with UNDP to do our internship.

Dhaka, July 15, 2019

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Introduction

Clean, reliable and affordable renewable energy is absolutely necessary for global development and especially to the developing countries. Renewable energy technology has often has been seen as an expensive item by the critics. Energy has a profound influence on human development, poverty, gender equality, health, food security and climate change. These aspects are linked directly or indirectly to each other and also influential to the social and economic development not only in the urban level also at the rural level. Renewable energy is still not a dependable source for rural electrification.

Pico PV has emerged as a concept of great significance in rural electrification. Pico PV is one of the Solar Home Systems (SHS), which could enable people in non-electrified areas to get access to modern energy systems and at the same time, it could be cost affordable and meet the small scale energy demand. Pico PV can be a dependable source for rural electrification because where the cost is not affordable or the energy demand is too low to be powered by Pico PV.

The application of Pico PV appliances is currently becoming increasingly global in nature, and this development is particularly noticeable in Underdeveloped and Developing Countries. This report aims to shed light on the current and future market of Pico- PV in Bangladesh and provide tentative suggestions to explain the observed development. The intention is to describe a development that is currently unfolding at an incredible speed and yet continues to occur somewhat below the radar (Kaplinsky, 2011).

Study Objective

- To identify the access to Pico PV (affordable and reliable energy services) for low-income people in the rural area.
- To analysis the present condition of Pico PV in the study area.
- To identify the Pico PV management related problems and provide recommendations for better management.
- To analyze the impact of Pico PV in a social and economic context.

Scope of the Study

Solar energy was the fastest growing component and continued to grow each year. Here is a list of factors that will make Solar Power one of the fastest growing energy sectors in the world increasing expensive and unreliable electricity supply. The rates of electricity prices are going up rapidly each year due to a combination of factors like higher costs of fossil fuels, increasing capital expenditure by utilities and privatization of power. The costs of Solar Energy has been decreasing rapidly over the last 2 years and has reached retail price grid parity in countries like Italy, Hawaii. Our government has provided strong support for the growth of this industry.

The main scopes of this study are:

1. Overviewing the existing solar condition of Study area.
2. The study will help to realize the present scenario and characteristics of selected Pico-PV and their consequent impact on the study area.
3. The study will also help to make a comparison between peoples demand and supply as well as address the importance of sustainable energy source to meet the ultimate demand of both present and future.
4. The study will help to provide some recommendation based on faced problem and peoples demand.

Limitation of the Study

In our study, we faced some problem. The issue of the solar panel (Pico PV) covers a large number of factors, which all didn't become possible to consider in this study. Some major problem faced during the study is

→ This type of study requires a lot of time to present successful research. But there is a lack of adequate time.

→ This research mainly discusses with the Pico PV only not all kind of solar panel.

→ Household people did not give proper information; sometimes they also gave wrong information.

Barriers of the Study

When collecting the data, there were some barriers/ obstacles which influenced the sample size for this study. The initial sample size was 200 but due to so many negative factors, the number of samples was reduced later. Some of the obstacles/barriers are as follows:

- Transportation has been one of the major obstacles during the study as there was no constant availability of transport mode it was very hard to move from one area to area quickly.
- The local accent of the language was also another major barrier, as 5 out of 6 team members were not used to the local accent, the time for collecting data from the individual sample were longer than the normal time.
- As the users of the Pico PV lives in the remote area, commute time was more than the data collection time each day.
- Home of the users was also far from each other, it was time-consuming when going to the house of one customer to the house of other customers.
- Another obstacle/barrier was some of the customers had moved to other places or villages or district.

Report Structure

The first part of the report describes the case in Sunamganj district (Chapter 2). After that chapter 3 is the review of the related literature on Pico PV and socio-economic impact assessment. The result of the research based on primary data collected from the field are described in the Primary Research (Chapter 5). Chapter 6 and Chapter 7 deals with the discussion on the findings and try to draw some recommendations. Finally, Chapter 8 presents the conclusions on the analysis of the findings.

Background Information of the Study Area

This chapter describes the current state of the Sunamganj district. The study areas are Dawarabazar, Jamalganj and Sunamganj Sadar Upazila.

Sunamganj District

Sunamganj is established as a district in 1984. The area of the district is 3747 sq. kilometres. There are 11 Upazilas in Sunamganj District. 10.38% of the total area is the urban area. Annual rainfall in Sunamganj District is 3334 millimetres. The average highest temperature is 33.2-degree Celsius, the average lowest temperature is 13.6-degree Celsius. Humidity ranges between 78% - 90%. 34% of total villages are covered by the Bangladesh Rural Electrification Board for the supply of electricity. The literacy rate is 35% in the Sunamganj district. The occupation in Sunamganj is mainly agriculture based. Total dependency on the occupation is 43.86%.

The Case Study

The study is conducted mainly on Three Upazilas. They are Dawarabazar, Jamalganj and Sunamganj Sadar. In this section, some of the cases of the Pico PV owners are given below.

Dawarabazar

Akhol Mia

Akhol Mia lives in Lokkhibao village of Dawarabazar Upazila of Sunamganj District. He is day labour. He bought a Pico PV one year ago. His Pico PV performances well. Bangladesh Rural Electrification Board line is also available in his house. He uses Pico PV during load shedding. His children use the Pico PV for reading purpose. He said that some people were interested in buying Pico PV.

Jamalganj

Tayeb Ali

Tayeb Ali lives in Bhimkhali village of Jamalganj Upazila of Sunamganj District. Tayeb Ali is a farmer. He has three children. They are going to school. Tayeb Ali has an alternative solar panel. He bought Pico PV mainly for his children. His children are using Pico PV for educational

purpose. Before using Pico PV they used another solar panel. He said that nowadays his children could complete their reading instinctively.

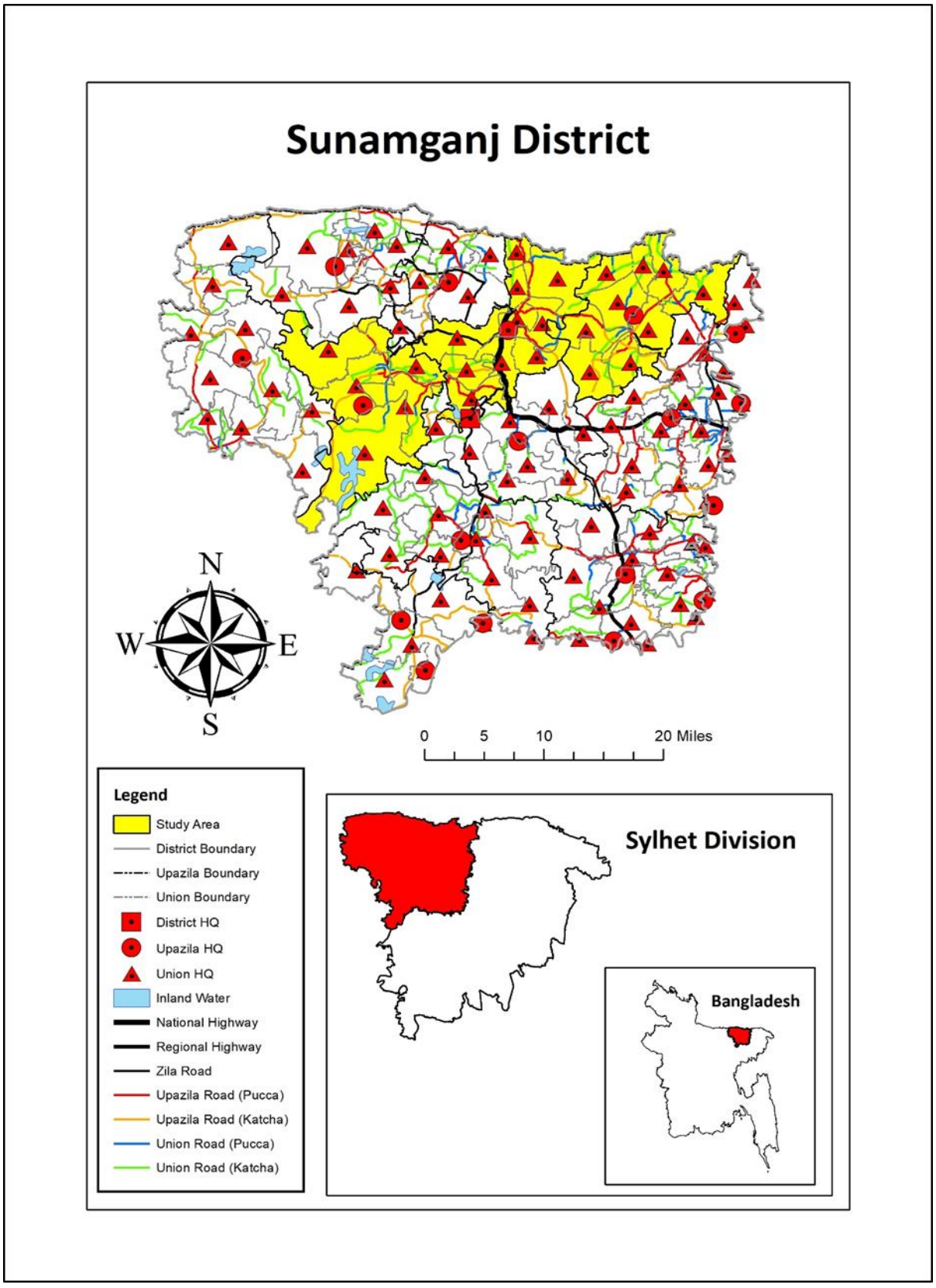


Figure: Sunamganj District. GIS Data Source: LGED, 2010

Shamola Rani Biswas

Shamola Rani Biswas lives in Hasnabaj village of Jamalganj Upazila of Sunamganj district. She is a housewife. Her husband is a Gram Police. She has two children. She has no electricity supply instead of Pico PV. Her Pico PV does not work well. After buying 3 months her Pico PV didn't support well. Service provider told her that Pico PV has 2 years guaranty. But now she can't contact the provider. She also said that her battery would be exchanged.

Sunamganj Sadar

Mrs Rokeya Begum

The maximum community of rural area of Sunamganj are very poor. Bati Sapela village situated at the Sunamganj Sadar Upazila. We met with five respondents of Bati Sapela village. One of them is Mrs Rokeya Begum. She is also very poor. She is a housewife. Her house is very simple. She is using only Pico PV. She has three children. Two of them are going to school. Her Pico PV is working for about 5 hours. Before using Pico PV Rokeya's children could not read spontaneously. But now they can read up to 11-12 AM. Before using Pico PV Rokeya needed about 1.5-2 L kerosene oil. But now she doesn't need. She told us that Pico PV solar freed them from the darkness.

Population

From Table, the demography of the Sunamganj district and the study areas are shown. Population, growth rate, the average household size, literacy rate and school attendance rate are collected from the Bangladesh Bureau of Statistics. Comparing the data collected from the Population Census conducted in 2011 and 2001. The population had increased by a significant number in Sunamganj district, Dawarabazar upazila, Jamalganj upazila and Sunamganj Sadar upazila.

The growth rate in those areas had also changed. While the growth rate of Dawarabazar upazila has increased from the previous census, the growth rate of Jamalganj and Sunamganj Sadar had decreased significantly. Although the overall growth rate of Sunamganj district had increased from the previous year. The average household size rate had decreased compared to the previous census.

The literacy rate and the rate of school attendance had also increased compared to the previous census.

Table: Demography of Sunamganj. Source: BBS, 2011

	Sunamganj	Dawarabazar	Jamalganj	Sunamganj Sadar
Population in 2011	2467968	228460	167260	279019
Population in 2001	2013738	179201	138985	367230
Growth Rate in 2011	2.02%	2.42%	1.84%	-2.67%
Growth Rate in 2001	1.66%	1.32%	2.58%	1.94%
Average Household Size in 2011	5.58%	5.35%	5.57%	5.57%
Average Household Size in 2001	5.76%	5.47%	5.87%	5.78%
Literacy Rate in 2011	35%	30.40%	32.50%	38.80%
Literacy Rate in 2001	34.40%	30.80%	29.60%	35.30%
School Attendance Rate in 2011	44.50%	47.20%	40.30%	48.80%
School Attendance Rate in 2001	31.30%	29.40%	28.50%	33.50%

Economy Outlook

According to the economic census conducted by BBS in 2013, the majority population in the Sunamganj district works in Wholesale and Retail Trade, Repair of Motor Vehicles & Motorcycles sector, Other Service Activities which are non-categorized and Accommodation and Food Service Activities (Hotel and Restaurant) comes in next. Manufacturing, Education, Human Health and Social Work Activities, Transportation and Storage, Financial and Insurance Activities follow the list. Total permanent establishment for economic activities in Sunamganj district is 50175 and total people engaged in the activity is 132802.

Table: Permanent Establishments and Total Persons Engaged by Major Economic Activity, and by selected areas. Source: BBS, 2013

	Sunamganj		Jamalganj		Dowarabazar		Sunamganj Sadar	
	Establishment	**Total People Engaged**	**Establishment**	**Total People Engaged**	**Establishment**	**Total People Engaged**	**Establishment**	**Total People Engaged**
Wholesale and Retail Trade, Repair of Motor Vehicles & Motorcycles	28422	50078	2191	4002	2628	3583	3279	5967
Other Service Activities	7607	15471	624	1211	787	1424	838	1781
Accommodation and Food Service Activities (Hotel and Restaurant)	3767	8932	89	224	408	947	636	1545
Manufacturing	3536	21535	142	610	432	1898	701	4396
Education	3447	19373	233	1151	322	1778	397	2382
Human Health and Social Work Activities	611	2007	41	145	23	43	129	694
Transportation and Storage	573	1119	87	120	39	69	93	227
Financial and Insurance Activities	412	3805	14	161	57	508	68	850
Public Administration and Defense, Compulsory Social Security	409	6748	29	208	48	430	64	3555
Administrative and Support Service Activities	350	854	11	30	32	54	80	218

	Sunamganj		Jamalganj		Dowarabazar		Sunamganj Sadar	
	Establishment	**Total People Engaged**	**Establishment**	**Total People Engaged**	**Establishment**	**Total People Engaged**	**Establishment**	**Total People Engaged**
Professional, Scientific and Technical Activities	311	586	10	16	31	40	55	131
Construction	243	664	17	57	0	0	17	107
Mining and Quarrying	136	513	0	0	22	98	46	140
Information and Communication	127	413	2	4	7	19	50	216
Arts, Entertainment and Recreation	112	200	0	0	12	17	12	68
Electricity, Gas, Steam and Air Conditioning Supply	67	387	4	15	2	27	18	80
Real Estate Activities	39	110	0	0	1	2	0	0
Water Supply, Sewerage, Waste Management and Remediation Activities	6	7	0	0	0	0	4	4
Total	**50175**	**132802**	**3494**	**7954**	**4851**	**10937**	**6487**	**22361**

Current Distribution of Pico PV

There are 1089 Pico PV in the Sunamganj district. Among them, 436 of them are in Dowarabazar, 316 in Sunamganj Sadar and 243 in Jamalganj. The distribution of Uninspected Pico PV in Sylhet division is shown in table and figure below.

Table: The distribution of Pico PV in the Sunamganj district. Source: List provided by the PO, 2018

District Name	Upazila Name	Number of Pico PV	Total
Sunamganj	**Dowarabazar***	**436**	1089
	Sunamganj Sadar*	**316**	
	Jamalganj*	**243**	
	Dakshin Sunamganj Sadar	40	
	Chhatak	21	
	Bishwambarpur	11	
	Dharampasha	9	
	Derai	8	
	Jagannathpur	4	
	Tahirpur	1	
***Denotes the study area**			

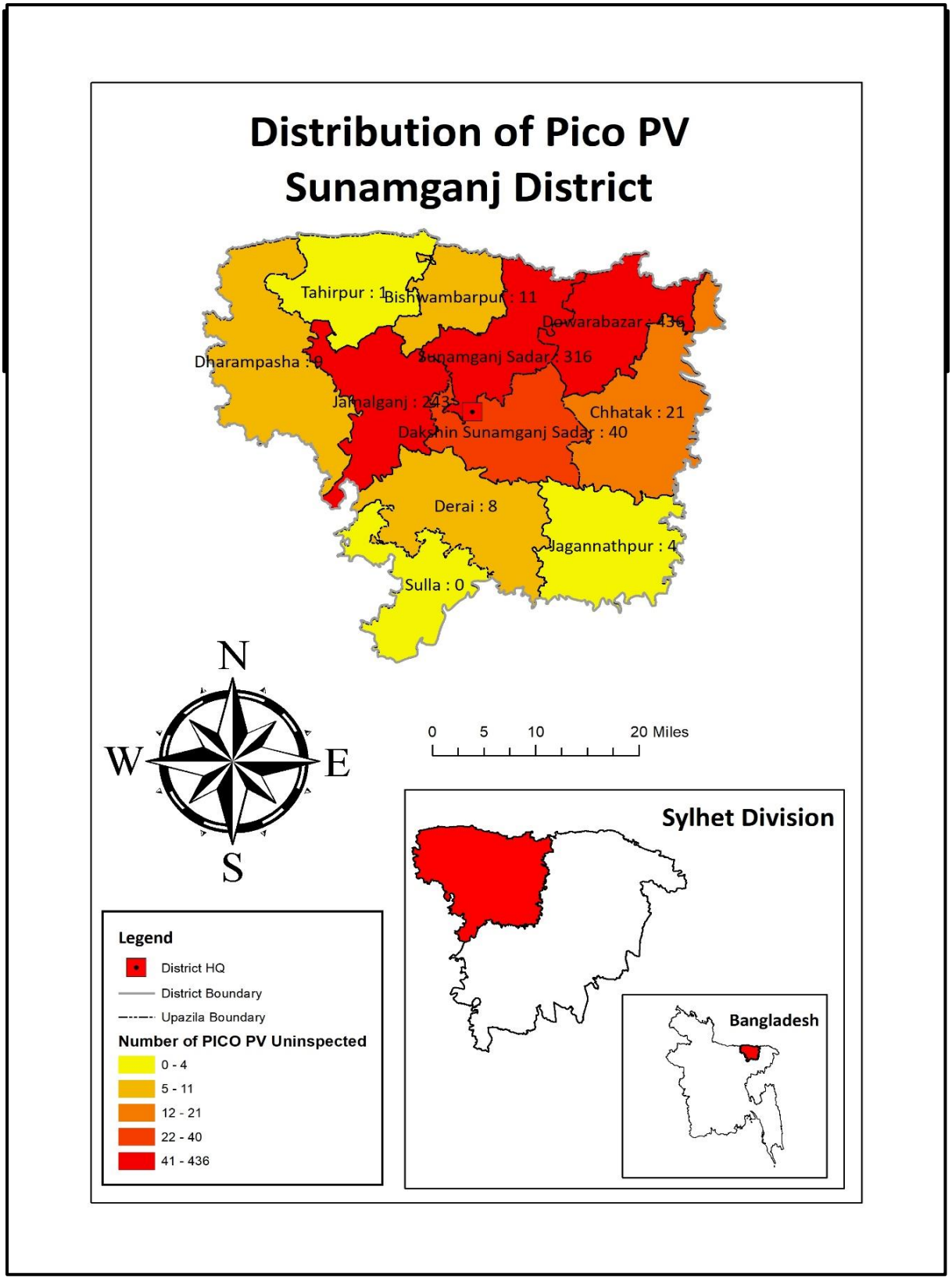


Figure: Distribution of Pico PV in Sunamganj District, 2010

Literature Review

Pico PV:

Pico PV has emerged as a new keyword in rural electrification. Also called Solar Pico Systems (SPS), Pico PV are the younger brothers of Solar Home Systems (SHS) and could enable people in non-electrified areas to get access to modern energy services in cases where the cost is not affordable or the energy demand is too low to be powered by SHS. In this regard, Pico PV can also help to replace the current expensive and polluting kerosene lamps and dry cell batteries.

Two different topologies of Pico PV systems are available:

Pico solar lanterns: besides providing light, some of them also provide energy to charge a cell phone or operate a radio.

Pico PV Home Systems: can provide energy for several lights, a radio and charging a mobile phone. Under this configuration, SPS is scalable and so can be extended in case the electricity demand grows over the years. Additionally, this scalability also provides a strategy for financing the system. Instead of paying connection fees and undertaking to pay a fee-for-service every month, users can upgrade their systems gradually when their economic circumstances allow it.

Pico PV System Components:

A Pico PV system mainly consists of three components:

Solar Panel: The PV panels for the lights are mostly made of polycrystalline or monocrystalline silicon. The peak power of the solar panel ranges from 0.3 Wp for a solar lantern with an integrated panel up to nowadays 80 Wp for the bigger plug-and-play systems.

Battery: While historically also a lot of lead-acid and NiMH batteries were used and still can be found on the market, nowadays nearly all Pico PV devices have Li-Ion batteries, with lead-acid still incidentally used for bigger systems amongst the Pico PV devices. Along with the batteries, a charge controller is important to protect the battery from damage caused by overcharging or deep-discharging.

Lamp: A Pico PV system can be equipped with various lighting technologies. Historically various Pico PV devices used Compact Fluorescent Lighting (CFL) lamps. In recent years,

however, Light Emitting Diode (LED) technology has overtaken CFL in terms of both durabilities (lighting hours) as well as lighting efficiency (lumen/watt). Consequently nowadays in nearly all Pico PV devices LED is used as a light source.

The majority of the more than 50 types of solar lanterns are manufactured in China, followed by India, USA and Germany. Laboratory tests of lanterns carried out by the Fraunhofer Institute for Solar Energy ISE (Pfanner, 2011)

The Pico PV systems were usually properly engineered, with panels on tall masts, charge controllers, home wiring and a battery in a box. Because of their relatively high costs, they required special financing packages and fee collection (Adib Rana, 2001).

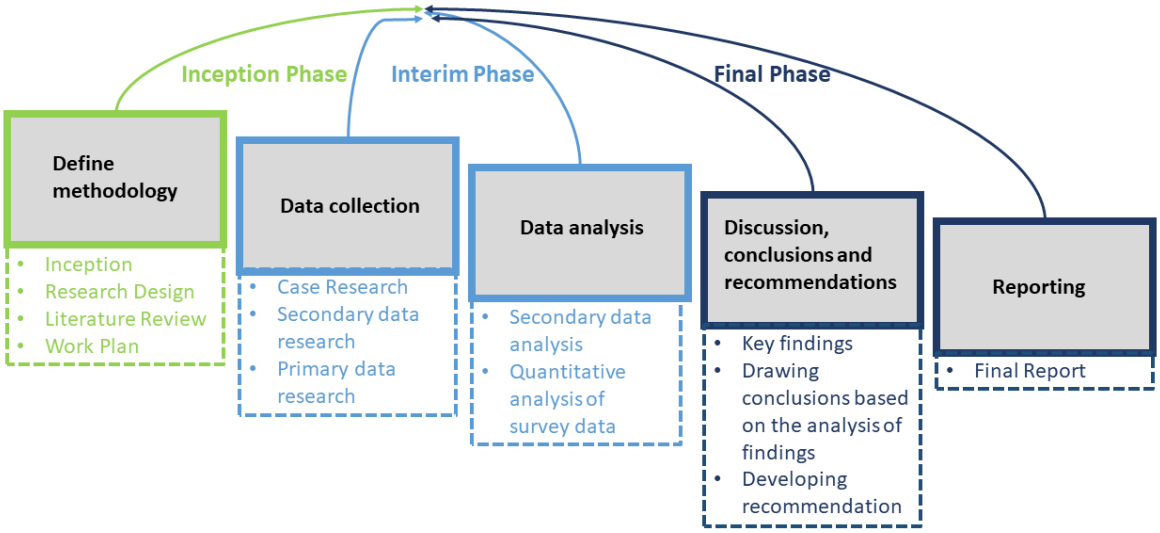
The mobile phone and solar PV technology being combined have already been realized by a Cambridge spin-off company, Eight19, that developed the so-called IndiGo technology (Block, 2011).

Individual solar PV systems for rural applications were introduced in the 1980s more or less independently in the Philippines, the Dominican Republic and Indonesia (Lysen, 1994).

Methodology

This part of the report describes the methodological approach used by the study team for conducting this study, meeting the specific objectives set. The methodology is adopted from the HOMER study conducted in 2013. The approach consisted of the following five distinct phases:

1. Define methodology
2. Data collection
3. Data analysis
4. Discussion, conclusions and recommendations
5. Reporting



Definition of Methodology

This study conducted on a mixed-methods approach. From a large sample size, 119 households are selected as a sample. This sample is selected by snowball sampling which serves to analyze the determinants of adoption of Pico-PV kits and the impacts of using them by using semi-structured questionnaires and open interviews of the real user of the Pico-PV. These questionnaires cover virtually all socio-economic aspects that characterize the households living conditions with a particular focus on the use of lighting devices and mobile

phones, security issues and activities after nightfall, energy expenditure and the financial situation.

Data Collection

The collection of data was based on two axes as follows:

a) Reviewing of existing literature, i.e. case description/secondary research to identify the common areas with the present study so as to utilize useful findings and compare with findings of the study. It is noted that the secondary sources relevant to the Pico PV focus on geographical regions, such as Sunamganj district as a whole. Previous literature related to the socio-economic impact of Sunamganj was not found. This is one of the limitations to compare this report outcome with another outcome. The full bibliography used during this stage is presented in Annex 1.
b) The collection of primary data for the purpose of this study was carried out using quantitive research methods. More specifically, as it has been mentioned above, the study was conducted using semi-structured questionnaires and open interviews of the real user of the Pico PV.

Data Analysis

Following the data collection phase, the process of checking any inconsistencies and data "cleaning" started. The next step was to check the quality of the data by carrying out some interim analysis and tests, such as frequency counts on specific questions, descriptive statistics. The results of each study area were compared against the average results to identify the differences.

The main phases of data analysis focused on exploring the answers given to the research questions by respondents.

Discussion, Conclusions and Recommendations

Upon completing the above phases, a comparison of the primary information collected with the existing findings in the literature was carried out for answering the questions in the discussion part and sum up at conclusions.

Reporting

The final step in the study implementation was the reporting stage, during which the study team proceeded with the compilation of the present report which includes a synthesis of the existing findings in the literature with the primary research findings and the conclusions and recommendations which derive from the analysis conducted.

Constraints of the Methodology

One of the main methodological constraints is the accuracy of the data on Pico PV owners. The absence of robust quantitive data on the size and impacts of Pico PV related activities and the socio-economic benefits and any related information of the improved version of Pico PV.

Chapter 2

Field Data

This chapter of the report presents the findings of the field data which was collected by covering the people who bought the Pico PV in the regions involved. As it has previously mentioned, the field data consisted of a questionnaire survey designed and developed especially for the purpose of this study. The questions included were discussed and finalized by the study team and its advisor ensuring that they cover the objective of the objectives and social and economic conditions of the study area.

Overview of Respondents

In total 119 respondents participated in the questionnaire survey, out of which 87 were male respondents and 32 were female respondents. The response rate was calculated at 11% of total Pico PV owners. The rate of response is similar to the study area. In the Dawarabazar and Jamalganj upazila, the response rate is 33.6% and in the Sunamganj Sadar, it is 32.8%.

Table: Overview of the Respondents

Name of the Upazila	Gender of the Respondent			
	Male		Female	
	Total (N)	Table N %	Total (N)	Table N %
Dawarabazar	28	23.5%	12	10.1%
Jamalganj	26	21.8%	14	11.8%
Sunamganj Sadar	33	27.7%	6	5.0%
Total	87	73.1%	32	26.9%
	N = 119			
Base: All respondents				

Occupations of the respondents

The results of the survey indicate that housewife is the major owner of the Pico PV. Farmer is the second. The small business owner and day labourer are the second and third in the list

respectively, while Pico PV owner is found less among the other occupation like shopkeeper, fisherman, transportation-related occupation, service holder, and teacher.

Table: Occupations of the respondents

Occupation of the Respondent	Name of the Upazila			Overall
	Dawarabazar	Jamalganj	Sunamganj Sadar	
	Table N %	Table N %	Table N %	Table N %
Small Business Owner	-	4.20%	19.33%	23.53%
Farmer	10.92%	8.40%	6.72%	26.05%
Fisherman	2.52%	.84%	-	3.36%
Housewife	10.08%	11.76%	5.04%	26.89%
Service Holder	-	-	1.68%	1.68%
Shopkeeper	4.20%	-	-	4.20%
Teacher	-	.84%	-	.84%
Transportation	2.52%	-	-	2.52%
Day Laborer	3.36%	7.56%	-	10.92%
Base: All respondents (N = 119)				

Overview of the Service Providers

This section provides on the performance of the Pico PV Distributor. This section will describe the distribution of the Pico PV to the respondents and the degree of satisfaction on the performance of the service provider.

Pico PV Provided by the Service Provider

In the study area, there are two service providers who provided the Pico PV. They are Panna Rural Development Foundation and RIMSO Foundation. Between them, Panna Rural Development Foundation has the majority of the share in terms of providing Pico PV to the respondents which are 95.79% of the total number of Pico PV provided to the respondents.

And the rest is 4.21% of the total number of Pico PV provided to the respondents by the RIMSO Foundation.

Table: Overview of the Service Provider

Name of The Upazila	Name of the Service Provider	
	Panna Rural Development Foundation	Rimso Foundation
	Table N %	Table N %
Dawarabazar	33.6%	-
Jamalganj	33.6%	-
Sunamganj Sadar	28.6%	4.2%
Overall	95.8%	4.2%
Base: All respondents (N = 119)		

Degree of Satisfaction on the Performance of the Service Provider

When talking to the respondents, the respondents whose Pico PV was provided by the RIMSO Foundation is overall "Good" which is 4.2% of total Pico PV. But a mixed reaction was found on the service of Panna Rural Development Foundation. The reaction varied from "Bad" to "Very Good". 33.6% of the total respondents said the service was "Bad", 37.0% of the total respondents were satisfied with their service and the rest 25.2% of the total respondents marked "Good" on the degree of the satisfaction with the service provider of the system provider.

Table: Degree of Satisfaction by the user on the Performance of the Service Provider

Name of the Upazila	Name of the Service Provider	Satisfaction with the service provider of the user		
		Bad	Good	Satisfactory
		Table N %	Table N %	Table N %
Dawarabazar	Panna Rural Development Foundation	7.56%	10.08%	15.97%
	Rimso Foundation	-	-	-
Jamalganj	Panna Rural Development Foundation	17.65%	.84%	15.13%
	Rimso Foundation	-	-	-
Sunamganj Sadar	Panna Rural Development Foundation	8.40%	14.29%	5.88%
	Rimso Foundation	-	4.20%	-
Overall	Panna Rural Development Foundation	33.61%	25.21%	36.97%
	Rimso Foundation	-	4.20%	-
Base: All respondents (N = 119)				

Cost of Pico PV

This section will show how much respondents paid to get their Pico PV. In table, we can see that most of the Pico PV was bought at the cost of BDT 2000 which is 87.5% of the total respondents, 9.2% of the total respondents had to buy the Pico PV for BDT 2500 and the rest of the respondents which is 0.8% of the total respondents had to buy the Pico PV for BDT 3000 from the service provider. More detailed information about the final sample is presented in Table.

Table: Cost of Pico PV

Cost of Pico PV	Name of Upazila					
	Dawarabazar		Jamalganj		Sunamganj Sadar	
	Name of the Service Provider					
	Panna Rural Development Foundation	RIMSO Foundation	Panna Rural Development Foundation	RIMSO Foundation	Panna Rural Development Foundation	RIMSO Foundation
	Table N %	Table N %	Table N %	Table N %	Table N %	Table N %
BDT 2000	31.9%	-	26.1%	-	26.1%	3.4%
BDT 2500	1.7%	-	6.7%	-	2.5%	.8%
BDT 3000	-	-	.8%	-	-	-
Base: All respondents (N = 119)						

Overview of the Pico PV

This section provides the findings related to the service of Pico PV such as how long the user is using the Pico PV and how much time the Pico PV provides light to the respondents.

Service Level

The will be calculated by cross-referencing the Years of using Pico PV and Number of service hour provided by the Pico PV and it indicates the relation between the years of using Pico PV and the number of service hour provided to the respondents.

Years of using Pico PV

In all the survey area, people bought their Pico PV almost at the same time. But the duration of the service is varied due to the battery quality of their Pico PV. Some batteries are not functional, so they stopped using their Pico PV and returned to their previous source of energy when they needed the electricity.

Table 5.6: Years of using Pico PV in the study area.

Name of the Upazila	Years of using Pico PV			
	0 - 5 Months	Less than 8 months	Less than 1 year	More than 1 year
	Table N %	Table N %	Table N %	Table N %
Dawarabazar	1.68%	.84%	18.49%	12.61%
Jamalganj	-	-	17.65%	15.97%
Sunamganj Sadar	3.36%	.84%	16.81%	11.76%
Overall	5.04%	1.68%	52.94%	40.34%
Base: All respondents (N = 119)				

Number of Service hour of Pico PV

Table: Number of Service Hour of Pico PV in the study area

Name of the Upazila	Number of Service hour of Pico PV					
	Doesn't Function	1 Hour	2 Hours	3 Hours	4 Hours	5 Hours
	Table N %	Table N %	Table N %	Table N %	Table N %	Table N %
Dawarabazar	1.68%	-	4.20%	10.08%	14.29%	3.36%
Jamalganj	-	-	1.68%	15.13%	10.08%	6.72%
Sunamganj Sadar	3.36%	.84%	5.88%	5.88%	8.40%	8.40%
Overall	5.04%	.84%	11.76%	31.09%	32.77%	18.49%
Base: All respondents (N = 119)						

Service Level

The Pico PV which doesn't function hardly functioned from 0 – 5 months while the Pico PV which are still in function providing the service from 3 hours to 5 hours and they are functioning less than 1 year to more than 1 year. The percentage varies from 11.76% to 20.17%. The result clearly indicates that if the quality of the battery is good it can provide service for more than 3 hours and can be used for more than 1 year.

Table: The cross-reference between the years of using Pico PV and the number of service hour provided

Number of Service hour of Pico PV	Years of using Pico PV			
	0 - 5 Months	Less than 8 months	Less than 1 year	More than 1 year
	Table N %	Table N %	Table N %	Table N %
Doesn't Function	5.04%	-	-	-
1 Hour	-	-	-	.84%
2 Hours	-	.84%	4.20%	6.72%
3 Hours	-	-	16.81%	14.29%
4 Hours	-	.84%	20.17%	11.76%
5 Hours	-	-	11.76%	6.72%
Base: All respondents (N = 119)				

Performance

After using the Pico PV for certain of time the user has given an opinion on their Pico PV. Among all the respondents 43.70% users have said that the performance of their Pico PV is "Good", 21.85% users have said that the performance is "Very Good", 19.33% users have said that the performance is "Satisfactory" and the rest 15.13% users have said that it is "Bad".

Table: Performance of Pico PV.

Name of Thana	Performance of Pico PV			
	Bad	Satisfactory	Good	Very Good
	Table N %	Table N %	Table N %	Table N %
Dawarabazar	3.36%	7.56%	11.76%	10.92%
Jamalganj	2.52%	6.72%	17.65%	6.72%
Sunamganj Sadar	9.24%	5.04%	14.29%	4.20%
Overall	15.13%	19.33%	43.70%	21.85%
Base: All respondents (N = 119)				

Negative Evaluation

- **The Brightness**

  The Brightness of the lamp is an important factor, as confirmed by 34% of households, in order to use the light for reading, for persons with special needs and additionally to use at the same time as other family members. Brightness was measured by the people by testing how much of their compound was illuminated by the light. According to their statements, a satisfying duration was one day (which means an estimated duration of four hours).

- **Batteries**

  It was observed during the field study that different technical problems occurred in Pico-PV. Most problems were connected with discharged batteries because charge controllers and low-voltage disconnect outputs did not work properly.

Aspects of impact using Pico PV

Income

As electricity is one of the key elements in the development of a modern economy, the result shows us that owning Pico PV didn't affect much to the income of the respondents. Farmer and housewife are the top in the result with just 5.04% in income change. When talking to the respondents they pointed out that the low capacity of Pico PV is may be the reason behind the small effect on the income of the respondents. From the observation, other reason may be the quality of the battery used in Pico PV. Most of the batteries are not that much durable. The battery doesn't perform up to its full potential.

Table: Change in the income of the respondent according to their occupation

Occupation of the Respondent	Change in Income	
	Table N %	Table N %
	Changed	No Change
Farmer	5.04%	21.85%
Housewife	5.04%	21.01%
Small Business Owner	3.36%	20.17%
Day Labourer	3.36%	7.56%

Fisherman	1.68%	1.68%
Service Holder	0.84%	1.68%
Teacher	0.84%	0.84%
Transportation	0.84%	-
Shopkeeper	-	4.20%
Overall	21%	79%
Base: All respondents (N = 119)		

Change in the Working Hour

Change in a working hour is another indicator of economic development. In the result, 65.55% of the total sample is not applicable because they don't use Pico PV for business purpose. Among the rest, 17.07% of the user said that their business has improved after using Pico PV. But 82.93% of owners said that it didn't bring any impact on their business.

Table: Change in the working hour of the respondent according to their occupation

Occupation	Change of Working Hour	
	Changed	No Change
	Table N %	Table N %
Small Business Owner	4.88%	19.51%
Farmer	4.88%	14.63%
Fisherman	4.88%	4.88%
Housewife	2.44%	2.44%
Service Holder	-	26.83%
Shopkeeper	-	4.88%
Teacher	-	4.88%
Transportation	-	2.44%
Day Labourer	-	2.44%
Overall	17.07%	82.93%
Base: All respondents (N = 119)		

Change in Study Hour

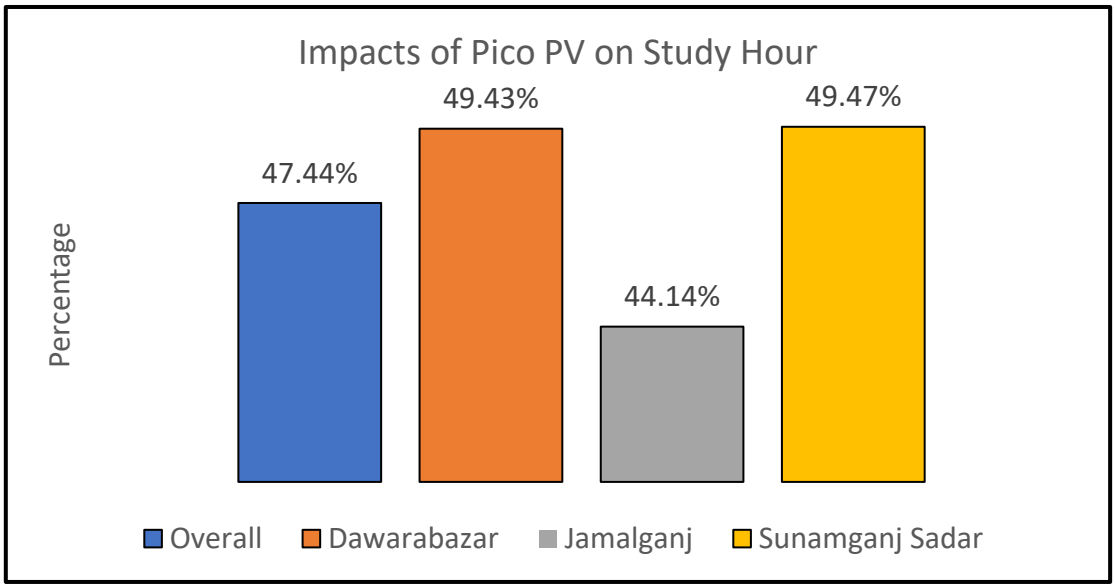
After calculating both study hour before and after the use of Pico PV, it is found that study hour has increased because of Pico PV. The overall increase in study hour is 47.44% whereas in Dawarabazar upazila is increased by 49.43%, 44.14% in Jamalganj upazila and 49.47% in Sunamganj Sadar. Among the 119 owners, only 113 owners have used Pico PV for the purpose of their children's study at night. Among 47.44% of respondents reported that children in particular benefit in terms of their daily studies: Quantitative, as well as qualitative improvements, were mentioned:

a) The quantity of studying is enhanced by the possibility of longer learning at night. Additionally, more children can study simultaneously because of the brighter light.
b) According to respondents, the quality of study is improved because learning at night becomes much easier and children claim to have better results in their homework and studies.

Working for school is very important for children. They are extremely concerned about doing their homework and studying for school. They want to achieve a better life than their parents. Therefore they spent a lot of their free time in the evening for doing work forschool.

Graph: Impacts of Pico PV on study hour.

Base : All respondents/Pico PV used for children's study (N = 113)

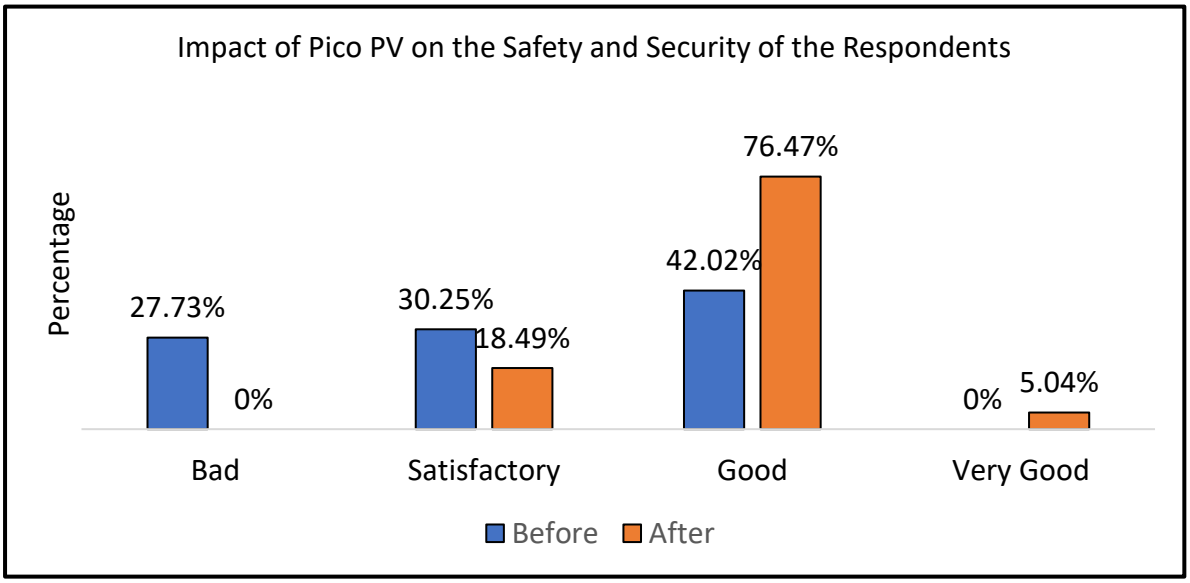


Change in Safety and Security

After analyzing the impact of Pico PV of the owners, it is found that Pico PV has an impact on the improvement of safety and security of the owner. The owners are mostly benefited by the Pico PV after sunset. The light of Pico PV has provided them with safety and security to do their task at night.

Graph: Impact of Pico PV on the Safety and Security of the Respondents

Base: All respondents (N = 119)



The feeling of increased security was expressed in various ways:

- **Enhanced autonomy**

  Most of the parents reported directly that their children are more independent because they can study on their own at night. Parents are not afraid of accidents (for example fire) anymore and children are able to use the lamp on their own. This frees up time for parents to do other things and even to leave the house. In the same way, children can go outside the house on their own (for example to go to the toilet) at night without fear.

- **Less sorrow and stress**

  Most of the households noticed less sorrow and stress. women are mainly responsible for the household ‘s energy supply, meaning that they organize and calculate the acquisition of material for light as well as the consumption of it. As a consequence of

sufficient light (if charged properly), women often reported that not feeling stressed anymore with thoughts about correct calculation or not enough light is the best advantage of the solar light. This results in a feeling of serenity. In the same way, it relieves women of the fear of not having enough light in an emergency situation, such as when someone is ill or dying and for people with special needs like women giving birth or families with very young babies.

- **The decrease in fire-related incident**

  There are no more accidents, for example, fire, inside the house because of either traditional energy, such as candle or kerosene, or unsecured and uncontrollable ways of making light, such as setting a tire on fire.

- **Walking outside**

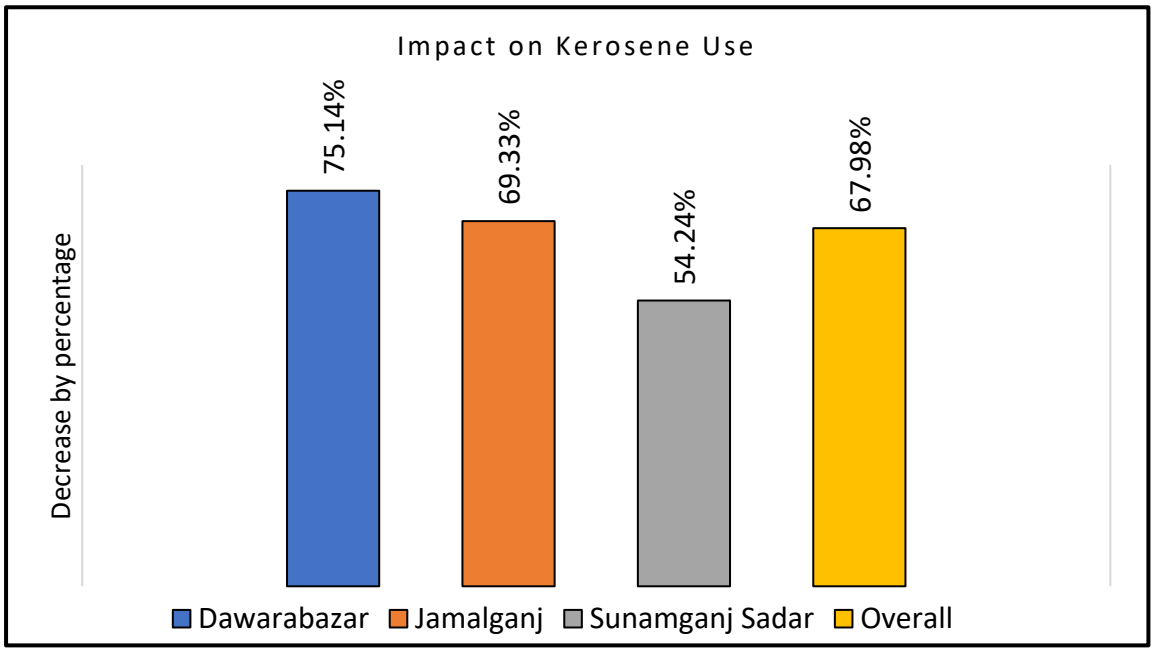
  Walking outside of the house is safer. for example, visiting people or going to the toilet, during the night is also more secure. With the help of brighter light which is resistant to wind, protection against wild animals, which attack people as well as animals and plants, is much easier.

Change in Kerosene Use

Graph 5.4 will show us how much Pico PV have influenced the use of kerosene. In the graph, it is shown that the overall 67.98% decrease in the use of kerosene. Among the study area, Dawarabazar has the most decrease in kerosene which is 75.14%. The use of kerosene decreased in Jamalganj by 69.33% and in Sunamganj Sadar it is 54.24%.

Graph: Impact on Kerosene Use

Base: All Respondents/who doesn't have electricity from Bangladesh Rural Electrification Board



Reducing the use of kerosene is one of the factors to encourage people to use a solar powered energy source. After calculating the use of kerosene from the samples, it is found 67.98% of total kerosene use is decreased overall. In Dawarabazar, it is 75.14%, Jamalganj it is 69.33% and finally, in Sunamganj Sadar, it is 54.24%.

Source of Energy

Access to Electricity

Table will show us how much people do have access to electricity in the study area. In Dawarabazar among the Pico PV owners doesn't have access to any electricity. But Overall 21.01% of the total sample have access to electricity.

Table: Access to electricity

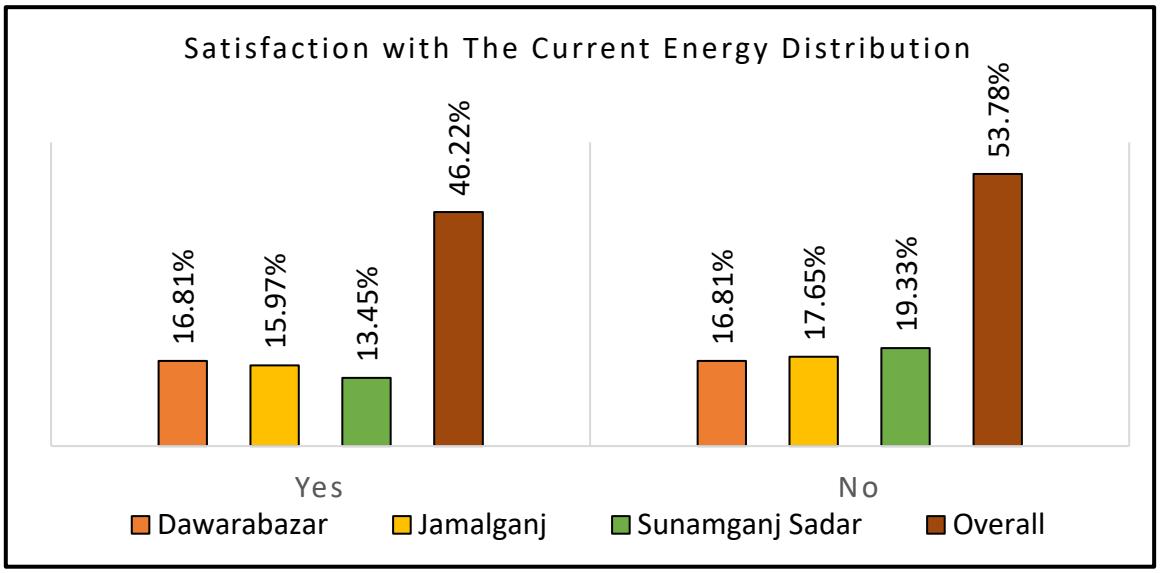
Name of the Upazila	Have Electricity	Doesn't Have Electricity
Dawarabazar	-	33.61%
Jamalganj	12.61%	21.01%
Sunamganj Sadar	8.40%	24.37%
Overall	21.01%	78.99%
Base: All respondents (N = 119)		

Satisfaction with Current Energy Source

The satisfaction with current energy distribution is 46.22% to 53.78%. 46.22% Pico PV owner is satisfied with the current energy distribution whereas 53.78% of Pico PV owners are not satisfied with the current energy distribution.

Graph: Satisfaction with the current energy distribution

Base: All respondents (N = 119)



Source of Energy

After analysis of the source of energy before and after the use of Pico PV, it is found that sources of energy haven't changed much. Solar doesn't become a dependable source of energy. People still dependent on the electricity provided by Bangladesh Rural Electrification Board and bazar and market still the source of kerosene for their daily use.

Table: Sources of Energy before and after the use of Pico PV

Name of Upazilla	Source of the energy fuel before Pico PV					Source of the energy fuel after Pico PV				
	Bazar	**BREB***	**Market**	**Shops**	**Solar**	**Bazar**	**BREB***	**Market**	**Shops**	**Solar**
	Total (%)	**Total (%)**	**Total (%)**	**Total (%)**	**Total (%)**	**Total (%)**	**Total (%)**	**Total (%)**	**Total (%)**	**Total (%)**
Dawarabazar	-	-	8.40%	25.2 %	-	-	-	8.40%	25.21 %	-
Jamalganj	32.7 %	-	-	-	0.84%	18.49 %	-	-	-	15.13 %
Sunamganj Sadar	18.4 %	14.2 %	-	-	0	18.49 %	14.29 %	-	-	-
Overall	51.2 %	14.2 %	8.40%	25.2 %	0.84%	36.97 %	14.29 %	8.40%	25.21 %	15.13 %
Base: All respondents (N = 119)										
***BREB**= Bangladesh Rural Electrification Board										

Findings

The main conclusions from the primary research can be summarized as follows:

- Owners of the Pico PV mostly from the low-income group of people. Most of them don't have access to electricity from the Bangladesh Rural Electrification Board. Those who have access to the electricity they use Pico PV when there is load shedding.
- Owners have to buy Pico PV from BDT 2000 – BDT 3000. In most of the places, the price of Pico PV is BDT 2000 but, in some places,, people had to pay BDT 2500 to BDT 3000.
- The service of the battery is very poor. The battery is not durable enough. In some places, the quality of the battery so bad that people had to return to their old source of energy just after using the Pico PV for less than 5 months. People are very furious in those over the Pico PV. Among those which are functioning good, those batteries are giving full service and owners are happy with Pico PV.
- In terms of economic impact, income and business hours after the use of the Pico PV haven't changed. Pico PV is mostly used for a short time but people want the solar system which will have a longer duration of service.
- The most positive point is an improvement of study hour after the use of Pico PV. Study hour of the student has significant improvement after the use of Pico PV. This has been a major positivity of Pico PV.

- Safety and security of the respondents have also improved after the use of Pico PV. Their outdoor activity at night has been more secure after the use of Pico PV.
- There is a significant amount decrease in the use of kerosene after the use of Pico PV.
- Overall 78.99% of the total respondents do not have access to electricity. But in most of the respondents' home, they have a solar system which has a longer duration. They are very dependent on that solar system. Pico PV is only used for the purpose of study and source of light in their yard to improve the security.

Chapter 3
Discussion

The study examines how the Pico PV generates socio-economic impact in Sunamganj district. The findings from the socio-economic impact assessment indicate that local economic impacts of Pico PV are relatively modest while certain social impacts seem more significant, at least in the short to medium term. In this discussion, we will address three topics. First, we will elaborate on the reasons the social impact of Pico PV. Second, we will elaborate on the Pico PV's contribution to economic development. Third, we will discuss Pico PV's contribution as a source of renewable energy. Finally, we will highlight the scope and limitation of the study.

Social Impact of Pico PV

Our findings suggest that the value chain of the Pico PV has high social value creation in Sunamganj district. Because of Pico PV overall study hour for the student increased by 47.44%, which is a very significant indicator of social impact. In the study area, there were students in the house of those respondents. Before Pico PV, children in those areas were dependent on the kerosene-based lamp, availability of kerosene was a major factor for their study. After Pico PV, the dependency of the kerosene has been largely reduced and now they study up to 5 hours at night which is helping them excel in their test results.

Safety and security have also improved. Now, people in some area use Pico PV as a source of light in their yard which is helping them to eliminate any kind of occurrence. Women and children in those areas are mostly benefited from this. Women and children are heavily interested in Pico PV due to this reason alone as the kerosene-based lamp doesn't provide much light during the night, it was scary for them to go to the toilet. Before Pico PV women and children in those areas used to avoid going to the toilet.

The use of kerosene has also decreased in the study area. Overall 67.98% kerosene usage has decreased after the Pico PV. Cost of the respondents has also reduced due to lower use of kerosene. The level of safety in households has also improved because of the lower use of kerosene.

Economic Impact of Pico PV

The economic impact of Pico PV is somewhat moderate. Pico PV doesn't have a significant impact on the economic development in those areas. Among the respondents, only 21 % of them have experienced an increase in their income. And among the respondents who use Pico PV for business purpose, the business hour of around 17% of the respondents have changed. These parameters suggested that Pico PV has an average impact on the economic development of Pico PV users.

Pico PV as a Source of Renewable Energy

Around 21.01% of the respondents have access to the electricity, the rest of the 78.99% of respondents don't have access to the electricity. But among the 78.99% respondents, some of the respondents use a solar powered system other than Pico PV. Those systems have a larger capability and longer duration than the Pico PV. They are very much dependent on those solar systems. People in those rural areas are heavily dependent on solar systems. Due to the higher cost of the other solar systems which have a higher capacity, people can not afford to buy those solar systems thus leading them to use the kerosene-based energy systems. Those who can afford are going for the electricity provided by the Bangladesh Rural Electrification Board. Pico PV has a chance to be a source of renewable energy, it is only for minor use. In a larger scale, it is not sufficient for the users.

Recommendations

The Goal 7 of Sustainable Development Goals by the United Nations is "Ensure access to affordable, reliable, sustainable and modern energy for all."

The global targets of goal 7 are as follows:

- By 2030, ensure universal access to affordable, reliable and modern energy services.
- By 2030, increase substantially the share of renewable energy in the global energy mix.
- By 2030, double the global rate of improvement in energy efficiency.

- By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology.
- By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular, least developed countries, small island developing States, and land-locked developing countries, in accordance with their respective programmes of support.

In order to achieve the global targets of "Goal 7", certain measurements can be taken. Such as:

1. Focusing on improving the quality of the Pico PV so that capacity and durability can be increased.
2. When selling the Pico PV, instalment system during the payment can be introduced. Many of the people asked for the instalment in the payment. It will help them to buy more Pico PV and also the sale of Pico PV will also increase.
3. Permanent service centres for servicing or repairing Pico Pv can also be introduced. Many users complained that there Pico PV battery didn't function just after the 4 months use, they wanted to fix their battery but they couldn't find any service centres. The regional office of the partner organizations has also shut down after selling the Pico PV. The same thing also goes for the light bulbs of the Pico PV system.
4. The service providing system of the partner organization can be improved. This can spread the advantages of Pico PV in more places.
5. People in rural areas are heavily interested in the solar-powered energy system. If proper steps can be taken by 2030, the share of renewable energy in the global energy mix can be achieved.
6. In rural areas, most of the population have little education. If the advantages of Pico PV and user manual can be adapted to their level, the rural people would be very much helpful.

Conclusions

In this study, we have identified the socio-economic impact of the Pico PV. When it comes to economic impacts, our findings indicate that a relatively low share of economic development in the economic development of Sunamganj district. These findings are applicable for the people in rural areas mostly. The cost of buying fuel is decreasing day by day. People are able to use that money for their other activities. Income and business hour of the rural people did not have significant improvement but it is improving day by day. The farming community, the fisherman community or any transportation/logistical related working group can be hugely benefited from the Pico PV if it can be accessible to those groups. We have further reflected on the fact due to the lower capacity of Pico PV, it can not impact the economic landscape of Sunamganj at a significant level. The high creation of employment is the reflection of economic development but it is missing in those areas.

Our findings have also indicated that the social life of rural people is arising because of Pico PV. Students are getting more time to study. Safety and security are also improving. Rural people especially the rural women and children are hugely benefited from the use of Pico PV. In spite of the limited scope of Pico PV, one should still acknowledge the notable increase in the social quality of those areas is arising.

Furthermore, the findings from our assessment indicate that socio-economic development arises from access to electricity. This observation contrasts the general belief that electricity is a key driver for socio-economic growth in developing countries. A number of country and region-specific may, however, explain this contradiction. Rural peoples in the Sunamganj district faces problems like lack of electricity coupled with underdeveloped infrastructure which restricts the market exchange. Economic sectors thus lack the ability and opportunity for economic growth provided by electricity. This further indicates that electricity is not a creation for socio-economic development, more a facilitator, explaining the income levels of both households and business hour of the business remain unchanged in the wake of electrification.

Although our findings do not support the link between electrification and classical development indicators, such as poverty reduction, electrification has significant impacts on people’s well being. Softer welfare impacts related to the convenience and flexibility of

people's daily life is the most prominent effect of electrification in Sunamganj district. This effect might give rise to broader structural changes in the economy of the Sunamganj district in the long run, although this possibility is not identified and captured in the existing literature. Also, the positive effects of electrification on health and educational indicators may translate into a more healthy and educated labour force, which in turn might enhance the income levels of rural people of Sunamganj district over time. It thus remains to see how the scope of association with electrification unfolds in the long-run.

Comparing the socio-economic impacts of the Pico PV with potential impacts of other energy sources and alternative electricity dissemination systems (e.g. off-grid electrification) is beyond the scope of this study. However, we see this as a highly relevant area for future research and an important contribution in the debate on whether investment into Pico PV deployment and on-grid electrification can be justified compared to alternative solutions.

Annex 1: Bibliography

Sunamganj At a Glance. Retrieved from http://www.sunamganj.gov.bd/site/page/35710fc2-0757-11e7-a6c5 286ed488c766/Sunamganj%20At%20a%20Glance

Bangladesh Bureau of Statistics. (2013). *Population and Housing Census 2011, Community Report: Sunamganj*. Dhaka: Bangladesh Bureau of Statistics.

Bangladesh Bureau of Statistics. (2016). *Economic Census, 2013. District Report: Sunamganj*. Dhaka: Bangladesh Bureau of Statistics.

Loucaidou, E., Polemitis, M., & Themistocleous, C. (2013). SOCIO-ECONOMIC IMPACT STUDY. Retrieved from http://www.sbla.com.cy/sites/default/files/3_1_Socioeconomic_impact_study_Final_v4_0.pdf

Hatlelid, I., & Aass, J. (2016). The Socio-Economic Impact of Renewable Energy in Sub-Saharan Africa A Ripple Effect Analysis of the ASYV Solar Power Plant in Rwanda. Retrieved from https://brage.bibsys.no/xmlui/bitstream/handle/11250/2432146/masterthesis.PDF?sequence=1

Adib Rana, Preiser K., Reinmüller D. Dissemination models for rural energy supply in developing countries- decision-making support for governments, industry and financial institutions, 17th European Photovoltaic Solar Energy Conference, 2001 Munich

Block, Elisabeth, An affordable way to light, Sun & Wind Energy, 12, 2011

The emerging market for pico-scale solar PV systems in Sub-Saharan Africa – Solar Energy Media. (2016). Retrieved from http://solarenergymedia.com/the-emerging-market-for-pico-scale-solar-pv-systems-in-sub-saharan-africa/

Kaplinsky, R., 2011. Schumacher meets schumpeter: Appropriate technology below the radar. Res. Policy 40, 193–203. doi:10.1016/j. respol.2010.10.003

Lighting Africa. 2010. Solar Lighting for the Base of the Pyramid - Overview of an Emerging Market

Lysen, Erik, 'Photovolts for villages', IEEE Spectrum, 31, (10), pp.34-9, 1994.

Pfanner N., Georg Bopp, Stephan Lux, Solar LED Lights– Investigations and Tests, Symposium Small PV-Applications Ulm, 2011

Solar Energy Foundation. 2010. Sun connect. Checklist solar lamps

Sun connect.2010. Rural Electrification with Photovoltaics.

Goal 7: Affordable and clean energy | UNDP. (2016). Retrieved from http://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-7-affordable-and-clean-energy.html

Annex 2: Questionnaire

Data Collection for PICO PV Assessment

Sample No:

Survey Date:

Survey Location:

Economic Information

Demographic Information	
Customer Name	
Guardian Name	
Village	
Post Office	
Thana/Upazila	
District	
Model	
Household Type	
Cost of Pico PV (Tk.)	
Battery Price (Tk.)	

Social Assessment (By Individual)

Name of Pico PV owner		
Occupation		
Number of family members		
Years of using Pico PV		
Number of Pico PV		
Service hour of Pico PV		
Change of monthly income	Before using Pico PV (Tk.)	
	After using Pico PV (Tk.)	

Change of business hour	Before using Pico PV (Hr.)	
	After using Pico PV (Hr.)	
Change of number of students	Before using Pico PV(Hr.)	
	After using Pico PV(Hr.)	
Study hour at night	Before using Pico PV(Hr.)	
	After using Pico PV(Hr.)	
Change in Safety and Security	Before using Pico PV	☐ Bad ☐ Satisfactory ☐ Good ☐ Very Good
	After using Pico PV	☐ Bad ☐ Satisfactory ☐ Good ☐ Very Good
How did they find the performance of Pico PV?	☐ Bad ☐ Satisfactory ☐ Good ☐ Very good	
Are you satisfied with your system provider service?	☐ Bad ☐ Satisfactory ☐ Good ☐ Very good	
What type of problems do you face with your Pico PV?		

Is electricity is enough for your family?		
Do you have any comment on Pico PV?		
Where do you dispose of the unusable batteries?		
Amount (Liter) kerosene used	☐ Before using Pico PV	
	☐ After using Pico PV	
Source of energy fuel	☐ Before using Pico PV	
	☐ After using Pico PV	

Annex 3: Roles of the Study Team

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