Title

Solar Panel Uses and its Impact on the Households and Businesses of the Kutubdia Island in Bangladesh

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Abstract

The paper investigates the impact of solar energy on the households and businesses of the Kutubdia island in Bangladesh. The inhabitants of this island are totally segregated from national grid electricity. The findings of this study show that majority of the respondents in the sample surveyed are male and low income households, and business owners are more likely to use loan for installing solar panel. All types of solar panel users are satisfied with the services provided by solar panels and their life standard have also been improved after installing solar panels. There are several benefits users get from the solar panels. Among the benefits received, both households and business owners reported that their average monthly income, average daily work hours, educational environment, labor productivity, suitable working environment and above all economic condition havesubstantially increased after the installation of solar panels.

Key Words:*Solar panel,alternative energy.*

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1. Introduction: Bangladesh is a developing country where electricity is mainly a facility for urban population. Although some attempts have been taken to meet the electricity demand of the rural people, there still remains a large gap between demand and generation of power in Bangladesh (Farheen et al 2012). Solar energy has a bright potential to narrow this gap. In Bangladesh, about 65% of the population lack access to electricity and most of them are in villages. The most significant social benefit of the use of decentralized energy sources is that it can be made available to isolated and remote areas, like islands. It is anticipated that renewable energy will play a vital role in future for off-grid electrification in the country.

It may be noted that the supply of power produced by conventional methods in rural areas and remote villages is gradually being recognized as not only uneconomic but also unmanageable. The supply of power to an island from the mainland, even if possible, is not economically viable because of the exorbitantly high cost of distribution and associated transmission cost. Alternatively, the use of non-conventional renewable energies appears more viable and efficient in the context of the program of total electrification (Sinha and Kandal 1991). With the increase in the distance from the centralized supply point, the use of locally generated power from solar energy is gradually becoming more viable. So a time would come when the per unit energy cost from the solar source would be comparable with that of the centralized system at all levels for a rural electrification program (Chakraborty& Ckakraborty2002).

The spread of solar power depends on how consumers value this technology which in turn depends on the benefits provided by the solar panels. The main objective of the study is to investigate the effects of solar panel uses among the households and business sectors in the Kutubdia island. The variety of impacts assessed in this paper include, among others, educational and economic benefits of solar energy as an alternative source of power supply.

The rest of the paper is organized as follows. After a brief discussion of the data and methodology in Section 2, the findings of the paper are presented in Section 3. The study is wrapped up with some concluding remarks in Section 4.

2. Data and Methodology:

A sample of 370 observations, of which 233 are households and 137 are businesses, is taken from the Kutubdiaisland. The island is an Upazila of the Cox's Bazar district in the Chittagong division in Bangladesh. It is located at 21.8167.N, 91.8585.E and has a total area of 215.8 square kilometer. Kutubdia has 6 unions, 9 mahallas, 29 villages, and 14,463 households. The data are analyzed based on simple statistical tools like charts, tables and statistical associations. Advanced statistical methods are avoided so that the paper remains accessible to general readers.

3. Results and Discussions

3.1 Gender Bias: There is a clear gender bias in using solar panel in this region. Figure 1 shows that out of 233 respondents 214 are male (91%) and 19 are female (9%). On the other hand out of 137 business respondents, 133 are male and 4 are female i.e., 97% of the total respondents of business-owners who purchased solar panels are male and only 3% of them are female. That is, the majority of the households and business respondents using solar panel are headed by male. Perhaps males have more socially connected which make them more conscious about purchasing solar panels.

Figure 1: Solar Panel Users by Gender and User types

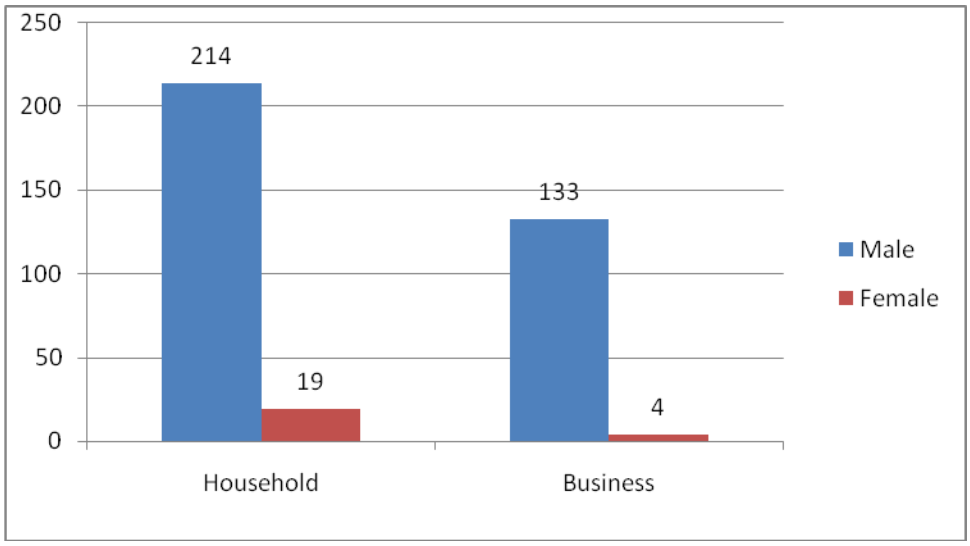

Figure 2: Solar Panel Use by Number of Years

Table: 2 Numbers of Years of Using Solar Panel in Household and Business by Gender

	Household			Business -owners		
	1-5 Years	6-10 Years	Total	1-5 Years	6-10Years	Total
Male	184 (86%)	29 (14%)	214 (100%)	104 (88%)	14 (12%)	118 (100%)
Female	18 (95%)	1 (5%)	19 (100%)	3 (100%)	0 (0%)	3 (100%)
Total	202 (86%)	31 (14%)	233 (100%)	107 (88%)	14 (12%)	121 (100%)

3.2 Market Penetration: Figure 2 shows the number of solar panel users both male and female who have been using solar panel for the last 10 years. It is seen from Table 2 that a large number of both male and female users have been using solar panel during last 1 to 5 years. Around 86% of male and 95% of female households are using solar panel during last 1-5 years as against only 14% male and 5% female users for 6 - 10 years. The rate of increase in the use of solar panel is found, above 6 times for male and 18 times for female users during the last 5 years. Taking male and female users together, this rate of increase is almost 7 times more over

1-5 years (86%) than over 6 - 10 years (14%) of using solar panel. On the contrary, in business sector the total number of solar panel users for male is 118 while for female the number is 3. It is seen that a large number of both male and female users are using solar panel during last 1 to 5 years. Around 88% of male and 100% female households are using solar panel for the last 1 to 5 years while only 12% male and 0% female are using solar panel for the last 6 to 10 years. The rate of increase in using solar panel during last 1 to 5 years is 8 times more for male and 3 times more for female users compared to 6-10 years time span.

3.3 Financing: Since many users are poor, it is interesting to know their financing technique. Figure 3 shows purchases of solar panels by using different means such as loans, savings (own source) and other means by the household respondents . Table 3 is classified into two groups male and female. It is seen from Table 3 that out of 204 male respondents, 65% of the respondents purchased solar panel through loans, 17% by using own savings and 18% by using other sources of financing. Out of 17 female respondents 47% of them in this group use loan, 24% used their own sources of savings and 29% used other means of financing for installing solar panel. In business out of 130 male respondents 82 (63%) users purchased solar panel by taking loan, 27 (20%) users purchased it by using personal savings and 21 (16%) users purchased it by using other means. Out of 4 female respondents, 3 respondents (75%) purchased solar panel by taking loan and 1 (25%) respondent purchased it by using personal savings. It is shown from the Table 3 that majority respondents are using loan for installing solar panel. They require financial support either in the form of loan or other means of financing.

Table 3: Financing Soar Panel

Households					Business-Owners			
Gender	Loan	Saving	Other Means	Total	Loan	Savings	Other Means	Total
Male	133 (65%)	35 (17%)	36 (18%)	204 (100%)	82 63%)	27 (20%)	21 (16%)	130 (100%)
Female	8 (47%)	4 (24%)	5 (29%)	17 (100%)	3 (75%)	1 (25%)	0 (0%)	4 (100%)
Total	141 (64%)	39 (18%)	41 (18%)	221 (100%)	85 (63%)	28 (21%)	21 (16%)	134 (100%)

3.4 Income Level and Financing: In this section we examine how financing methods vary depending on income levels. Table 4 shows the purchase of solar panel by the respondents of different income levels. From the table it can be seen that the number of respondents with an income below 5,000 is 6. Among them 3 respondents used loan, 1 used own savings and 2 others used other means of financing solar panel. The number of respondents with an income from 6,000 - 10,000 is 33. Among them 22 respondents used loan, 5 used own savings and 6 others used other means of financing solar panel. With income group ranging from 11,000 to 15,000, the total respondents are 40, out of them 35 used loan, 1 respondent used saving and 4 respondent used other means to purchase solar panel. With income group ranging from 16,000 to 20,000, the total respondents are 27, out of them 16 used loan, 4 used savings and 7 used other means to install solar panel. In the income group 21,000 - 25,000, total respondents are 23, out of whom 5 used loan, 6 used savings and 12 used other means. In the income group 26,000 - 30,000, total respondents are 9. Out of them 4 used loan, 1 used savings and 4 used other means .In the income group with 31,000 - 35,000, total respondents are 12, 6 of whom used savings and 6 used other means.

Table 4: Loan Type and Income Range

Household					Business-owners			
Income	Loan	Savings	Others means	Total	Loan	Savings	Others means	Total
(Below 5,000)	3	1	2	6	7	1	1	9
(6,000-10,000)	22	5	6	33	38	6	2	46
(11,000-15,000)	35	1	4	40	26	10	6	42
(16,000-20,000)	16	4	7	29	11	7	7	25
(21,000-25,000)	5	6	12	23	1	1	4	6
(26,000-30,000)	4	1	4	12	1	2	1	4
(31,000 +)	0	6	6	12	1	1	0	2
Total	85 (57%)	24 (16%)	41 (27%)	150 (100%)	85 (63%)	28 (21%)	21 (16%)	134 (100%)

A similar relation between income range and finance types for businesses is shown at the right hand portion of table 4. The number of respondents with an income below 5,000 is 9. Among them 7 respondents used loan, 1 used own savings and 1 others used other means of financing solar panel. The number of respondents with an income from 6,000-10,000 is 46. Among them 38 respondents used loan, 6 used own savings and others 2 used other means of financing solar panel.With income group ranging from 11,000 to 15,000, the total respondents are 42, out of them 26 used loan, 10 respondents' used saving and 6 respondents used other means to purchase solar panel. With income group ranging from 16,000 to 20,000, the total respondents are 25, out of them 11 used loan, 7 used savings and 7 used other means to install solar panel. In the income group 21,000-25,000, total respondents are 6, out of whom 1 used loan, 1 used savings and 4 used other means. In the income group 26,000-30,000, total respondents are 4. Out of them 1 used loan, 2 used savings and 1 used other means. In the income group with 31,000-35,000, total respondents are 2, 1 of whom used loan and 1 used savings. Concluding remarks

3.5 Impacts on Education: Table 5 shows the percentage of household respondents who enjoy the benefits of improved education level that arise from for the numbers of years for which solar panel has been used. About 94% of the household respondents who are using solar panel from 1

to 5 years, expressed that they got an education friendly environment due to their use of solar panel. On the other hand 100% of the respondents, who are using solar panel for 6 to 10 years, opined that their educational level has improved due to the use of solar panel. These figures are 100% for both male and female in case of the businesses.

Table: 5 Effects of Solar Panels on Education

Educational Level						
Years of using solar panel	Household			Business Owners		
	Yes	No	Total	Yes	No	Total
1 to 5	76 (94%)	2 (6%)	78 (100%)	51 (100%)	0 (0%)	51 (100%)
6 to 10	17 (100%)	0 (0%)	17 (100%)	4 (100%)	0 (0%)	4 (100%)
Total	93 (97%)	2 (3%)	95	55 (100%)	0 (0%)	55

3.6 Impacts on Economic Conditions: The respondent's views about the changes in economic condition in terms of the number of years in using solar panel are summarized in Table 6 below. From the table it is seen that 81% of the household's respondents who are using solar panel from 1 to 5 years, reported that their economic conditions improved after they had installed solar panel. On the other hand, it is seen that 30 (75%) who are using solar panel from 6 to 10 years, expressed that their economic conditions have improved. Out of total 135 respondents, 107 (79%) stated that their economic conditions have improved. Only 28 (21%) respondents opined that their economic conditions have not improved.

The right hand side of Table 6 shows the results for the businesses. 96% of the business respondents who are using solar panel from 1 to 5 years, reported that their economic conditions improved after they had installed solar panel. On the other hand, it is seen that 11 (100%) who are using solar panel from 6 to 10 years, expressed that their economic conditions have improved. Out of total 107 respondents, 104 (97%) stated that their economic conditions have improved. Only 3 (3%) respondents opined that their economic conditions have not improved.

Table 6 Number of Years Solar Panels Used and Change in Economic Conditions

Households				Business-owners		
Years of using solar panel	Economic condition improved		Total	Economic condition increased		Total
	Yes	No		Yes	No	
1 to 5	77 (81%	18 (19%)	95 (100%)	93 (96%)	3 (4%)	96 (100%)
6 to 10	30 (75%)	10 (25%)	40(100%)	11 (100%)	0 (0%)	11 (100%)
Total	107 (79%)	28 (21%)	135 (100%)	104 (97%)	3 (3%)	107 (100%)

3.7 Satisfaction With Solar Panels: In the previous few sections some specific effects of using solar panels were discussed which are summarized in this section with a catch all measure "satisfaction" from using solar panels. If specific items are evaluated positively then it should be reflected in this measure. Table 7 presents the satisfaction level of the respondents after using solar panels. Among 149 respondents, 96 (64%) male respondents are moderately satisfied, 28(19%) respondents are over satisfied and 24 (16%) respondents are less satisfied and 1(.67%) respondent is not satisfied. Out of the 9 female respondents 7 (78%) respondents are satisfied, 1 (11%) respondent is over satisfied and 1(11%) respondent is less satisfied. From the Table 5.8 it is clear that out of 158 respondents, 103(65%) respondents are satisfied, 29(18%) are over satisfied, 25(16%) respondents are less satisfied and 1 (63%) is not satisfied.

In case of businesses, among 104 respondents, 75 (72%) male respondents are satisfied, 22 (21%) respondents are over satisfied and 6 (6%) respondents are less satisfied and 1(1%) respondent is not satisfied. Out of the 13 respondents 9 (69%) respondents are satisfied, 2 (15%) respondent is over satisfied and 1(8%) respondent is less satisfied and 1 (8%) is not satisfied. From Table 5.8 it is clear that out of 117 respondents, 84 (72%) respondents are satisfied, 24 (21%) are over satisfied, 7 (6%) respondents are less satisfied and 2 respondents (1%) are not satisfied.

Table 7: Satisfaction Levels of Using Solar Panel by Gender

	Consumer					Business-owners				
Gender	Not Satisfied (%)	Less Satisfied (%)	Satisfied (%)	Over Satisfied (%)	Total (%)	Not Satisfied (%)	Less Satisfied (%)	Satisfied (%)	Over Satisfied (%)	Total (%)
Male	1 (1%)	24 (16%)	96 (64%)	28 (19%)	149 (100%)	1 (1%)	6 (6%)	75 (72%)	22 (21%)	104 (100%)
Female	0 (0%)	1 (11%)	7 (78%)	1 (11%)	9 (100%)	1 (8%)	1 (8%)	9 (69%)	2 (15%)	13 (100%)
Total	1 (1%)	25 (16%)	103 (65%)	29 (18%)	158	2 (1%)	7 (6%)	84 (72%)	24 (21%)	117

3. Conclusion and Policy Recommendations:

Bangladesh is an energy-deficient country and the energy constraint is a great barrier to its overall economic development. Bangladesh is endowed with plenty of renewable energy resources and its proper utilization is crucial for meeting the energy requirements. The utilizing of renewable energy resources in Bangladesh is only the option to meet its enormous energy need. The most significant social benefit of the use of decentralized energy sources is that it can be made available to isolated and remote areas, like islands.

The study finds that a majority of the households using solar panel are headed by male and they are dependent on loan for installing solar panel. Most of the respondents (94%) feel that their education levels have improved. After they had installed solar panel, 79% of the respondents think that their economic conditions have improved. Out of 201 respondents 99% respondents admitted their life standard has been improved. Respondents also opined that they are satisfied with the use of solar panel. In case of businesses the qualitative impacts of solar panel uses are almost similar, though there are some quantitative differences.

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