Journal of Science and Technology, 7(1 & 2): 45-56, December 2017

ASSESSMENT OF RENEWABLE ENERGY (PHOTOVOLTAICS ENERGY) USES IN CHAR LAND AREAS AT JAMALPUR DISTRICT, BANGLADESH

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Abstract

Photovoltaic (PV) systems have widely used as a reliable and alternative energy source to meet the electrical energy demand of rural settlements in the char land areas of Bangladesh. For the purpose of estimating solar energy potentials and durability of PV systems in the study area, a questionnaire survey was performed among 86 households. It has been observed that respondents accept the PV system as an alternative energy source. The sunlight radiation in the area is almost available all the year round as about 12 hours a day. The study revealed that around 48% people use the PV energy to meet their basic energy demand. The PV energy system was adjusted to meet the load requirement of the area as lighting, fanning, mobile charging and TV watching but the uses of electronic loads varies with the power capacity of photovoltaics. Major advantages include cost effectiveness and power storing capacity and the main identified challenge for promoting PV system is its variability in power capacity compared to the energy supplied by Bangladesh Power Development Board (BPDB). From the study, it is apparent that electricity generation system for rural household could be attractive as a photovoltaic system (PV), which can improve the quality of life and socioeconomic status of rural people as well as can reduce power crisis of the country.

Key words: Renewable energy, PV system, Char land, Power capacity

Introduction

Energy is of utmost importance as most modern activity relies on it. International Energy Agency (IEA) predict that the global demand for primary energy sources will increase by 36% between 2008 and 2035 with fossil fuels accounting for over one-half of the increase in total primary energy demand (IEA, 2010). The increasing demand of electric power and shortage of present energy resources lead today engineers and scientists to think about the alternative sources of energy, the sunlight is a potential sources for generating electric power (Rifat and Islam, 2014). Energy is a key to development and a

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fundamental issue in relation to poverty reduction and achievement of SDGs in Bangladesh. It is a low energy consuming country with per capita annual consumption of 220 KW hours. The country is struggling to meet the current demand of 5500 MW (MoEF, 2012).

The demand for energy outstrips the availability. Energy demand will continue to rise in response to expanding economic activity and exploding population. The increasingly high population density in the urban areas and rapid industrialization is also driving up the demand for energy. Indeed, energy security is essential for Bangladesh's sustainable development (MoEF, 2012). Energy is the source of growth and the driver for economic and social development of a nation and its people. Akter (1997) asserted that it is not possible to alleviate poverty and to achieve development until providing sufficient energy to our people for seeing, reading and working.

In Bangladesh is only 55.26% of the households have access to electricity with 90.10% households in urban and 42.49% households in rural areas (BBS, 2010). Low access to electricity and frequency of power outages threaten welfare of citizens. Electricity being an important input to production in manufacturing, agriculture, services and construction. Inadequate supply and frequency of outages has emerged as a binding constraint on production. Increased use of renewable energy such as solar, wind, tidal, geothermal and modern bio-mass technologies can help to achieve energy security in the country as there is shortage of non-renewable energy as the source of fuel (MoPEMR, 2012). Bangladesh is a country where energy crisis seems to be the major problem in spite of being blessed available solar radiation. Solar Energy is inexhaustible and pollution free. Islam and Rashid (2012) stated that solar energy is available everywhere but the greatest amount is available between two broad band's encircling the earth between 15^{o} and 35^{o} latitude north and south. Fortunately, Bangladesh is situated between 20.30 to 26.38^{o} N and 88.04 to 92.44^{o} E, which is a favorable position in respect of utilization of solar energy (Hasan *et al.*, 2010). Annual amount of radiation varies from 1840 to 1575 kwh/m^2, which is 50-100% higher than that of Europe. Present total yearly consumption of energy is about 700x1018 J in Bangladesh. This shows that even if 0.07% of the incident radiation can be utilized, total requirement of energy in the country can be met. At present energy utilization in Bangladesh is about 0.15 watt/sq. meter land area, whereas the availability is above 208 watt/sq. meter. This shows the enormity of the potentiality of this source in this country (Islam and Rashid, 2012).

The Government of Bangladesh has taken a number of actions on priority basis to promote production and use of renewable energy in different areas of the country. There has been some progress in expanding use of solar power for domestic purposes especially in off-grid areas. Irrigation pump driven by solar power, solar mini-grids in the distant islands, solar panel assembly plants and telecommunication towers driven by solar power have been installed. In 2011 the government made it mandatory for developers to install

solar power in new buildings to meet 3% of their total electricity requirements before getting electricity connections. This saves energy from non-renewable sources and forces the developers to plan for green buildings (MoPEMR, 2012).

Solar photovoltaic (PV) systems are in use throughout the country with over 300,000 household-level installations having capacity of about 15 MW as of November, 2008 (MoPEMR, 2008). Scaling-up of solar PV systems assisted by the development partners are being implemented through Infrastructure Development Company Limited (IDCOL), Rural Electrification Board (REB), Local Government Engineering Department (LGED), Bangladesh Power Development Board (BPDB), NGOs and Private Organizations implementing solar energy program. There is a strong potential for solar energy within the country (MoPEMR, 2008). The objectives of the study were: to identify the present status of renewable energy in selected char land areas; to assess the potentiality for promoting PV systems as a renewable energy sources and to explore obstacles and opportunities for promoting PV energy system in the study area.

Materials and Methods

Study area

This research was conducted in char land areas at Chorcharia in Palbandha union and Degreerchor, Boardbazar at Islampur upazila in Jamalpur district (Fig. 1). Chorchachira has 221 households with a population of 804 and Degeerchor has 115 households with a population of 1263 (BBS, 2011). These selected char lands are located in the bank of Brahmaputra River. In the char lands, the majority of the households are either directly or indirectly dependent on agriculture for their livelihoods (BBS, 2001).

Data collection

The study is primarily based on primary and secondary data sources regarding renewable energy uses in the selected char settlements. Primary data were collected from field observation, questionnaire survey and personal interview. The status of renewable energy was assessed by direct observation and personal interview. Primary data were collected from interview with different institutions (BUET, IDCOL, GIZ, Rahimafroz, Grameen Shakti, CBE, GTS Solar, Solaric, Intraco Renewable Energy LTD. etc.), Government body (MoEPMR, BPDB, REB, SREDA, and LGED), officials (local union parishad chairman, electrical engineer on study area) and questionnaire survey on the users of PV energy systems on study area.

Key informant interview

As a part of primary data collection key informant interview (KII) was carried out with various relevant personnel and professionals. Interviews were usually carried out in a “one to one mode”, “one to many mode” and in many cases with more “elderly

informants/ members of the community" as well. The KIIs were carried out with relevant institutional resource personnel (e.g. engineers of MoPEMR, PDB, REB, LGED, BUET, IDCOL, GTZ), local knowledgeable people, livelihood group members, female members in the community, and other associated people (e.g. NGO workers of Grameen Shakti, BRAC, Agriculture Extension Officer, local union parishad officer, school teacher etc.).

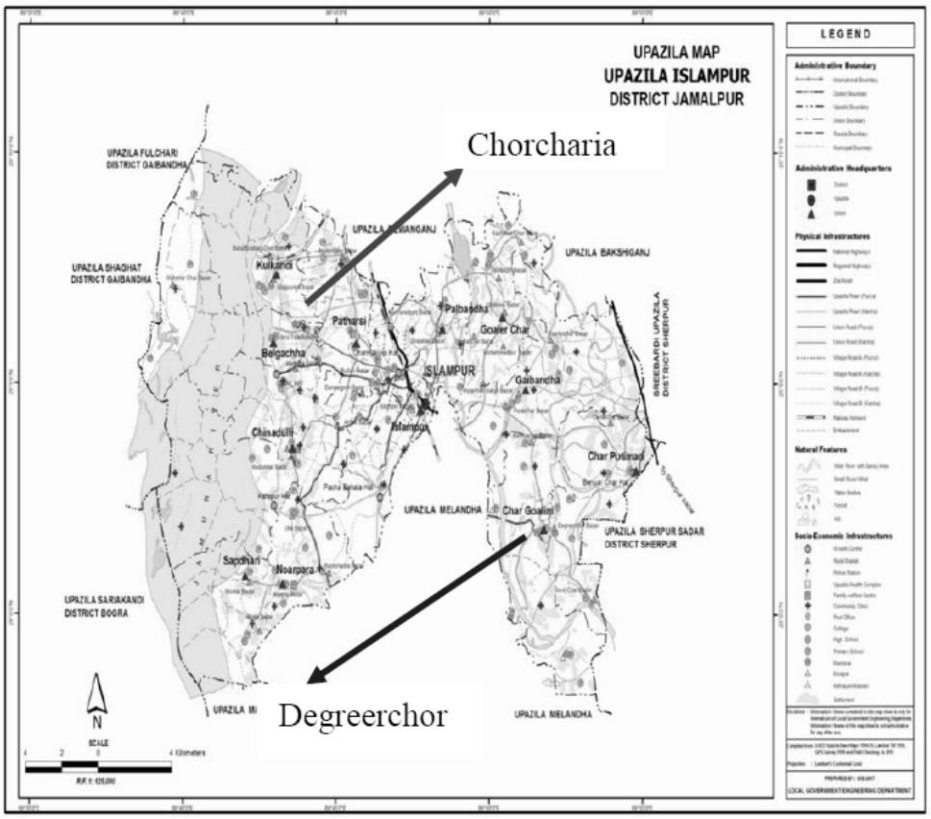

Fig. 1. Map showing the study area in selected char lands (Chorcharia and Degreerchor)

Questionnaire survey and field observation

To know the energy status of the selected char lands a questionnaire survey was conducted where 86 respondents were selected randomly. The questionnaire was designed based on the study objectives so that it would track down the real condition of that area. Both open ended and close ended questions were included to carry out the survey. Information regarding how the people were benefitted by renewable energy uses in the study area were collected through field observation.

Secondary data collection

Apart from primary data, the collection of relevant secondary data were also very crucial to conduct the study. relevant secondary data like as the energy situation, renewable

energy status, future energy project of Bangladesh and of the studied area, study area population, previous data on energy uses were collected from different sources such as the Ministry of Power, Energy and Mineral Resources (MoPEMR), BPDB, REB, LGED, IDCOL, BRAC university, Grameen Shakti, Union Parishad office etc. Population data was collected from BBS and local Union Parishad office.

Sampling procedure

There are around 221 households in Chorcharia and 115 households on Degreerchor on which around 100 households on Chorcharia and 80 households on Degreerchor use PV energy systems for various purposes. Out of the 180 households of the two selected char lands who use PV energy system, 86 households (i.e. Sample size, N=86) (25 from Chorcharia and 61 from Degreerchor respectively) are randomly selected for the questionnaire survey.

Results and Discussion

Beneficiary of PV system in Chorcharia and Degreerchor

The study showed that around 48% of total population has the access to electricity as PV system in the char land areas of Chorcharia and Degreerchor (Fig. 2). Asaduzzaman *et al*. (2010) asserted that solar photovoltaics (PV) are used widely throughout the country with more than 80,000 reported households and enterprise level installations (3.5 MW total capacities). The study also identified that solar PV system could be used within a broader rural electrification program if affordable products that meet consumer needs were supplied and supported (Asaduzzaman *et al*., 2010).

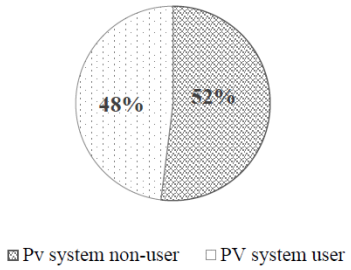

Fig. 2. Beneficiary of PV system on Chorcharia and Degreerchor

NGO involved in supply of PV system

As a part of the government project, IDCOL (Infrastructure Development Company Limited) is mainly responsible to supply electricity in remote areas and poor people in Bangladesh. IDCOL supplies around 2 lacks of SHS (solar home system), battery and solar panel every year in Bangladesh. The other companies that work on the same objectives are Rahimafroz, GTZ, Grameen Shakti, BRAC etc. (MoPEMR, 2008). On

Chorcharia and Degreerchor the users know about PV system through six different NGOs such as Rahimafroz, Grameen Shakti, BRAC, Super star, Srizony Bangladesh and Abha Development Society. On Chorcharia and Degreerchor majority of the people uses PV system supplied by Rahimafroz, followed by Grameen Sakti, Abha Development Society, Srizony Bangladesh, BRAC and Superstar (Fig. 3).

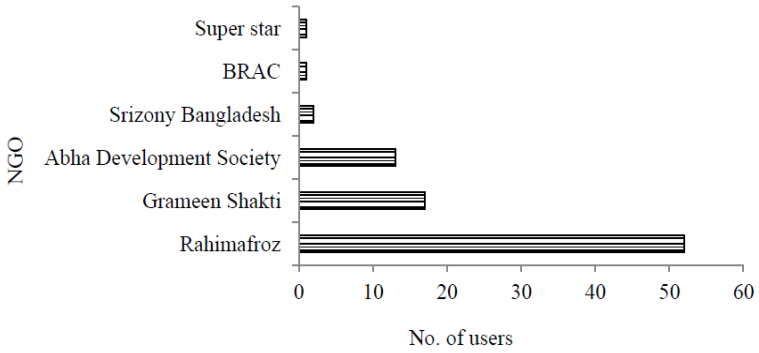

Fig. 3. NGO involved in supply of PV system on Chorcharia and Degreerchor

Power capacity of PV systems

The study explored that PV systems in Chorcharia and Degreerchor belongs to very poor in power capacity as the technology is not so developed yet in Bangladesh and also for the unwillingness and lack of basic knowledge about PV energy system among the rural people and most of all due to poverty. The people are poor and cannot afford too much for the installment payment. The available PV systems on Chorcharia and Degreerchor were ranged from 20 to 100 watt. The maximum users in Chorcharia and Degreerchor use 20 watt PV system, followed by 50, 40, 30, 65, 85, 75, 105 and 100 watt' respectively (Fig. 4).

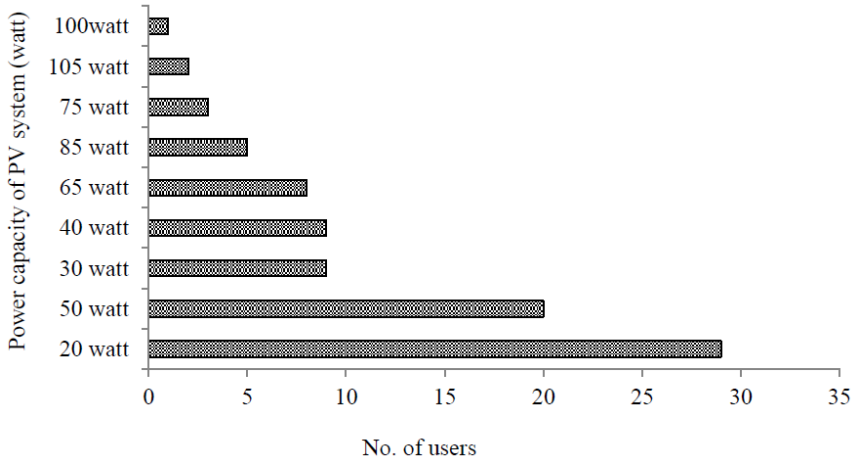

Fig. 4. Power capacity of PV system uses on Chorcharia and Degreerchor

Status of sunlight availability for PV systems

Geographically Bangladesh is situated in an ideal location for solar energy utilization. The study revealed that majority of the respondents mentioned that sunlight is available on their PV system and it remains more than 12 hours on the areas, which can help to reduce power crisis in these remote char land areas. For instance, Hasan *et al.* (2010) asserted that solar energy can be a great source for solving power crisis in Bangladesh. According to the respondents, among the three periods (pre-monsoon, monsoon and post-monsoon), maximum sunlight penetration occurs in pre-monsoon period in the char land areas and which is around 12 hours a day. Then the radiation hour decreases from pre-monsoon to monsoon and from monsoon to post monsoon respectively. On monsoon period maximum radiation occurs up to 10 hours and on post monsoon maximum radiation occurs up to 8 hours a day (Fig. 5).

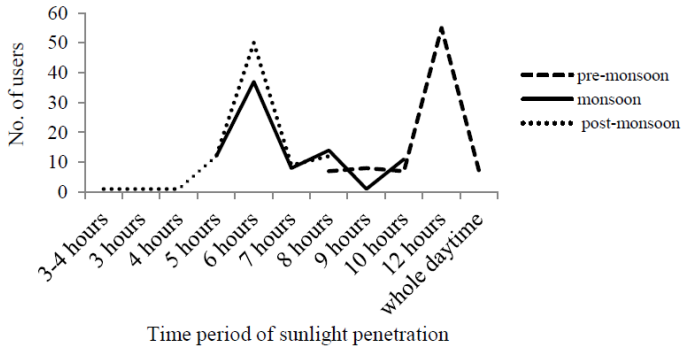

Fig. 5. Duration of sunlight penetration in different periods

Duration of PV systems uses in Chorcharia and Degreerchor

The study showed that as Chorcharia and Degreerchor are remote areas and for the poor power capacity of PV systems, users use PV energy on night time mainly for lighting. The study showed that the majority of the respondents (85%) uses PV system energy about 4-8 hours per day, followed by 1-4 hours per day (8%), 8-12 hours per day (3%) and more than 12 hours per day (1%) (Table 1). A similar study was conducted by Maherin (2009) showed that in rural areas of Bangladesh beneficiaries uses PV energy system up to 6 hours a day.

Table 1. Duration of using PV systems on Chorcharia and Degreerchor

Duration of using PV systems (hr./ day)	No. of user	Percentage
1-4	7	8
4-8	73	85
8-12	3	4
more than 12 hours	1	1
Unknown	2	2

Uses of PV system in char land areas

It is revealed from the study that in the char land areas of Chorcharia and Degreerchor, the PV system is currently used by the local inhabitants in various sectors. For instance, all of the surveyed respondents use this energy for lighting, 87% of them uses for mobile charging, 63% uses for fanning, 26% uses for reading and educational purposes and only 2% uses it for watching TV in their houses (Fig. 6). Photovoltaic technologies are generally recognized as enabling technologies, providing electric power for a variety of applications, such as lighting, communications, water pumping and purification (John, 2003).

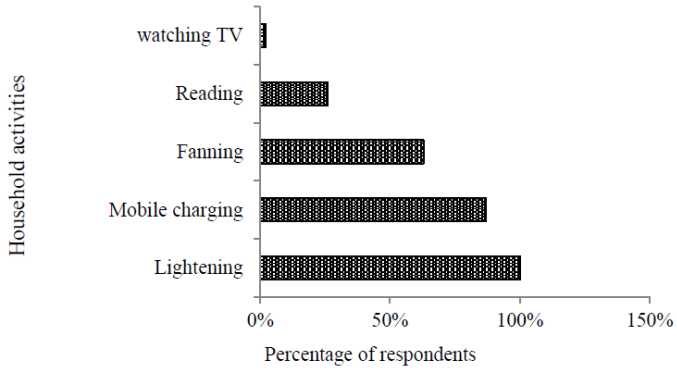

Fig. 6. Electricity consuming activity through household

Advantages of PV system

PV system energy has a lot of advantages in comparison with conventional energy system provided by the Power Development Board (PDB). It is cost effective and durable, once the PV system is installed it can serves more than 25 years.

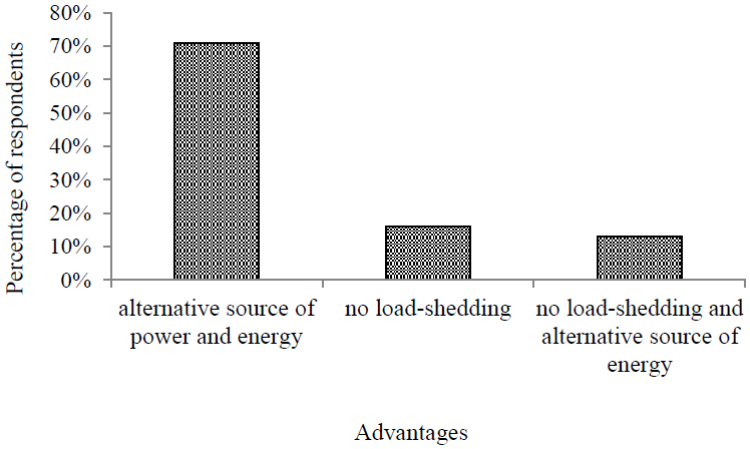

Fig. 7. Advantages of PV system uses on Chorcharia and Degreerchor

The study showed that in Chorcharia and Degreerchor, majority of the respondents (71%) accept it as an alternative source of electricity, which they considered as a major advantage of PV system uses, followed by no load shedding occurred (16%) (Fig. 7). The study conducted by Choudhury (2006) showed that PV energy increases education opportunities, willingness to study, attendance to school, expansion of local business and trade, work opportunities increases for unemployed, cottage industries established, increase in livestock production, working possibility extends at night, new shop emerged, security increases due to light at night and reduces theft and robbery.

Impacts of PV system in char land areas

As an alternative source of energy and blessings of technology for 21st century, PV system has some economic, social and environmental impacts some of which are identified during the survey in the char land areas (Table 2).

Major Barriers of PV system development

The main limitation for PV system development on Chorchachira and Degreerchor is its variability of power capacity. Energy capacity ranged from 20 to 105 watt per SHS (Solar Home System) is very poor and thus with poor power capacity it is very difficult to fulfill the energy demand in char land areas. However, the study identified some other barriers of PV system uses in the char land areas such as willingness to use the PV system, lack of basic knowledge on PV system, its operation and maintenance (OM), initial cost of installment, variability of power storage etc. (Fig. 8). The study conducted by Islam and Islam (2005) stated that there are plenty of barriers hindering the widespread deployment of potential PV system including policy barriers, institutional barriers, market barriers, economic, financial and financing barriers, information barriers, human resource barriers. Moomaw *et al.* (2011b) also asserted that there are four types of barriers to promote PV system as an alternative energy source such as i) market failures and economic barriers, ii) information and awareness barriers, iii) socio-cultural barriers and iv) institutional and policy barriers.

Table 2. Impacts of PV system in the char land areas

Economic impact	Social impact	Environmental impact
It revealed from the study that in the char land of Chorcharia and Degreerchor all of the respondents identified the PV system is a cost effective energy source for them in comparison with the energy supplied by the PDB (Power Development Board) which they considered as the economic impact of PV system.	The study identified some factors that are considered as social impacts of PV system by the local people such as: - it is an alternative source of energy in the char land areas specially for low income people - PV system also can be a sustainable source of energy for these remote areas.	As the environmental impacts of PV system in char land areas the majority of the respondents identified it as an environment friendly source of energy which can meet their energy crisis as well as it can also reduce carbon emission.

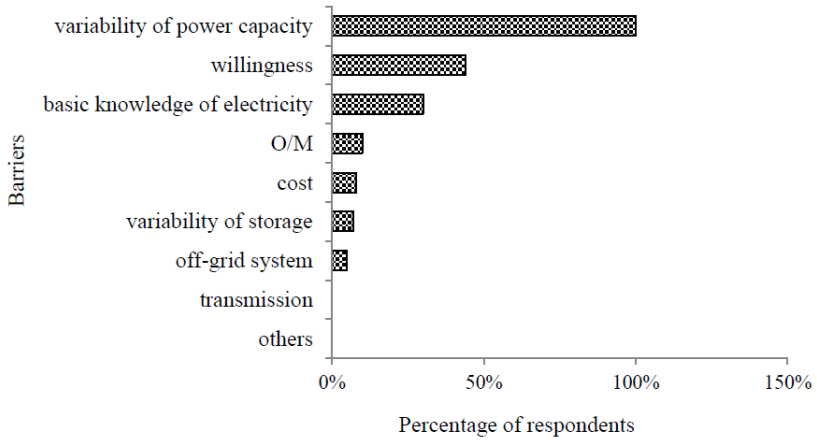

Fig. 8. Barriers of PV system uses on Chorcharia and Degreerchor

Suggestions for promoting PV system

In the char land of Chorcharia and Degreerchor the respondents suggest some options that can assist to promote solar PV system. For instance, all the respondents suggest that through increasing power capacity, it is possible to promote PV system in char land areas, followed by developing of PV system (80%), reduction of installment cost (35%) and change the PV system from off-grid to on-grid system (10%) (Fig. 9). To promote PV energy many countries like Denmark, Spain, and Germany have already declared national policies to generate at least 20% of their national demand through renewable sources and by 2050 become completely powered by renewable energy (Muzzammir and Foraji, 2014).

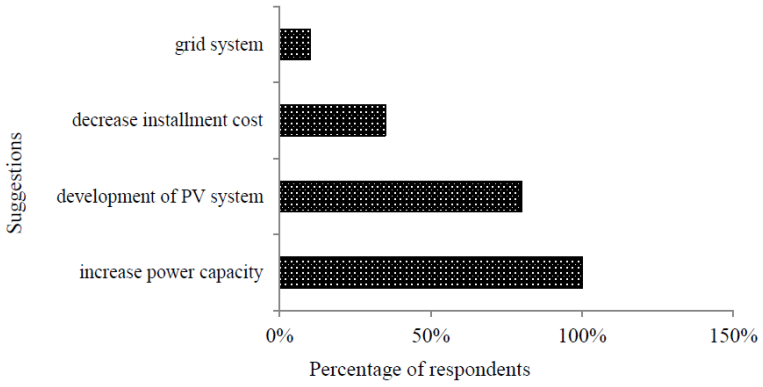

Fig. 9. Suggestions for promoting PV system

Conclusion

Photovoltaics energy can help to mitigate the energy crisis in the charland areas of Bangladesh like Chorcharia and Degreerchor with enough solar radiation, although in

monsoon and winter sunlight radiation hour remains short due to weather. It is therefore, become a positive step to involve rural communities directly in this technology because this is the potential way of increasing energy supply and can also contribute to overcome the country's energy crisis and reduce global carbon emission, which can contribute towards achieving sustainable development. To overcome the existing barriers for developing PV system in the char land areas as well as for future planning for its development and implementation this study suggests that technical, social, and institutional barriers have to be overcome; use of solar energy can be disseminated in off-grid rural areas of Bangladesh; social awareness should be built up regarding the benefits of using PV system and government should provide legal support and follow the policies adopted by developed countries in this sector.

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