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The Utilization of Solar Energy in Bangladesh: Present Status, Prospects and Challenges

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Abstract: The Earth receives an unbelievable supply of solar energy. The sun was burning above 4 billion years. It provides enough energy in one minute to supply the world's energy needs for one year. A reliable, affordable, and secure supply of energy is important for socio-economic development. As a country of acute power crisis Bangladesh is now looking forward to developing its renewable energy sources in addition to its traditional sources of fossil fuel. It has very limited nonrenewable energy sources of its own, but it's endowed with renewable energy sources like biomass, wind, hydro and solar insolation. The following research paper is based on the present status, prospects, and challenge of solar energy from Bangladesh perspective.

Introduction

Today's energy requirement increasing in trend due to population growth, economic and technological advancement. Also, on behalf of new energy exploration condition and present energy consumption rate, whereas discovered energy will deplete within a few decades. Energy has been reported as a critical component in our lives. The primary energy resource situation of Bangladesh is not good at all in comparison with world energy. The proved reserved of oil, natural gas, coal, and hydropower in Bangladesh are limited and larger scale of infrastructure development needed in the country. The Ministry of Power, Energy and Mineral Resources quotes that with a 160 million population Bangladesh government provides electricity to 70% of people in 2015 (Bangladesh: Increasing Access to Energy) and currently per capita energy generation 372 kWh while 75 the world total Primary Energy Consumption per Capita (Million Btu per Person) 75 which is equivalent to 21980.33025 kWh (kilowatt-hours); this consumption is much greater than per capita energy consumption in Bangladesh. Bangladesh produces its maximum electricity from national grid gas supply which is almost 62.31 % and petrol Bangla reports that Bangladesh power generation largely depends on 80% on gas.

Hence the maximum production of electricity being controlled by local sources of energy and imported only 4.28% which is a key factor of a challenge for future electrification of Bangladesh. The Bangladesh Petroleum Corporation (BPC) in the FY 2014-2015 imported 1.297 million tons of crude oil and 4.095 million tons of refined oil of which 63 per cent is diesel oil. Bangladeshi gas field provided 2725 million cubic feet gas, 9263.7 million cubic feet condensate during the last operation on 21-22 Sept. 2015 with a demand of 3800 between 2015-16. The production of coal in the fiscal year 2014 June-15 July 345751.44 metric tons. Table 1 represents the installation and dated capacity of BPDB (Bangladesh power development board) power plants and major fuel contribution in Bangladesh as of Sep 2018.

The deficiency of power generation in Bangladesh against demand is higher which the obstacle for countries growth and development. Solar energy is an important energy resource in Bangladesh and

solar photovoltaic (PV) cell is one of the popular technologies mainly used in rural areas, hilly areas, and coastal areas in Bangladesh. Bangladesh has a long history of hydroelectricity generation and Bangladesh has already established micro-hydro and mini hydropower projects. Wind energy is another renewable resource in Bangladesh, mini and micro wind generation sites are available for electricity generation. Therefore, renewable energy plays a vital role in energy security in Bangladesh.

The global warming due to greenhouse gas emission and the energy scarcity worldwide are prompting almost all the countries in the world to look for alternative sources of energy such as nuclear and renewable such as solar, wind, geo-thermal and wave energies, which do not cause carbon emission. Whereas developed countries can tap into nuclear energy, a developing country like Bangladesh is not fortunate enough to have that option available. Consequently, the only option that is open to Bangladesh now is renewable energy such as solar and hydroelectric. Bangladesh is a semi-tropical region lying in northeastern part of South Asia gets abundant sunlight year-round. The average bright sunshine duration in Bangladesh in the dry season is about 7.6 hours a day, and in the monsoon, season is about 4.7 hours. Solar energy can be harnessed in two ways:

a) Photovoltaic Cells (PV) and
b) Solar thermal energy (STE).

In general, a solar cell or photovoltaic cell (PV) is a solid-state electrical device that converts light into electric current using the photoelectric effect. Materials presently used for photovoltaic solar cells include mono-crystalline silicon, polycrystalline silicon, amorphous silicon, cadmium telluride, and copper indium selenide/sulfide. Different materials offer varying level of efficiencies, with the current average efficiency of a solar cell ranging from 8%-20%. Historically, most PV panels have been used for off-grid purposes, thus it can be seen as a means of avoiding construction of long and expensive power lines to remote areas. Off grid PV systems have normally use storage devices (Battery) to store excess electricity which can run the cell for a few hours in the absence of sunlight. On the other hand, solar thermal energy is a form of energy in which the sun is used to produce heat that can be used in a variety of ways. For thousands of years, people have been using this energy for a variety of tasks, and modern technology has considerably expanded the applications for the sun's heat.

Methodology

This study is entirely a state- of- art- of approach for readers and researchers and. A secondary source of knowledge has been adopted in this study. It is an empirical study. A good number of magazines, articles, reports, and research articles have been considered for this article. Both exclusion and inclusion criteria were followed to adjust with the overall objective of the study.

Solar Energy

The relation between man and the sun is ancient. The sun has played a massive role in the history of mankind. Some old civilizations even had spiritual belief in the power of the sun. According to Hsieh (1986), the sun is a giant nuclear reaction that transforms four million tons of hydrogen into helium per second. The earth will receive only a tiny amount of the sun generated energy.

A Swiss scientist, Horace de Saussure, built the first thermal solar collector in 1767, which was later used to heat water and cook food. The first commercial patent for a solar water heater went to Clarence Kemp of the US in 1891. This system was bought by two California executives and installed in one-third of the homes in Pasadena by 1897. The ability to use solar power for heat was the first discovery. A Swiss scientist, Horace de Saussure, built the first thermal solar collector in 1767, which was later used to heat water and cook food. The first commercial patent for a solar water heater went to Clarence Kemp of the US in 1891. This system was bought by two California

executives and installed in one-third of the homes in Pasadena by 1897. Solar energy may have had great potential, but it was left on the backburner whenever fossil fuels were more affordable and available.

The radiated energy from the sun must be equal to the energy it produces to ensure its structural stability. The evidence of this stability over the last 3 billion years can be seen by the relative stability of the temperature of the earth's surface. Oxidized sediments and fossil remain reveal that the water fluid phase has been presented through this time. The earth's orbit around the sun is slightly elliptical, making the distance between the two vary throughout the year. The earth and sun are 91.4millionmiles apart in January compared to 94.5millionmiles in July; this leads to an annual disparity of 3%–4% in the irradiance at the edge of the atmosphere. Although the earth receives just a tiny fraction of the sun's generated energy, it is still a massive amount of energy. The earth's radiation reception rate is 1.73 ∗ 1017 J/s, and, in a year made up of 365.25 days, the total amount of radiation is 5.46 ∗ 1024 J. Boylestad and Nashelsky (1996) stated that the received energy at sea level is about 1 kW/m2. There are strong links of all known forms of energy resources to the sun and how they are used by mankind.

The small portion of energy demand of Bangladesh partially filled by solar photovoltaic (PV) system and the positional view of Bangladesh in perspective of solar radiation 241 0' 0″ N latitude and 901 0' 0″ E longitude. However, the total production of solar energy in Bangladesh 500 MW and the total share of renewable energy 39.5 %. Bangladesh state-owned infrastructure development company limited (IDCOL) have already installed 3 million solar home systems (SHS) by providing clean energy over 13 million of the rural population. Bangladesh receives an average daily solar radiation in the range of 4-5 kWh/m. The new mega electricity project vision 2021, implemented by Prime Minister's electricity. Global Post quotes that Bangladesh installed over 50,000 SHS and Bangladesh is the fastest growing nation around the world. Solar energy is now estimated for one-third of the United States new generating capacity in 2014, surpassing both wind energy and coal for the second year in a row. However, the current photovoltaic (PV) panels are not highly efficient.

Potential of Solar Energy in Bangladesh (Environmental Analysis)

Bangladesh is located between 200 30‟ and 260 45‟ north latitude and has a total area of 1.49E+ 11 m2. An average of 5 kWh / m2 solar radiation falls on this land over 300 days per annum. Maximum amount of radiation is available on the month of March-April and minimum on December-January. A 2012 study found the daily sunlight hours in Bangladesh to range from 10 to 7 hours; they further reduced this by 54% (to 4.6 hours) to account for rainfall, cloud, and fog. So, this abundant solar energy has a large potential to be used in various sector in Bangladesh reducing the traditional fossil fuel-based power consumption and ensuring a green environment for the future generation.

Prospects of Solar Energy in Bangladesh

Bangladesh is a potential ground for applying solar energy in different aspect using both solar PV and STE technology. Some applications specially designed for Bangladesh is described below.

i. Solar Based Recharging Stations for Electric Vehicles

Currently two types of electrical verticals are running in our country. One is locally called "easy bike". It looks closely like traditional CNG based auto rickshaw except its run-on battery. The second one is two seated rickshaws. Both are energy efficient and environment friendly being popular in the world as well as Bangladesh. Typically, they run on 50 Ahr.80 Ahr, 100Ahr and 120 Ahr battery based on the size and speed of the vehicle.

ii. System design

The PV modules are accommodated on the roof of fuel filing stations. Generally, the roof is plain as a result there is no problem to set up but for maximum efficiency. PV modules are tilted with an angle which depends on the location of the installation. For Bangladesh the optimum tilt angle is around 23°.Capacity of the PV module should be selected taking in consideration the rooftop size for accommodating the panels and the desired output.

Solar PV Based Irrigation in Rural Bangladesh and Solar DC Micro-grid

Irrigation problem is the most acute problem of Bangladesh being an agricultural county. About 3, 36,000 pumps are used during dry seasons for irrigation purpose. About 50% people living in this country are off-grid and mostly use diesel generator for irrigation. People of on-grid use 1700Mw of power only for irrigation purpose, creating load shedding throughout the nation. So, we need to look for an alternative solution. Solar PV based irrigation is not a new concept and there are already several such irrigation schemes running in Bangladesh. Technologically, it is not a big challenge, as it does not require any highly sophisticated component. However, the main challenge comes from the actual cost of irrigation which is heavily dependent on the irrigation model in the context of the socio-economic condition of rural Bangladesh. As irrigation requirements are quite severe only during the dry months (3-4 months) the overhead cost becomes too high for dedicated irrigation projects.

Storage Device

Solar PV thus storage device is also modeled so that the energy from solar panels can be stored in battery, and it can be used whenever the solar radiation is weak or when the generation is not feasible from solar cells, such as during cloudy days, rainy days. The storage device can also be used as the source of energy during the period of night. As the terminal voltage of the individual battery is 12V hence to get 12V bus single battery per string is used.

Solar Cooking and Its Prospects in Bangladesh

A solar cooker is a device that uses sunlight to produce heat to cook food. Solar cooking is the cleanest and safest mode of cooking. It utilizes solar energy which is abundantly available in nature to cook food. There are three major types of solar cookers:

a) Box-type solar cooker
b) Panel-type solar cooker
c) Parabolic reflector solar cooker

Advantages of solar cooking:

There are several advantages of implementing a countrywide solar cooking practice like,

- Reduction of Deforestation: In Bangladesh, 40 million tons of firewood are burnt for cooking causing air pollution. Solar cooking neither produces smoke nor involves cutting down of trees.
- Reduction of GHG emission: By burning 1000kg of firewood, 1900g of carbon dioxide gas isreleased into the atmosphere. Burning of 1000 cubic feet of natural gas produces 55,622.38 g of carbon dioxide. As previously mentioned, solar cooking does not emit any greenhouse gas.
- Gas Crisis Mitigation: The total number of gas connections is 23, 25,456 If such a household uses a solar cooker on every sunny day, it is possible for that household to save about 94.49×145=13,701 cubic feet of natural gas per annum.
- Health issues and safety reasons: Burning firewood or Combustion of gas releases nitrogen dioxide, sulphur dioxide and also formaldehyde, which, if inhaled over a long period of time, results in asthma, wheeze and even lung cancer. Occasional accidents also led to fatal consequences.

Prospects of solar cooking in Bangladesh

Using solar radiation data for Bangladesh has been plotted. It is found that there are on average 294 and 145 days in a year when the global horizontal radiation and the direct normal radiations respectively are above 4.0 KWh/m2 Solar cookers mainly depend on direct radiation, although box cookers make use of both direct and diffused radiations. Hence, on average, solar cookers can be used on 145 days per annum. As on June 2010, the annual consumption of natural gas by the domestic sector is 80.20 billion cubic feet. The total number of gas connections is 2,325,456 which mean that on average, each household with gas connection uses about 34,488 cubic feet of natural gas per annum and 94.49 cubic feet of gas per day. If such a household uses a solar cooker on every sunny day, it is possible for that household to save about 94.49×145=13,701 cubic feet of natural gas per annum.

*Challenges of solar cooking:*Despite the many advantages that solar cooking can bring about in the lives of Bangladeshi people, there are several obstacles to successful deployment of solar cookers over a countrywide range. The obstacles are discussed below:

Lack of flexibility: Solar cooking can be done only in the presence of sun and with necessary solar insolation moreover; solar cooing takes longer to cook food than conventional methods.

Limited Access to Sunlight: Although rural people in Bangladesh may still get plenty of sunlight for cooking, very few residents of the city area have access to sunlight for solar cooking purpose.

Challenges to solar energy adoption

At the level of individual homeowner decision making, there are several barriers to the adoption of solar energy, even in cases where the local climate, utility electrical prices, and the regulatory environment may make the installation of a rooftop panel system a rational choice. The first, obvious potential obstacle is the significant capital cost, which typically is in the neighborhood of US$20 000. While this outlay may be subsidized through several avenues or financed attractively, it is still a major barrier to more widespread adoption of distributed solar energy. Even if this financial barrier can be overcome, there remain other potential obstacles. The homeowner may lack the information or the ability to perform the financial calculations that would otherwise lead to a rational decision to install solar panels, thereby possibly saving money in the long run: the obstacle here is simple lack of information, possibly combined with innumeracy.

Even when a solid financial case cannot be made for a homeowner to install solar panels, he or she may choose to do so for several other reasons. There are anecdotal reports of homeowners deriving psychological benefits from the sensation of achieving independence from the public utility for power. Many homeowners also report that their decision to install was influenced by the desire to contribute to the amelioration of the global climate change problem. Here we come to another set of barriers to solar energy adoption, however. In the United States, in particular, there is a resurgence of hostility and suspicion, in some quarters, directed against the message of scientists about anthropogenic climate change, or simply a counterfactual, largely politically motivated, denial that a scientific consensus exists. There is also simple ignorance: a recent survey revealed that, while greater numbers of Americans accept the reality of anthropogenic climate change than before, only 13% know that “nearly all climate scientists (more than 90%) are convinced that human-caused global warming is happening.” It seems likely that at least some of these Americans were they better informed, would become part of the population that reports concern over global warming as a factor in their decision to install a solar energy system; therefore, their lack of knowledge in the aggregate can be considered a barrier to more widespread adoption of solar energy.

Solar power, along will all other forms of energy that do not consume fossil fuels, competes directly with the economic interests of corporations that profit from the extraction and sale of oil, coal, and natural gas. Every joule of energy that is consumed from a renewable resource replaces a joule of energy that would otherwise need to be made available through chemical combustion, usually of a fossil fuel, or nuclear energy. It may not be surprising, therefore, to learn that the fossil-fuel industry has invested in targeted lobbying campaigns for the purpose of suppressing the adoption of renewable energy, including solar energy. In the United States, this takes the form of direct lobbying of state legislators with the goal of reversing existing incentives in state law that have the effect of encouraging installations of solar panels. It also takes the form of propaganda campaigns designed to inject the idea that net metering discriminates financially against homeowners who are not equipped with solar panels. The recent decisions of the state legislatures in Hawaii, Arizona, Maine, and Indiana to eliminate those states' net metering mandates have been attributed to these lobbying efforts. Even in the absence of a legislative victory, the doubt about the future of net-metering programs raised by lobbying and propaganda efforts is sufficient to dissuade many homeowners from making the substantial investment in rooftop panels, as their financial calculations may assume that the net-metering mandate will remain in force for a substantial fraction of the panels' lifetime.

The situation at the federal level in the United States may be even direr for the future of solar energy adoption. The current leadership of the Department of Energy shows every sign of being unfriendly to renewable energy in general: the chief of staff of the Energy Secretary is a former high-level executive at a leading fossil-fuel lobbying firm, and the Secretary himself has been forthright about his concern for the possible harm that renewable energy could do to the fossil-fuel business.

Conclusion

Solar insolation is the most abundant renewable energy source of Bangladesh. Taking advantage of it we can enrich our regular life. In this paper we have tried to focus on the alternative uses of solar energy to ensure the energy security in near future. A solar based electric vehicle recharging station can reduce the fossil fuel consumption in transportation sector without using any power from grid and will keep our environment clean. A DC grid in off grid area based on solar PV can solve our irrigation problem as well as will ensure a better life for the rural people. Solar cooking can be a viable option for cooking both in rural and city area for reducing the natural gas consumption and burning of wood stock. So, by ensuring these prospects we can solveour energy and gas crisis; and ensure a green environment for the future generations.

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