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Current Status of Renewal Energy: Solar System as an Alternative to Electricity Generation in Bangladesh

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ABSTRACT

Under British rule, Bangladesh introduced electricity on 7 December 1901. However, Bangladesh's power system is complex and old, lacking and poorly managed. Bangladesh will need an estimated 34,000 MW of power by 2030 to sustain and install a capacity of 25,514 MW present (2022). Bangladesh Power Distribution Board (BPDB) applied the load shading technique to manage this package. It is high time to initiate plans to combat the odd electric situation in Bangladesh. Renewable energy can be replenished at a higher rate than consumed from natural sources. Main two renewable energy areas-Sunlight and wind. This two are plentiful and all around us. The main objectives of this study are to discuss where, how and for whom Solar can be used as electricity substitution and its challenges and opportunities.

Keywords: Solar system, Electricity- demand, Renewable energy, and Bangladesh power distribution board.

INTRODUCTION:

One of the most vital issues of the 21st century is preventing a power crisis. This century will experience unpredictable growth and challenges in power generation, delivery and usage. Currently, the country's economic activities mainly depend on Electricity power. Oil, gas and coal are the primary sources of fuel for electricity generation. Therefore, it is essential to secure primary energy sources for ensuring electricity generation, But these sources are not a considerable amount in the earth, are not available for every country, and have too many harmful effects on the environment. Environmentally friendly (renewable and clean alternatives) power generation technologies can play an essential role in power supply. These technologies reform renewable energy resources to power generation. Renewable energy sources - available all around us, are provided by the sun, photovoltaic (PV), micro-

hydro (MH), biomass, geothermal, wind, water, ocean wave and tides, waste, and heat. They are replenished by nature and emit little to no greenhouse gases or pollutants into the air. Bangladesh is situated in the South Asia region and is surrounded by India and Myanmar (Hasan *et al.*, 2020).

This country's electrical network is not interconnected with any of these countries. Therefore this country cannot import nor export any electricity except these two countries and must sustain its own internal demand. Bangladesh has 18 power plants in the public sector which a total capacity of 3331 MW. In the case of the private sector, this statistic is 25 power plants with a total capacity of 2045 MW (according to en.banglapedia.org). Bangladesh has a very limited energy supply and sources. The principal sources of energy are natural gas, and by 2030 its reserves will be

exhausted if new gas reservoirs are not found (MoPEMR, 2016). From natural gas, about 62.9% of Bangladeshi electricity comes, while from diesel-10%, coal-5%, heavy oil-3%, and renewable sources-3.3% (according to energypedia.info). The country regularly imports gas, oil and coal, an obstacle to economic development. Electric generation from this source is also a cause of environmental pollution. When any crisis arises in the world, governments take different short-term strategies to overcome that particular crisis. Such as, In Australia, notified by SMS to overcome the electricity crisis, households were asked to reduce their energy consumption for one to four hours and offered a discount on the next electricity bill. In the same case, the Bangladesh government declares at least one hour per day loads adding. Which is somewhere some time rises 4 to 6 hours per day, it makes life miserable. Since electricity can't get directly from any source, we get it by generating. So, relevant sectors have to think of clean, available and environment-friendly alternative sources that must be taken and executed in short, medium and long-term planning. The sun is a massive source of nuclear power. On per meter square earth surface, it gives 1KW electric power. By using this, the whole world can meet its electricity demand. Bangladesh has a success story in developing off-grid rooftop solar power known as the solar home system (SHS), but not for the whole country.

This system can run every house - rural and urban to avoid unwanted load shading. This system also helps full for people in remote areas who would not have electricity. The study is divided into four sections, Introduction and literature review on the 1st section. The second section describes the methodology, results and discussions. The third section mainly focuses on generating electricity by solar, different uses of solar, prospects, challenges and suggestions.

Objectives of the study

This study is an attempt for the achievement of some objectives of the electricity sector in Bangladesh.

- 1) To find alternative sources of power generation to meet the electricity shortage in Bangladesh.
- 2) To prevent load shedding from public life.
- 3) To promote solar systems.

Literature review

Bangladesh is facing an intimidating energy threat: problems of security over growing fuel Imports for power generation with limited domestic energy resources will exceed domestic supply capabilities within a few years for projected electricity demands. Therefore, every day, Bangladesh has to find new ways to produce more electricity to meet the electricity demand of the growing population. Only the electricity sector costs Bangladesh a lot. Generally, developing a country's energy system depends on reducing carbon emissions, improving power quality and reliability, and in some cases looking at the combination of heat and power operations, significantly improving overall system efficiency. Ahmed. F. *et al.* (2001) have discovered the different factors that are useful to the current power supply crisis and the lack of infra-structure and summarized the current energy scenario in Bangladesh. They also promote regular energy sources (renewable energy sources) to fulfil the power demand in Bangladesh. In our country, we cannot discover any new way or bear the cost of installing a new grid. The Bangladesh government has launched all the schemes in the last few years. This is a compulsory lottery which has made public life miserable. Our researchers have given many suggestions to overcome this load shedding or how to produce more energy. Habib *et al.* (2013) describe different Energy-saving strategies and how electricity can be reduced by using variable speed drive (VSD) and efficiency motors (HEM). Some researchers give short and mid-term solution load shedding (Meah *et al.*, 2010). Since this kind of (load-shedding) problem is happening not only in Bangladesh but the whole world, it is seen that some have paid more attention to the technology sector (Jamal *et al.*, 2012; Lannez, S. and Passelergue, J.C., 2011) and some have tried to find some other way. As an alternative, most researchers have suggested using solar systems. As a result, wind and PV power generation technologies are being discovered day by day on how to use them more and more. The study by Mandal, A.H., (2015) showed the potential of energy generation from renewable energy sources through various uses of currently available technology. However, their analysis mainly focused on long-term energy system models. Renewable energy technologies, such as solar photo-voltaics, will play a special role in future energy security.

Different sources of energy generation are helping each other to increase their performance and efficiency of energy generation (M. R. Islam *et al.*, 2008). Not only energy production many researchers have looked at the economic aspects and environmental impact of conventional energy generation. If we produce from solar, the total cost will be much less. Whiting *et al.* have shown in their study cost and the environmental impact of generating energy from different sources like biogas, fossil fuel, natural gas, etc. The negative impact of fuel consumption on the environment is proven. Energy consumption is essential for power generation. Developing more effective methods for increasing environmental efficiency is imperative (Gryznova *et al.*, 2019). Devabhaktuni *et al.* (2015), in their paper, addresses the costs of continuation, supervision, and operation, and economic policies that promote the installation of generating electricity from solar energy systems. The popularity of electricity generation from solar systems increases daily, increasing its opportunity. Many countries take this opportunity in many sectors. For example, China already uses in the rail and transport sector (Jia *et al.*, 2010). In telecommunication, agricultural, water desalination and building industries to operate lights, engines, fans, pumps, refrigerators, and water heaters can be widely applied solar electricity (Mekhilef *et al.*, 2011). Africa has taken a big step for generating electricity from Solar and gets an advantage in economic development [iea]. At New York Times, 2 July 1916, Frank Shuman (Inventor of PV system) gave a golden speech about solar power. According to his thought, after our oil and coal reserves are exhausted, the human race will harness the

infinite energy from the sun's rays and prove how to exploit the sun's energy commercially.

METHODOLOGY:

This study attempts to determine the electrical power situation of Bangladesh by using time series electricity energy data and to show the importance of Solar as subside of electricity. This study depends on secondary data sources; a list of sources is given in table 1. This study employs several indicators, namely electricity demand, electricity sources, gross domestic product (GDP) and population, electricity generation by different sources, and total and per capita energy use, to explore the progress and challenges of the energy sector in Bangladesh. Using the time-series data analysis to derive trends concerning energy supply, electricity generation, and total and per capita energy consumption. The study calculates the annual growth rate (%) of electricity consumption of Bangladesh based on equation (1) which is compared with the annual growth rate (%) of electricity generation and also between per capita generation and per capita consumption.

$$\text{Annual growth} = \frac{\text{Current year growth} - \text{Previous year growth}}{\text{Previous year growth}} \times 100 \quad (1)$$

This study determines the current trends of energy indicators and highlights policies and challenges relevant to Bangladesh's energy sources' sustainability.

RESULTS AND DISCUSSION:

Present Electricity Generation Situation in Bangladesh

Year-wise per capita generation and consumption (Grid)					
Year	Total net generation (GWh)	Per Capita Generation (kWh)	Per Capita Consumption (kWh)	The annual growth rate of generation	The annual growth rate of consumption
2015-2016	52193	326.41	283.3	-	-
2016-2017	57276	354.1	310.75	8.4831	9.6893
2017-2018	62677	383	336.71	8.1615	8.3539
2018-2019	70533	426.05	374.73	11.2402	11.2916
2019-2020	71419	426.23	378.16	0.0422	0.9153
2020-2021	80423	475	422.13	11.4421	11.6273

Source: Annual Report 2020-2021. Bangladesh Power Development Board (BPDB): 14 October 2021.

The fiscal year 2020 to 2021 total generation was 80423 GWh which is 12.61% more than last year, where net

generation was 71419GWh. Time series analysis of the last five years of energy generation shows that 8497.4

GWh will be generated in 2022, and in 2013 it will be 90480 MKWh. Time analysis shows that the per capita annual growth rate of consumption is always greater

than the generation growth rate, according to which in 2022 will be 443.756 and in 2023 it will be 470.176.

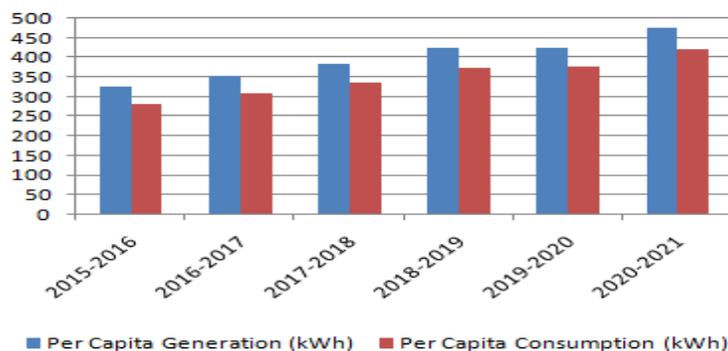


Fig. 1: Comparison between per capita generation and consumption.

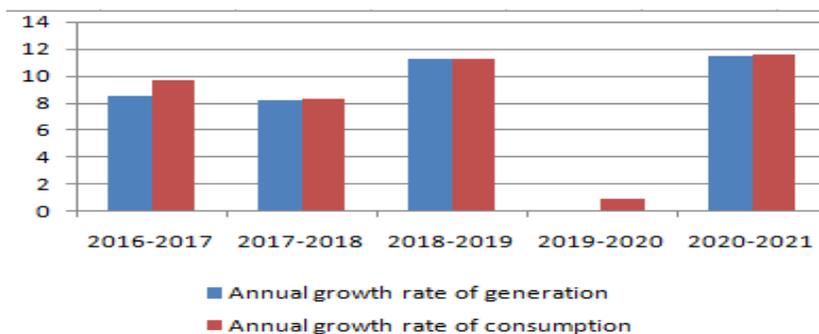
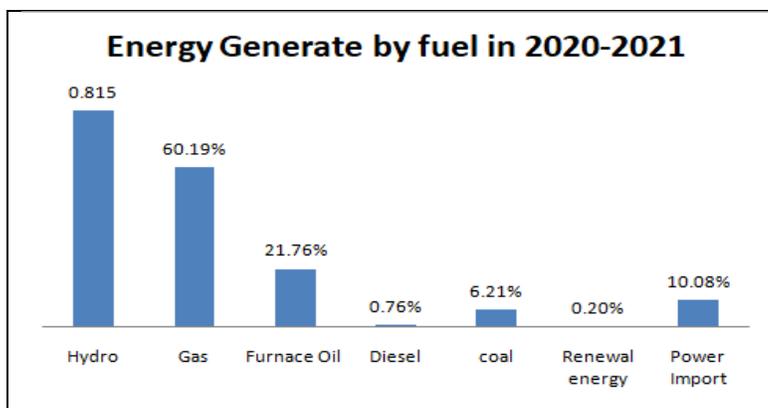


Fig. 2: Comparison between the annual growth rate of generation and consumption.

Total net Energy generated by fuel types is as follows

Fuel type	Net amount (GWH)	Percentage
Hydro	655	0.815
Gas	48403	60.19%
Furnace Oil	17497	21.76%
Diesel	609	0.76%
coal	4997	6.21%
Renewal energy	158	0.20%
Power Import	8103	10.08%
Total	80423	100%



Source: Annual Report 2020-2021. Bangladesh Power Development Board (BPDB): 14 October 2021.

The main source of electricity generation in Bangladesh is gas which is 60.19% of total generation and the second is furnace oil which is 21.76%, which is insufficient in Bangladesh. Besides this, gas and oil are cited as the main causes of greenhouse gases in this mission.

Cost of Electricity Generation

Among the power plants in Bangladesh, the top 12 power plants with a capacity of 4763 MW per year charged 65.02 billion Tk., which is 49.4% of the total capacity charge in FY 2020-2021. These six power plants did not generate electricity; they also consumed

3.15 GWh from the national grid. According to BPDB annual report, the total installed capacity will reach 37731 MW and 49392 MW, respectively, in 2025 and in 2030 against the demand of 19900MW and

27400MW. More than one-third power generation capacity is not being used to create standard generation assets. As a result, the electricity price per unit for consumers increases more than we can imagine.

Environment Impact for Generating Electricity

The efficiency of various Methods of generating electricity		
Mode of production	CO ₂ emissions	The amount of energy per kg of substance, kWh
Combustion:		
Coal	2.76from per unit ton burning	7
Fuel oil	2.04from per unit ton burning	11
Natural gas	1.62from per unit ton burning	14
Atomic Energy	0	24.106
Thermonuclear Energy	0	60.106
Quark-gluon level	0	6940.106
Thermoelectric (Solar)	0	0.6 Per sq. m. of solar cell panels with an average level of activity sunlight

Source: Gryznova et al., 2019.

Solar System concept

To understand solar energy, you must first understand how solar panels are made. A solar cell, called a photo-voltaic (PV) cell, is the main component of a solar power system that converts sunlight into power. Photo-voltaic means that it produces a voltage when radiant energy, such as light, falls on it. Usually, each PV cell is made of a type of semiconductor metal (germanium, silicon, carbon, silicon carbide, etc). These silicon sheets are doped with impurities to improve their conductivity, allowing them to maintain a charge. The top layer is doped with boron which creates a positive charge (the P layer) while the bottom layer is doped with phosphorus which creates a negative charge (the N layer). Thus magnetic induction creates an electric field. At this P-N junction, the electrons created by an electric field are always travelling as the nature of energy flows from the P layer to its bottom N layer. This nature begins to change when sunlight hits the panel. Sunlight tries to take this energy out of its normal orbit and change its direction of motion from the end toward the Player. The electric field at the P-N junction tries to resist this motion, but the external force drives the N-P intersection, resulting in electricity generation. The second component is a rack system that holds the panels in place. This electricity can be used directly in electronic devices, stored in batteries, or used later. Solar panels are generally installed on the roof for better energy generation. These panels

must be installed facing east or north or westerly or south facing direction never works well especially in winter. These panels must be installed at a minimum angle of ten degrees so that they can be self-cleaned by rain. These solar PV panels installed on the roof of a home or business can generate clean electricity when exposed to direct sunlight. This conversation text places with interest sales of solar panels, which are specially fabricated silicon.

Solar power has improved rapidly in recent years with photovoltaic panels by improving efficiency and decreasing prices. The cheapest electricity in the world today is Solar and wind power. If we look around in the future, every year or more, they will get both of them as free power that can generate green-house videos and reduce global warming. There are three types of solar systems:

System 1

Ongrid solar system: On-grid solar system does not use any battery. The solar panel is connected directly to the home's electrical connection through an inverter. That is, if a home already has electricity, on solar grid system can be installed. This method is used to reduce electricity bills in urban areas. On-grid solar systems cannot be used in rural areas, or remote areas where electricity does not reach i.e. this method cannot be used for load shedding.

System 2

Off-grid solar system: In an off-grid solar system, the electrical Energy from Solar is stored in the battery i.e. this method can be used during load shedding as well as at night when the sun is not present, off-grid solar system can be used during the day when the sun shines on the solar panel with electric energy from Solar. The battery is charged. And using the inverter or converter with that charged battery, the energy stored in the battery is regulated to a specific voltage to provide the right amount of electrical energy to various devices.

System 3

Hybrid solar system: Hybrid solar systems can work as either on-grid or off-grid solar systems. That is, the electricity from this solar panel can be directly used in the home appliance and the battery can be charged and used later. In this system, when the battery is fully charged, the excess electricity is used directly with the mains electricity, thereby reducing the electricity bill.

Power requirement in Solar Panels

Different solar panels have different capacities and sizes. One has to buy solar panels according to the amount of electricity required, but the problem is how to understand how much to buy; a simple calculation is shown- Let's say that generally, in a family, if two like one fan is run, two lights need 10 to 20 watts and fan needs 20 watts, that's min 40 watts, that's min 40 watts, if it is run for six hours every day, then 240 watts is required in total. The battery requirement will be 240 divided by twelve i.e. 20 amperes or 12 volts. The charging current of lead acid batteries in the solar panel is ten per cent. So if someone has 12-volt demand, then he has to buy and install a 24-watt solar panel. Only then can he fulfil his demand.

Significances of solar

The sun is an unbelievable and renewable resource that has the power to fuel life on earth and provide clean, sustainable energy to its entire occupant. The sun gives us more energy in one hour than the total energy in one year consumed by the entire population of the world. All over the world equally, distribute the sun shines, anyone can make solar electricity workable anywhere. Solar Energy can be stored in batteries for energy storage; Solar systems are independent of the utility grid, making them cost-effective for remote areas. Solar

modules have no maintenance, or additional parts cost except setup costs and have a long life (25+ years) and guaranteed electricity. Solar electricity comes from the sun directly, so it has no transport cost, refine cost, or drill cost and no effect on the environment and health.

Availability of Energy Sources

About eighty per cent of people in the world have to import fossil fuel from other countries, creating geopolitical conflict and crisis between them. On the other hand, renewable energy sources are insufficient in every country. And whose potential is no harm at all? The International Renewal Energy Agency (IREA) estimates that about 90 per cent of the world's electricity in 2050 will come from renewable energy. Renewable energy sources offer us a way to reduce energy import dependency while diversifying each country's economies and protecting us from unpredictable energy prices. Not only will that, but all these things drive us towards economic growth, new jobs and poverty alleviation.

Cheaper Renewable Energy

Relive energy is considered to be the cheapest power option in the world today. The cost of renewable energy technology is decreasing by the day. Between 2010 and 2020, the cost of electricity generated from solar power decreased by almost 80 per cent. Where the electricity consumption of our country is increasing day by day, the demand for solar panels is also increasing. Looking at the list of solar panels in Bangladesh, we see that there are different prices, but the price depends on the number of plates. So I can buy solar panels as per my requirement. There are different types of solar panels in the market, and the prices are different in Bangladesh, but generally, the types of panels available are 325-watt, 400-watt, and 500-watt solar panels.

The cost of the solar panel is basically one-time, i.e. setup and battery costs. Once the solar panel is set up, then it lasts for approximately 30 years. In Bangladesh, a middle-class household consumes 250-kilowatt hours per month, costing approximately 1500 taka. The lowest cost of solar panels in Bangladesh is 22 thousand 500 taka, and the highest price is 45 thousand takas.

Economic features of the Solar System

The economic impact of a solar system can be calculated by calculating the impact for all its parts, such as panels, inverter/ controller, cables of power, battery for storing and devices that use solar energy and technology that improve all these sectors. For example, we consider water pump at remote area: photovoltaics does not have any maintenance or operation cost, while diesel generator has very high maintenance cost, in addition, its efficiency drops with time. If we overlook on the economic comparison, that shows the installation cost of PV systems is a little higher than electric and diesel generator machines. Second, electric utility and diesel fuel operation and maintenance cost is very high than PV system. Third, after ten years the, replacements are needed for a PV system and the electric utility is only the controller/pump but in a diesel generator, it needs to buy a new one. Meah *et al.* calculate in their study and conclusion that PV system is the most suitable option and the lowest cost for rural areas. About \$4 trillion per year up to 2030 invested in the renewable energy sector (including technology and infrastructure) to reach net-zero emissions by 2050. In comparison, \$5.9 trillion had to contribute at the fossil fuel industry in 2020 (including explicit contributions, tax breaks, and health and environmental damages).

Impact of PV System in the Environment

The main cause of environmental pollution is carbon dioxide emission. About 75% of global greenhouse gas emissions and 90% of carbon dioxide emissions come from fossil fuels (such as coal, oil and gas). If we take water pumping as an example, we see only PV system does not have any disadvantageous on the environment while the diesel generator has sound pollution and both air pollution by carbon dioxide emission. In case of electricity generated by dumping it has a great impact on the environment. For this reason time create a

flood, some time it make dry land. If electricity generating by windmills, it makes sound pollution. By all examples and comparisons, PV system has no major impact on the environment.

Impact of Solar system on health

According to the World Health Organization (WHO), assign about 99 percent people in the world to breathe in danger and health risks air. Over 13 million deaths each year are caused by environmental pollution, including air pollution. Nitrogen dioxide and the unhealthy levels of fine particulate matter is mainly produced by burning fossil fuel. In 2018, air pollution caused by fossil fuel burning, costs \$2.9 trillion in health and economic, which is \$8 billion per day. To transition to a healthier climate, we need to switch to clean energy sources, such as wind and Solar. This will help us fight climate change but also help prevent air pollution and improve health and well-being.

Employment opportunities

Renewable can create three times more jobs than the fossil fuel industry. According to the International Renewable Energy Agency, this sector created 1150 0000 in 2019, up from 11000000 the previous year. The International Energy Agency estimates that the fossil fuel industry loses about 5 million jobs, and 14 million new jobs would be created in clean energy, which means, net gain 9 million jobs. In addition, more 16 million workers would be required in energy related industries, which means 16 million more jobs. For instance, on the roles of renewable energy need to manufacture electric vehicles and hyper-efficient appliances or have to invent new technologies.

Renewable Energy Prospects in the Bangladesh and overseas

The government goals

Project under planning	Sonagai, Feni	109.77 MWp
-	Gangachara, Rangpur	90.25 MWp

Sources: Annual Report 2020-2021, BPDB.

Project planning under the private sector

Project under construction	Jamalpur	0.813 kWp
	Ranguia, Chattogram	5.55MW
	Dharmapasha, Sunamganj	32MW
	Gangachara, Rangpur	30 MW
	Sundarganj, Gaibandha	200MW

	Patgram, Lalmonirhat	5MW
	Sylhet	5MW
	Tetulia, Panchagarh	30MW
	Boro Durgapur, Mongla	100MW
Projects under planning	Panchagarh	50MW
	Pabna	100 MW
	Deviganj, Panchagarh	20 MW
	Moulvibazar	10 MW
	Nilphamari	50 MW
	Jamalpur	100 MW
	Pabna	3.77 MW
	Dhamrai, Dhaka	50 MW
	Bariahaat	50 MW
	Chuadanga	50 MW
Netrokona	50 MW	

Sources: Annual Report 2020-2021, BPDB.

Findings

The day is not far away when Renewable energy will monopolize power generation, overtaking fossil methods. According to the BPDB report, there is very little deficit in the generation and consumption of electricity, but the disparity of electricity which supposes to face a lot of load shedding at a certain time every year. Comparing the conventional power generation method and the solar system, it was seen that the solar system is ahead in all aspects; moreover, the conventional method of energy production cannot produce electricity for a long time. Therefore, it is essential to find alternative methods for power generation before the crisis reaches its peak.

Limitations

The solar PV system has several disadvantages -

- 1) Initial investment is huge.
- 2) Solar panel degeneration is about 20% over time.
- 3) Inverter replacement cost is very high. Almost every ten years, inverter replacement has to be done.
- 4) In this method, only a limited amount of energy is available on each roof.

CONCLUSION AND RECOMMENDATIONS:

The solar energy system is the graded source for solving the energy crisis in Bangladesh. The location of Bangladesh is between 20.3 and 26.38 degrees Knot Latitude and 88.04 and 92.44 degrees which is an ideal location for solar energy utilization. In this position, it is possible to collect electricity from sunlight at the

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maximum time every day throughout the year. If we start generating electricity from solar systems now, this technology will be updated a lot in the future when it is possible to reduce the initial cost of the solar system, i.e. PV systems. Off-grid rooftop solar power systems can be introduced in Bangladesh. Solar systems can be used instead of conventional electricity for lampposts in every major city in Bangladesh as industries are more in urban areas, so the need for electricity is also more. Also, urban areas are more densely populated than rural areas. So if we can introduce rooftop solar systems in every industry and every roof, then we can save electricity. Bangladesh government should provide funds to the technology sector to upgrade the PV system and can offer loans without interest for installing a Photovoltaic plant. When a nation faces a problem, not only the country's government but every nation member has to be involved in getting rid of that problem. If we can use every roof to generate electricity, then load shedding will be removed from our public life. As well as the development of Bangladesh will not depend on conventional power generation in the future. We can dream that electricity reaches every house in Bangladesh, whether it is a city or a village.

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CONFLICTS OF INTEREST:

This research declares no competing interests.

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