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Design of a 40 MW Grid-Connected Solar Photovoltaic Power Plant for a School in Patenga

Md. Arifur Rahman[1†], Md. Tamzid Hossain Rifat[2†], Sanjana Fyruj Ananna[3†], Palash Chandra Paul[4]

[1†,2†,3†]B.Sc. Graduate, Department of Mechanical and Production Engineering (MPE), Ahsanullah University of Science and Technology (AUST), Dhaka, Bangladesh.
[4]Bachelor of Pharmacy, Lovely Professional University, Jalandhar - Delhi, Grand Trunk Rd, Phagwara, Punjab 144001, India

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Abstract - *Bangladesh faces the dual challenge of meeting growing energy demands and mitigating environmental degradation while reducing reliance on fossil fuels. Sustainable development and the global climate change crisis necessitate the adoption of renewable energy sources. This paper examines the potential of solar photovoltaic (PV) power plants to address Bangladesh's energy issues, focusing on the Patenga region. With its favorable geographic coordinates (latitude: 22.235128°N, longitude: 91.806085°E) along the Bay of Bengal, Patenga is well-suited for solar energy exploitation. This study proposes a 40 MW solar PV power plant to meet the energy needs of South Patenga City Corporation High School and contribute surplus energy to the national grid.*

Economic analysis shows the project's viability, with a payback period of seven years and estimated revenue exceeding Tk 9 billion, demonstrating both profitability and sustainability. The project aligns with the United Nations Sustainable Development Goals (SDGs), particularly those promoting industry, innovation, infrastructure, decent work, and economic growth. Feasibility studies using platforms like the Global Solar Atlas, PVGIS, and PVsyst confirm the project's potential. Optimization through PVGIS and other advanced software ensures maximum efficiency and reliability.

By adopting solar energy, the school can secure a stable, cost-effective electricity supply, reduce its carbon footprint, and advance green energy initiatives, contributing to climate change mitigation. This project underscores the strategic role of solar PV power generation in achieving sustainable energy solutions for Bangladesh, offering a model for similar regions facing comparable energy and environmental challenges.

***Key Words*: Solar power plant, Solar PV Panels, PVsyst, PV-Sol, Global Solar Atlas, Renewable Energy, Sustainable Development Goals (SDGs), Power System, Plant Layout, Performance Prediction.**

1. INTRODUCTION

In recent years, the global energy landscape has witnessed a significant shift towards renewable sources, driven by the urgent need to address environmental concerns and reduce dependency on fossil fuels. Among these renewable energy options, solar power stands out as a promising solution due to its abundance, sustainability, and minimal environmental impact. As the world strives to transition towards cleaner and more sustainable energy systems, the utilization of solar photovoltaic (PV) technology has gained prominence, offering a reliable means of generating electricity from sunlight.

Solar photovoltaics, often referred to as PV, is a rapidly evolving field of technology dedicated to converting sunlight directly into electrical energy. This technology holds immense potential for revolutionizing the way we produce and consume electricity, offering consumers a clean, quiet, and reliable alternative to traditional power sources. With ongoing advancements in PV technology and decreasing costs of solar panels, solar energy is poised to become increasingly economical and accessible in the coming years.

To harness the full potential of solar energy, it is essential to develop efficient and scalable solar PV systems capable of meeting the growing energy demands of both developed and developing nations. This necessitates the development of standardized procedures and methodologies for the design, installation, and operation of large-scale grid-connected solar PV systems. Several research studies have been conducted to explore the feasibility, performance, and economic viability of grid-connected solar PV projects in various region.

The first study discussed in the literature explores the design of a convectional procedure for a 50MW on-grid solar PV system, utilizing PVsyst Software and AutoCAD. By simulating the output of the system and designing the plant layout and substation, the study lays the groundwork for efficient and effective large-scale solar PV deployment [1].

Similarly, another study focuses on the development of a standard procedure for designing 5MW grid connected solar PV systems using PVsyst Software. By utilizing meteorological data and databases of renewable energy components, the study validates its procedure through the design of a solar PV system in Shivanasamudram, Mandya [2].

Furthermore, amidst concerns about the environmental impact of fossil fuel-based energy generation, a study presents the design and simulation of a 100MW solar PV grid-connected electricity generation system at Umm Al-Qura University. The study highlights the technical, economic, and environmental potential of solar PV systems, emphasizing their role in reducing CO_2 emissions and conserving natural resources [3].

In addition, the favourable climate conditions in regions like Belakavadi, Mandya district, Karnataka, India, offer significant potential for solar PV installations. Studies evaluating the performance of solar PV plants in such regions underscore the economic viability and environmental benefits of harnessing solar energy [4][5].

Moreover, performance analysis of grid-connected solar PV plants in regions like Karnataka, India, provides valuable insights into their efficiency and reliability. By evaluating technical parameters and comparing performance with international standards, these studies contribute to the optimization of solar PV systems [6].

Lastly, a comparative study of outdoor performance among different solar cell technologies sheds light on the efficiency and suitability of various PV systems in real-world conditions [7]. In light of these developments, this research paper aims to contribute to the body of knowledge on solar PV technology by investigating the design, performance, and potential of grid-connected solar PV systems. By synthesizing insights from existing literature and empirical studies, the paper seeks to provide valuable insights into the opportunities and challenges with greater efficiency, reliability, and sustainability. associated with largescale solar PV deployments, with a specific focus on the Patenga region of Bangladesh. By leveraging these findings, future solar PV projects can be designed and implemented with greater efficiency, reliability, and sustainability.

1.1 Site Selection

This is a satellite image of the selected site Fig 1, taken from 500 m above. From the picture, it is noticed that the location has open space which is suitable for Solar PV.

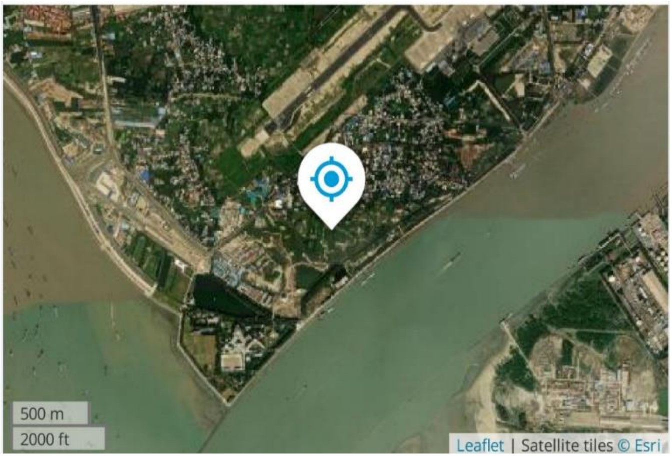

Fig -1: Satellite Image of the Site

For Resource Assessment, Global Solar Atlas website is used for detailed analysis. This website helps to do resource assessment without visiting the location.

The value of PVOUT Specific is 1546.0 kWh/kWp, which is quite good for the chosen site. The most important parameter for Solar PV is Global Horizontal Irradiation, which can be seen in the Fig 2, that is 1805.6 kWh/m².This has proven to be sufficient for solar power sites.

Map data			Per year
Direct normal irradiation	DNI	1319.8	kWh/m²
Global horizontal irradiation	GHI	1805.6	kWh/m²
Diffuse horizontal irradiation	DIF	880.6	kWh/m²
Global tilted irradiation at optimum angle	GTI opta	1941.8	kWh/m²
Optimum tilt of PV modules	OPTA	24 / 180	°
Air temperature	TEMP	25.8	°C
Terrain elevation	ELE	6	m

Fig -2: Map Data of Patenga

From Fig 4, The azimuth angle for solar power needs to be 180°. This means that the solar power needs to face south. Sun-path is required for tracking solar power systems, but it is not used in this project due to the increased cost and complexity.

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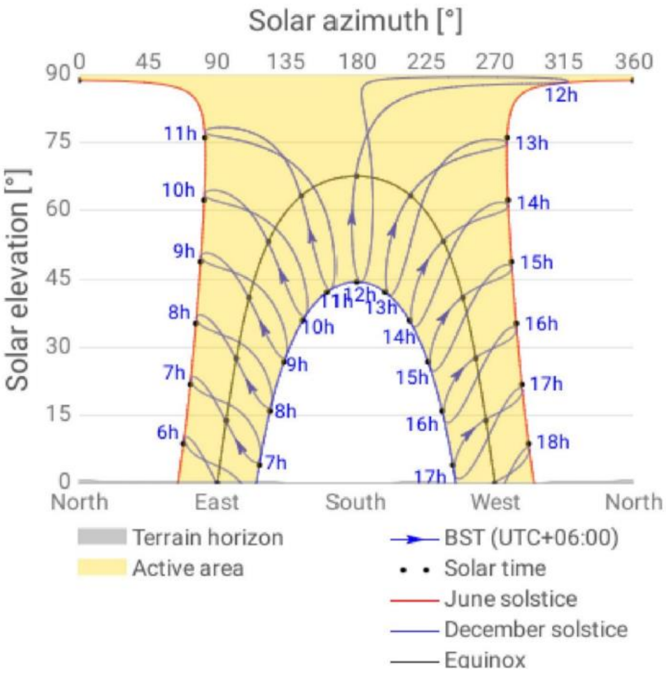


Fig-3: Sunpath and Solar Azimuth angle of Patenga

DNI is the degree of the sum of sun-oriented radiation transmitted by a surface that's opposite to the sun's coordinate way through the climate. DNI is required for CSP plant, so usually not a vital parameter for the Project. The value of annual average DNI is 1327.8 kWh/m² which is not enough for a CSP plant. Point by point data with respect to the month-to-month average and hourly profile of DNI can be found in Fig 4.

Fig- 4: Average Annually, Monthly and Hourly Profile

1.2 Key Findings

The most important parameter for a Solar PV plant is the Global Horizontal Irradiation. The value of GHI on the site location is 1805.6 kWh/m2, So the location has enough potential for a PV site. The PV potential falls in the middle ground of the global scale. It can also be seen that the location has enough space to build a Solar PV power plant. The PVOUT specific of the location is 1546.0 kWh/kWp.

1.3 Selection of Conversion Technologies

It is a grid-connected solar power system, as depicted in Fig 6. Power is supplied from the solar power generation system and the power grid as needed. On day, power is provided by the solar power system. Excess energy produced during the day. It is fed into the power grid. When the Bi Directional meter is rotated in negative, electricity bill will be reduced. In the event of a wet day or at night, the electric grid will provide the load demand. In this situation, the bi-directional meter will revolve in the positive direction

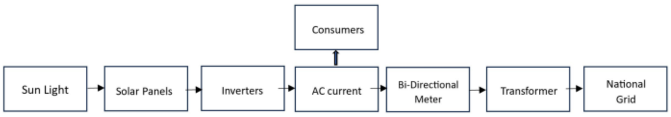


Fig-5: Schematic Diagram of the PV System

The system's five main parts are the national electric grid, solar panels, inverters, Bi-Directional meter, and AC circuit box. DC current is the form of power generated by solar panels. Then, an inverter will be used to convert this to AC power. The AC circuit box will receive this AC electricity. The circuit box is linked to AC loads or Consumers. The circuit box will also be linked to a Bi-directional meter, and the meter itself will be connected to the electric grid. The electricity supplied and fed into the grid is monitored by this meter.

2. Technical Specification of the final Design

2.1 Solar PV Panel

In Table-1, The Triana TSM-DE20 is a powerful 610W power output solar panel that can be used for a wide range of applications, including large-scale solar systems and residential rooftops. All information collected from PVsyst Software report and SREADA.

Table-1: Specification of Solar PV Module

Manufacture	Generic
Model	TSM-DE20-610Wp
Maximum Efficiency	21.6%

Unit Nom. Power	610Wp
Number of PV Modules	65574 units
Module Dimensions	2172×1303×35 mm
Glass thickness	3.2 mm
Weight	34kg
No. of cells	120 cells
Panel Technology	Monocrystalline Silicon
Product Workmanship warranty	12 Years
Power Warranty	25 Years
Glass Type	Anti-reflection Coating, Tempered
Voltage at Max Power	34.6 V
Current at max power	17.49 A

2.2 Inverter

In Table-2, specification of inverter is shown. SOFAR Solar created the SOFAR 110KTLX-G4 solar inverter. This inverter, a vital part of a solar energy system, transforms the direct current (DC) power produced by solar panels into alternating current (AC) electricity suitable for use in residences and commercia buildings. With a suggested capacity of 110 kilowatts, the "110KTLX-G4" classification indicates that it is appropriate for bigger solar setups. The" G4" designates that it is a member of the fourth generation of SOFAR solar inverters, which are anticipated to have enhanced monitoring capabilities, dependability, and efficiency.

Table-2: Basic Information About the Inverter

Manufacturer	Sofar Solar Generic
Model	SOFAR 110 KTLX-G4
Pnom ratio (DC:AC)	1.35
Number of inverters	297
Total Power	29700 KW_{ac}
Operating Voltage	200-850 V
Data of DC input	
Max. Input Voltage	1100 V
Rated Input Voltage	625V
MPPT Operating Voltage Range	180-1000 V
Max. Input Current per MPRT	10*40 A
Max. Input Short Circuit Current	10*50 A

3. PERFORMANCE AND FINANCIAL ANALYSIS

3.1.Performance analysis on Global Solar Atlas

The Global Solar Atlas website is used to simulate the performance of the preliminary design. The tilt angle and azimuth angle are used to run the simulation. A 40000kWp(40MWp)ground mounted large scale PV system is chosen. Setup details can be seen in Fig 6.

In Fig 6, The solar power system produces a total solar power output is 61.926 GWh per year and Global tilted irradiation is 1941.2 KWh/m² per year. Monthly average profiles are also provided. Here February has the highest PV output. On the other hand, production in July is the lowest.

Fig-6: Simulation Setup, Annual, Monthly Average of PV Power Output

Fig-7: Average Hourly Profiles of Total PV Power Output

Each month shows in Fig 7, the total PV output at different times of the day. The month with the most solar power is February, and the month with the least is July. This indicates that the project can ensure sufficient power generation throughout the year.

3.2. Optimization of Tilt and Azimuth Angle on PVGIS

The design is further optimized with the help of the PVGIS website. From Fig 8, The optimal tilt angle is 27°.The PVGIS recommended azimuth is 7° (Ref-South).These values will be used in the next step to optimize the design

Provided inputs:	
Location [Lat/Lon]:	22.235,91.806
Horizon:	Calculated
Database used:	PVGIS-SARAH
PV technology:	Crystalline silicon
PV installed [kWp]:	40000
System loss [%]:	14

Simulation outputs:	
Slope angle [°]:	27 (opt)
Azimuth angle [°]:	7 (opt)
Yearly PV energy production [kWh]:	62054510.32
Yearly in-plane irradiation [kWh/m²]:	2050.34
Year-to-year variability [kWh]:	1660203.04
Changes in output due to:	
Angle of incidence [%]:	-2.58
Spectral effects [%]:	0.58
Temperature and low irradiance [%]:	-10.21
Total loss [%]:	-24.34

Fig-8: Optimization of the System using PVGIS

Optimized tilt and azimuth angles are ran the simulation again with the Global Solar Atlas.

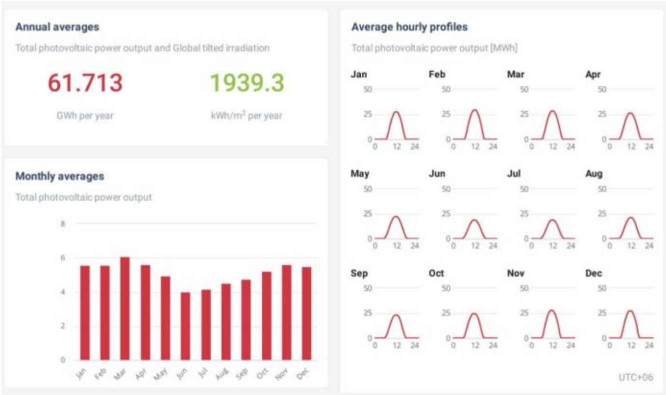


Fig-9: Annual Average of PV Output after Optimization

Fig-10: Average Hourly Profile of PV Output after Optimization

After optimization, the total solar power generation will be 61.713 GWh per year, shown in Fig 9. Both values are very similar. This shows that the solar power plant works well.

3.3. Performance analysis on PVsyst

The Fig 11 shows annual performance ratio (PR). Performance Ratio(PR) refers to the proportion of energy used that would be generated if an entire system functioned at its nominal STC efficiency. Losses include temperature loss in the PV module, tilt angle, dust, shade, and module. The results for mono crystalline silicon PV modules show that while there are fluctuations in system performance throughout the year, the share of solar power generation shows a decreasing trend in the first four months of the year. Then, It slightly increasing for the next four months, and finally showed a bearish trend in the last three months of the year. The Performance Ratio(PR) is 0.845 Which is very similar to PV-Sol software report.

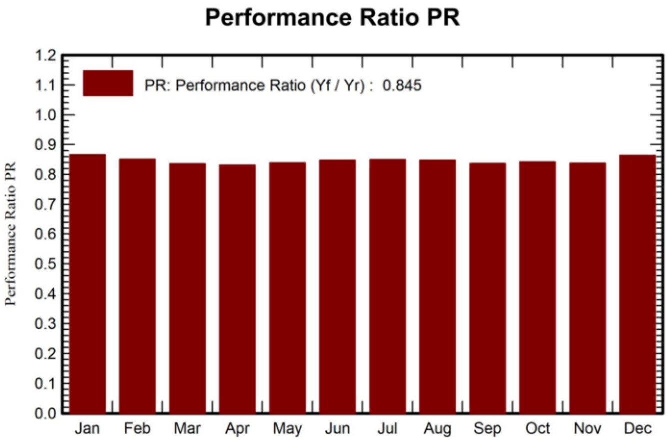


Fig-11: Performance Ratio PR for Tilt Angle 27 Degree.

In Fig 11, also shows the a concordant healthy average values over the entire observation period.

Fig 12 shows the normalized energy production distributed over the year. The highest energy production is less than 5 kWh/kWp/day and occurs from April to May. In contrast, the lowest production occurs in the winter from November to February, when the value exceeds 2 kWh/kWp/day. As shown in Figure 5.7, most PV module losses occur in March, November, and April. As seen in this Fig 14 the PV system's collection losses are 0.66 kWh/kWp/day and the losses for the inverter system are only 0.06 kWh/kWp/day.

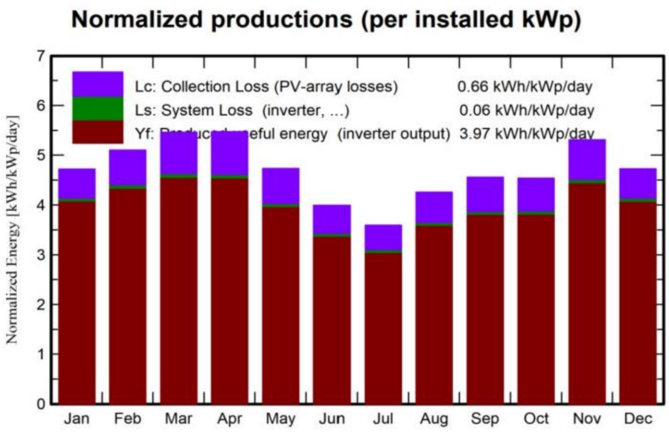


Fig-12: Normalized productions (per installed kWp)

The amount of useful energy produced by this system is 3.97 kWh/kWp/day. The loss diagram of the solar power generation system is shown in Fig 15. The annual global horizontal radiation dose received by a solar power system is 1617 kWh/m2.After subtracting the power loss of the during the solar conversion process the rated energy of the array at Standard Test Conditions (STC) is 67141701 kWh. Moreover, the resulting energy delivered to the grid is 57996325 KWh per year after deducting losses due to Global incident in cell (6.10 percent), Temperature (-8.70 percent), and Inverters (-0.49 percent).

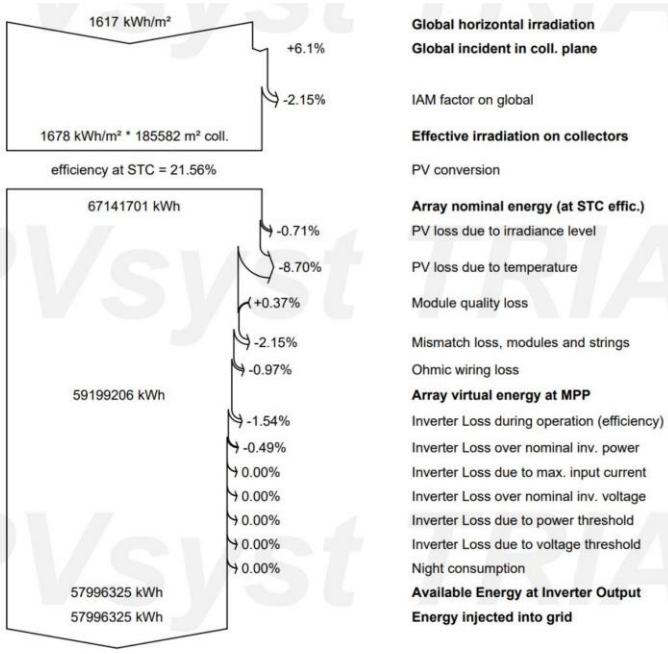


Fig-13: Loss diagram at 27-degree tilt angles

There is a tabulated data in the Fig 14 which shows the monthly and yearly data of global horizontal irradiation and energy injected into grid.

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	116.0	60.55	21.05	146.2	143.7	5138366	5062811	0.866
February	122.5	64.35	23.98	142.9	140.5	4940799	4865733	0.851
March	157.2	80.28	26.90	169.2	166.1	5748250	5657792	0.836
April	166.8	86.00	28.45	164.1	160.4	5541614	5456134	0.831
May	161.3	94.94	29.26	146.7	142.7	5005730	4926901	0.840
June	133.7	90.63	28.31	119.7	116.2	4126997	4059297	0.848
July	122.8	88.62	28.26	111.5	108.2	3854768	3791389	0.850
August	139.1	92.69	28.49	131.8	128.3	4536849	4466538	0.847
September	133.1	76.30	28.30	136.7	133.5	4647847	4574224	0.837
October	127.2	76.64	28.25	140.7	137.7	4812436	4738635	0.842
November	125.0	50.85	25.48	159.3	156.9	5421977	5336813	0.838
December	112.2	54.61	22.45	146.4	144.0	5136212	5060058	0.864
Year	1616.9	916.48	26.61	1715.1	1678.2	58911845	57996325	0.845

Fig-14: Balances and main results for tilt angle 27 degree.

Here shows also the ambient temperature, Global incident in cell plane, Performance Ratio etc.

3.4. Economic/Financial Analysis

Utilizing websites like SREDA(Sustainable And Renewable Energy Development Authority), various com□ponents are chosen. Efficiency and cost-effectiveness are the primary factors that went into selecting the components. The items are chosen in a way that allows them to work well together. A particular kind of inverted grid connection is chosen. A wide variety of tiny parts, such as fasteners and accessories, psychrometer are taken into account in the Other Accessories. According to the website of SREDA, there are 73 authorized grid-tied inverters and 38 total approved solar modules under the Net Metering Program. Selected components of Table 3 have been approved By SREDA.

Table-3: Components of the 40 MW Grid-Connected Solar PV Power Plant.

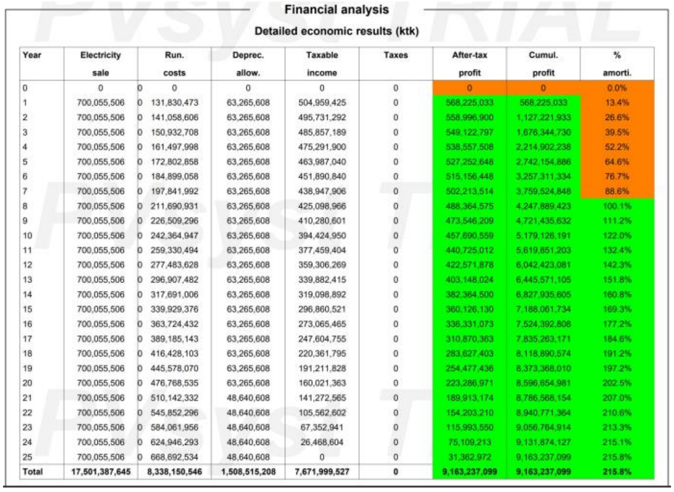
No	Components	No of Units	Price per Units (BDT)	Total Cost(BDT)
1	Trina Solar TSM-DE20-610Wp 29V	65574	16652.94	1091999887.56
2	Sofar Solar Sofar 110KTLX-G4	297	417560	124015320
3	Monitoring system, Display screen	1	24053380	24053380
4	3 Phase Net Bi-directional Meter	-	-	100000
5	Transformer	15	19500000	292500000
6	Combiner Box	1	1430000	1430000
7	Wiring	32000 0	999.70	319904000
8	Surge Arrester	100	16248.70	1624870
9	Other Accessories	-	-	2389694432.56
10	Total Cost	-	-	4245321890.56

To make an accurate decision, a simulation is performed with correct information for all components. Which is done at PVsyst software. The results of this simulation will be most suitable for solar power plant and it will be cost effective. Through this it is also possible to get the correct results. Installation cost, land cost, salaries along with study analysis have all been worked on PVsyst software.

Table-4: Financial Parameters of the Research

Parameter	Value
Project Life(Years)	25
Investment Cost(Taka)	4245321890.56
Yearly Electricity Production (MWh)	57998
Production Cost (Taka/KWh)	5.751
Price of Electricity (Taka/KWh)	Peak Tariff: 12.10 Off Peak Tariff: 8.72
Expected Revenue during the Project Life (Taka)	9163237098.78
Simple Payback Period (Years)	7

Various financial parameters of the project are shown in the Table 4. The payback period is very short at 7 years. This will make the project profitable and make it possible to repay the investment. Meanwhile, the expected revenue during the project period is approximately Tk 9,163,237,098.78.As this project is for schools, the rest of the electricity can be fed into the national grid to meet the school's electrical needs. According to BPDP(Bangladesh Power Development Board), the price of electricity is 8.72tk per kilowatt for Off peak tariff and 12.10 tk per kilowatt for peak tariff. But according to our analysis at PVsyst software, the price per kilowatt is tk 5.751 which will help us to meet the electricity demand at a low cost. If weather conditions do not generate enough electricity for the project, The project uses the current from power grid that supplied into grid previously and has no requirement for batteries, resulting in lower investment costs compared to other power plants. Projects like this take us one step further towards sustainable development.


Financial analysis

Detailed economic results (ktk)

Year	Electricity sale	Run. costs	Deprec. allow.	Taxable income	Taxes	After-tax profit	Cumul. profit	% amorti.
0	0	0 0	0	0	0	0	0	0.0%
1	700,055,506	0 131,830,473	63,265,608	504,959,425	0	568,225,033	568,225,033	13.4%
2	700,055,506	0 141,058,606	63,265,608	495,731,292	0	558,996,900	1,127,221,933	26.6%
3	700,055,506	0 150,932,708	63,265,608	485,857,189	0	549,122,797	1,676,344,730	39.5%
4	700,055,506	0 161,497,998	63,265,608	475,291,900	0	538,557,508	2,214,902,238	52.2%
5	700,055,506	0 172,802,858	63,265,608	463,987,040	0	527,252,648	2,742,154,886	64.6%
6	700,055,506	0 184,899,058	63,265,608	451,890,840	0	515,156,448	3,257,311,334	76.7%
7	700,055,506	0 197,841,992	63,265,608	438,947,906	0	502,213,514	3,759,524,848	88.6%
8	700,055,506	0 211,690,931	63,265,608	425,098,966	0	488,364,575	4,247,889,423	100.1%
9	700,055,506	0 226,509,296	63,265,608	410,280,601	0	473,546,209	4,721,435,632	111.2%
10	700,055,506	0 242,364,947	63,265,608	394,424,950	0	457,690,559	5,179,126,191	122.0%
11	700,055,506	0 259,330,494	63,265,608	377,459,404	0	440,725,012	5,619,851,203	132.4%
12	700,055,506	0 277,483,628	63,265,608	359,306,269	0	422,571,878	6,042,423,081	142.3%
13	700,055,506	0 296,907,482	63,265,608	339,882,415	0	403,148,024	6,445,571,105	151.8%
14	700,055,506	0 317,691,006	63,265,608	319,098,892	0	382,364,500	6,827,935,605	160.8%
15	700,055,506	0 339,929,376	63,265,608	296,860,521	0	360,126,130	7,188,061,734	169.3%
16	700,055,506	0 363,724,432	63,265,608	273,065,465	0	336,331,073	7,524,392,808	177.2%
17	700,055,506	0 389,185,143	63,265,608	247,604,755	0	310,870,363	7,835,263,171	184.6%
18	700,055,506	0 416,428,103	63,265,608	220,361,795	0	283,627,403	8,118,890,574	191.2%
19	700,055,506	0 445,578,070	63,265,608	191,211,828	0	254,477,436	8,373,368,010	197.2%
20	700,055,506	0 476,768,535	63,265,608	160,021,363	0	223,286,971	8,596,654,981	202.5%
21	700,055,506	0 510,142,332	48,640,608	141,272,565	0	189,913,174	8,786,568,154	207.0%
22	700,055,506	0 545,852,296	48,640,608	105,562,602	0	154,203,210	8,940,771,364	210.6%
23	700,055,506	0 584,061,956	48,640,608	67,352,941	0	115,993,550	9,056,764,914	213.3%
24	700,055,506	0 624,946,293	48,640,608	26,468,604	0	75,109,213	9,131,874,127	215.1%
25	700,055,506	0 668,692,534	48,640,608	0	0	31,362,972	9,163,237,099	215.8%
Total	17,501,387,645	8,338,150,546	1,508,515,208	7,671,999,527	0	9,163,237,099	9,163,237,099	215.8%

Fig-15: Financial Analysis By Pvsyst

In Fig 15, shown the payback period of our research and Detailed economic results.

4. CONCLUSIONS

This study explored that the installation of a 40-megawatt grid-connected solar power plant for a school in Patenga, Chittagong, Bangladesh, represents a significant step towards community empowerment and sustainable development. Through this innovative initiative, the dedication to affordable and sustainable energy, high-quality education, climate action, innovation, and partnership development is evident. Furthermore, the project aligns with numerous United Nations Sustainable Development Goals (SDGs), illustrating its multifaceted impact and significance. The research conducted on the potential of solar photovoltaic (PV) power plants in Patenga underscores the economic viability and environmental benefits of renewable energy adoption. By leveraging advanced software tools such as Global Solar Atlas, PVGIS, PVsyst, PV-Sol, and Helioscope, the feasibility of solar PV power generation in the region was thoroughly analyzed and confirmed. The geographic advantage of Patenga's coastal setting, combined with favorable solar irradiance levels, positions it as an ideal location for solar energy exploitation. The projected payback period of seven years and estimated revenue exceeding Tk 9 billion further highlight the economic viability and profitability of the proposed solar PV project. Beyond financial considerations, the project's contribution to advancing industry, innovation, infrastructure, decent work, and economic growth underscores its alignment with the United Nations SDGs. Moreover, the project's positive ripple effects extend beyond the school grounds, benefiting the wider Patenga community by improving access to clean, dependable electricity, healthcare, clean water, and promoting general well-being. Through this endeavor, valuable insights were gained regarding the utilization of solar PV in Bangladesh, resource evaluation, project planning, and development utilizing various software programs and reliable websites. This newfound expertise, coupled with the demonstrated success of the project, serves as a blueprint for future initiatives aimed at harnessing renewable energy sources to address energy challenges, promote sustainable development, and mitigate climate change. In essence, the installation of a grid-connected solar power plant in Patenga exemplifies the transformative potential of renewable energy in promoting environmental sustainability, economic growth, and social well-being. As we look towards a future powered by clean and renewable energy, initiatives like these pave the way for a more sustainable and prosperous tomorrow.

REFERENCES

[1] Hindocha, Krunal and Shah, Sweta. 2020. "Design of 50 MW grid connected solar power plant". textitInternational Journal of Engineering and Technical Research 9.

[2] Vasanth Kumar, Dr S and Nagana gouda, Dr H. 2017. "Design and development of 5MW solar PV grid connected power plant using PVsyst". textitInternational Research Journal of Engineering and Technology (IRJET) 4 (8) : 778-785

[3] Alnoosani, Ahmed and Oreijah, Mowffaq and Alhazmi, Mohammed and Samkari, Yousef and Faqeha, Hosam. 2019. "=Design of 100mw solar pv on-grid connected power plant using (pvsyst) in umm al-qura university". textitInternational Journal of Science and Research (IJSR) 8 (11): 356-363

[4] Bharathkumar, M and Byregowda, HV . 2014. "Performance evaluation of 5 MW grid connected solar photovoltaic power plant established in Karnataka" textitInt J Innov Res Sci Eng Technol 3 (6) : Citeseer.

[5] Kalita, Pankaj and Das, Samar and Das, Dudul and Borgohain, Pallab and Dewan, Anupam and Banik, Rabindra Kangsha. 2019 . "Feasibility study of installation of MW level grid connected solar photovoltaic power plant for northeastern region of India" textitS¯adhan¯a 44 : 1-24 : Springer

[6] Padmavathi, K and Daniel, S Arul. 2013 . "Performance analysis of a 3 MWp grid connected solar photovoltaic power plant in India" textitEnergy for sustainable development 17 (6): 615-625. Elsevier

[7] Kagilik, Ahmed and Tawel, Abduraouf. 2015. " Performance Analysis of 14 MW Grid-Connected Photo�voltaic System" 4 (1): 11-21