PROSPECTS OF FLOATING SOLAR POWER PLANT
IN BANGLADESH

A Project report is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

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25/02/2023

DECLARATION

We solemnly affirm that the project entitled "**PROSPECTS OF FLOATING SOLAR POWER PLANT IN BANGLADESH**" represents the culmination of Our individual effort and original work, conducted in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering at Daffodil International University. This project is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering.

I further declare that this research has not been previously included in any other thesis, dissertation, or submission for a degree, diploma, or other qualifications at this or any other academic institution.

Throughout the course of this research, we have conscientiously endeavored to identify and address all potential risks related to this study. In cases where applicable, we have obtained the necessary ethical and safety approvals, and we were fully aware of our responsibilities as researchers and respected the rights and well-being of all participants involved.

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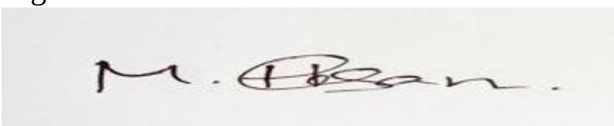
APPROVAL

The project entitled **"PROSPECTS OF FLOATING SOLAR POWER PLANT IN BANGLADESH"** submitted by **Selim Islam (201-33-5321) & Abu Naem (201-33-5330)** has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronic Engineering** in **November, 2023.**

Signed



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Dedicated

To

Mr. Md. Mahmudul Hasan

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ACKNOWLEDGMENT

First of all, we want to give thanks to **Almighty Allah**. With his blessing we are able to complete our work with best effort.

We want to pay our utmost respect to our Supervisor **Mr. Md. Mahmudul Hasan, Lecturer** of the **Department of EEE, Daffodil International University** for who has given us the chance to work on an impactful idea and taken care of every issue of development of this concept. Then we would like to take this opportunity to express gratitude to our supervisor for being dedicated in supporting, motivating and guiding us throughout this project. This project can't be done without his useful advice and help. Also thank him very much for giving us the opportunity to work with this project.

We also want to convey our thankfulness to **Mr. Md. Mahmudul Hasan, Lecturer** of the **Department of EEE, Daffodil International University** for his support and encouragement. Apart from that, we would like to thank our entire class fellows for sharing knowledge; information and helping us in making this project a success. To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this Institution.

ABSTRACT

As the demand for sustainable and renewable energy sources surges, solar power stands out as a promising solution to meet the escalating energy needs of Bangladesh. This research endeavors to outline the process of establishing a 10 MW floating solar power plant tailored to the unique geographical and environmental conditions of the country.

The study extensively explores the advantages of opting for a floating solar power plant over conventional ground-mounted installations. The floating systems demonstrate superior power generation capacity, efficiently harnessing solar energy from direct sunlight and reflected light off water surfaces. By utilizing water bodies, such as rivers, ponds, and lakes, the solar panels benefit from enhanced cooling, thereby boosting their output efficiency in comparison to ground-mounted counterparts. This technology also helps preserve precious land resources, a critical factor in densely populated regions like Bangladesh.

A thorough feasibility assessment was conducted by the research team to gauge the viability of implementing a 10 MW floating solar power plant in Bangladesh. Comprehensive modeling and analysis of key environmental factors, including solar irradiance, wind patterns, and water levels, were meticulously carried out to ensure the system's optimal performance and long-term sustainability. The proposed project aligns harmoniously with Bangladesh's commitment to curbing greenhouse gas emissions and transitioning towards a greener energy landscape.

Economically, the research delved into a comprehensive cost analysis of the project, encompassing the initial capital investment, operational expenses, and potential return on investment. Leveraging available incentives and subsidies for renewable energy initiatives in Bangladesh, the study convincingly demonstrated that floating solar power plants offer a compelling economic case and present a financially viable alternative to traditional energy sources.

The findings of this research illustrate a promising pathway towards widespread adoption of floating solar power technology in Bangladesh. The envisioned 10 MW floating solar power plant holds the potential to make substantial contributions to the national energy grid, effectively reducing the country's reliance on fossil fuels and mitigating the adverse impacts of climate change.

In conclusion, this study presents a comprehensive blueprint for the implementation of a 10 MW floating solar power plant in Bangladesh, offering an eco-friendly, cost-effective, and efficient solution to meet the country's burgeoning energy requirements. Beyond Bangladesh, the research findings hold significant implications for other regions with similar geographical attributes, fostering a global shift towards a renewable and sustainable energy future.
Keywords: Floating Solar, Design parameters, Floating Platform, ecosystem, renewable.

CHAPTER 1
INTRODUCTION

1.1 Introduction

Photovoltaic (PV) technology directly converts solar energy, in the form of solar irradiance, into electricity by utilizing solar cells composed of semiconductors that absorb sunlight and convert it into electrical energy [1]. Floating PV, an emerging solar technology, presents a groundbreaking approach to challenge the conventional practice of placing solar panels on land. By harnessing the potential of water surfaces, this innovative technology allows for the partial or complete avoidance of land use by photovoltaic (PV) plants. Currently, floating PV projects are being successfully deployed worldwide, demonstrating its viability and effectiveness in tapping into solar energy resources while conserving valuable land resources [2].

Over the past decade, floating solar power plants (FSPPs) have garnered increasing global interest and have been successfully implemented in various countries like Japan, South Korea, and the USA. This innovative technology, initially proposed by the authors nearly 10 years ago, has seen rapid growth, supported by numerous studies confirming its potential. These floating PV plants are installed on water bodies, such as natural lakes or dam reservoirs, making them a promising avenue for renewable energy generation [2].

From a practical standpoint, floating solar power plants (FSPPs) offer several technical advantages that have been well-documented in the literature:

a) Enhanced Efficiency: The presence of water bodies beneath the PV modules and cables allows for evaporative cooling, which helps increase the overall efficiency of the system. Cooler operating temperatures lead to improved performance and energy output.

b) Water Conservation: FSPPs contribute to the reduction of water evaporation from the free surface of the water, helping to conserve the volume of stored water in reservoirs or natural lakes.

c) Algae Growth Mitigation: By covering the water surface, FSPPs hinder sunlight penetration, which in turn reduces the growth of algae. This is beneficial as excessive algae growth can negatively impact water quality.

d) Erosion Prevention: The floating systems act as a buffer, diminishing the formation of waves and subsequently minimizing erosion along the banks of the reservoir. This helps maintain the stability of the surrounding environment.
e) Efficient Land Use: FSPPs provide a notable economic advantage since they do not require the utilization of land areas. This can be particularly beneficial in areas where land availability is limited or expensive, making it a more cost-effective alternative.
f) Increased Energy Generation: The reflective nature (albedo) of the water surface results in a higher incidence of solar radiation on the PV array. Consequently, the energy generation capacity of the system is augmented, improving overall performance.

When FSPPs are installed on existing generation structures, such as hydroelectric power plants, or supplied structures, such as pumping stations, several advantages can be identified:

a) Water Conservation: Installing a floating solar power system on the reservoir of a hydroelectric power plant allows for the conservation of water in the reservoir. By covering part of the reservoir surface with FSPPs, the system can generate electricity using solar energy without consuming additional water resources, thus preserving water levels and replacing a portion of the traditional hydroelectric generation.
b) Efficient Infrastructure Sharing: In the case of floating PV systems installed on the reservoir of an already electrically connected structure, such as a power plant or pumping station, there is no need for significant investments in new transmission infrastructure. The existing electrical infrastructure can be shared, allowing for the integration of solar power generation seamlessly into the existing electrical grid.

By leveraging the existing generation structures and infrastructure, the deployment of FSPPs becomes more cost-effective and sustainable, optimizing the utilization of resources while enhancing the overall efficiency of the power generation system [2].

In this paper, we want to analyze in detail how to build a floating solar power plant in Bangladesh. We have done extensive research on how to use Bangladesh's rivers, reservoirs and places where water accumulates throughout the year.

In this report, we investigate the highly compelling integration of FSPPs with standard wastewater treatment basins, highlighting the significant environmental advantages and economic benefits it offers to both the energy production and water conservation sectors. By coupling floating solar power plants to wastewater treatment basins, we explore a promising synergy that enhances energy production while simultaneously promoting water conservation [2].

1.2 Objectives

The primary objective of our research is to develop a modern floating solar power plant in Bangladesh that prioritizes environmental preservation, sustains water levels, and ensures water quality to safeguard aquatic life. Our study thoroughly evaluates the potential impact of this floating solar power plant on the environment and addresses concerns related to water quality and fish welfare.

Additionally, our investigation has revealed that the power generation capacity of a floating solar power plant surpasses that of a conventional ground-mounted solar power plant. This finding emphasizes the superior efficiency and energy-generating potential of the proposed floating solar installation, making it an even more attractive and sustainable solution for renewable energy production in Bangladesh.

Our main focus is to identify suitable rivers, ponds, and reservoirs where floating solar power plants can be constructed. By pinpointing these water bodies, we aim to assess their potential for accommodating floating solar installations, thereby harnessing their renewable energy potential and contributing to sustainable power generation in the region.

Kaptai Dam/ Lake, Rangamati

Prospect:

a) Water body: 3,000 Sq. Km
b) Potential: 500MW can be possible by using 1% of the land
c) Prospect of a feasibility study for setting up 50MW plant under ADB's TA project

Muhuri Dam, Feni: Proposed Capacity 25 MW

Teesta Barrage, Lalmonirhat [3].

Megnah Dhonagoda Dam,

Chandpur

a) Proposed Capacity: Feasibility Study requires

Shrimp culture Field may be a good option for Floating Solar Plant [3].

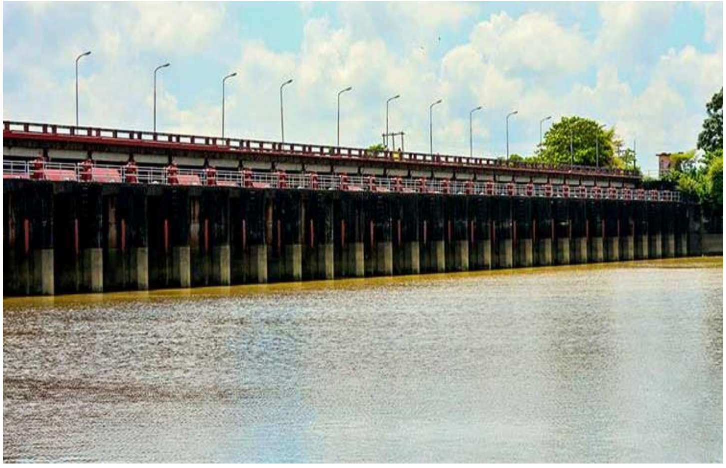


Fig 1.1: Muhuri Dam, Feni [4]

1.3 Methodology

This paper aims to assess the viability and benefits of adopting floating solar panel technology in Bangladesh. The focus is on understanding how this technology can be effectively integrated into the country's energy landscape. To achieve this, a comprehensive analysis of existing studies on solar technology is conducted, critically evaluating their findings [4].

To facilitate the completion of this project, two software tools are utilized. Firstly, the design of a 10 MW solar plant is carried out using the PVSyst software. This enables us to simulate and optimize the solar plant's performance, taking into account various factors such as solar irradiance, shading, and efficiency.

Secondly, a floating solar power plant is modeled using SketchUp software. This modeling exercise allows us to visualize the layout and arrangement of the floating solar panels, considering factors like water surface area, sunlight exposure, and engineering feasibility.

By employing these software tools and conducting a thorough evaluation of floating solar technology, we aim to shed light on its potential and how it can contribute to the sustainable energy development of Bangladesh.

In this study, a comprehensive literature review on solar technology is conducted, using a range of relevant keywords such as clean energy, evapotranspiration, floating photovoltaic technology, submerged PV panels, and sustainable water supply [4]. To ensure a thorough search, various reputable sources are employed, including popular search engines like google.com and reputable journal websites such as ScienceDirect, Elsevier, Springer, and IWAP [4].

The database of relevant articles is compiled based on the findings from these searches. To maintain the quality and relevance of the review study, inclusion, and exclusion criteria are applied, which help in citing only the most relevant and reliable articles in the final review. By adopting this rigorous approach, we aim to present a comprehensive and reliable overview of the existing research on solar technology and its various applications [4].

CHAPTER 2
LITERATURE REVIEW

2.1 Literature Review

In this study, we refer to floating solar as a Very Large Floating Solar Structure (VLFSS), which is designed and installed on water surfaces to generate power. The selected location for this VLFSS is the shoreline, situated close to human populations for efficient energy distribution [5].

The configuration of the floating solar structure comprises several key components. These include the main design shape, which can take any form, the solar array responsible for capturing solar energy, floatation foam utilized to keep the solar array afloat on the water surface, a pre-wired unit to simplify electrical connections during installation, a power cable for transmitting the generated electricity, and the powerhouse that manages the energy production and distribution.

Additionally, to ensure stability, the floating solar structure will be anchored directly to the seabed, utilizing an appropriate type of mooring line for secure attachment [5]. By integrating these components, the floating solar system aims to efficiently harness solar energy and contribute to sustainable power generation near densely populated shoreline areas.

The floating solar power plant literature review includes a thorough examination of existing research, studies and articles related to this innovative technology. The review discusses various aspects of floating solar power plants including design, performance, environmental impact and potential applications. Here is a summary of the key findings from the literature review:

Technology Overview: The literature provides a comprehensive overview of floating solar power plants, describing concepts, components and installation methods. It highlights the benefits of using aquifers for solar panel installation, such as reduced land use, reduced evaporation and increased energy efficiency due to natural cooling.

Performance Analysis: Several studies have compared the performance of floating solar panels to conventional land-based solar installations. The literature indicates that floating solar power plants can achieve high energy yields due to the cooling effect of water, which helps mitigate the effects of temperature-induced efficiency losses.

Environmental Impact: The review examines the environmental impact of floating solar power plants. This suggests that these installations can have a positive impact on water quality by reducing the growth of algae and preventing water evaporation. However, potential environmental concerns, such as impacts on aquatic ecosystems and native wildlife, are also discussed.

Technological Advances: The literature review highlights ongoing technological advancements in floating solar panel systems. These include improvements in anchoring methods, material durability and design innovation to increase the overall performance and longevity of floating solar power plants.

Case Studies: The review includes case studies of various regions where floating solar power plants have been implemented These case studies provide insight into the real challenges faced during the installation, maintenance and integration of floating solar projects into the existing power grid.

Economic feasibility: The literature explores the economic feasibility and cost-effectiveness of floating solar power plants compared to traditional solar installations and other renewable energy sources. It evaluates factors such as installation costs, energy production, and potential revenue streams.

Policy and Regulatory Framework: The review also examines existing policy and regulatory frameworks around floating solar power plants. It identifies potential barriers and incentives that affect the widespread adoption of this technology.

Overall, the literature review presents a comprehensive understanding of floating solar power plants, highlighting their advantages, challenges, and potential for sustainable energy production. The information collected from various studies serves as a valuable resource for researchers, policymakers, and stakeholders interested in harnessing the potential of floating solar technology to meet the growing energy demand in a sustainable manner.

2.2 Compare and Contrast

The population of our country is on a continuous rise, and despite having substantial power generation capacity, we find ourselves needing to import electricity from neighboring nations. In light of this situation, the Bangladeshi government is actively exploring alternative strategies to address the electricity deficit. Presently, numerous solar initiatives are underway across Bangladesh, predominantly consisting of ground-mounted installations. However, this approach demands extensive land usage. Given the country's high population density and the need to preserve arable land, there is a growing interest in establishing solar power plants on floating platforms.

Taking a quick look, it's evident that there is significant untapped potential for solar energy and other renewable sources in Bangladesh.

The current trend in energy requirements is on the rise, driven by population growth, economic expansion, and technological advancements. [6].

Presently electricity is the most useful form of energy. It plays a significant role in developing the socioeconomic status and the standard of living of a country. Sadly, in Bangladesh, only 62 % of the total population has access to it [7].

Bangladesh has a significant potential for solar energy due to its geographical location and climate. The government of Bangladesh has set a target of generating 10% of its total electricity from renewable sources by 2021, and solar energy is expected to play a significant role in achieving this target. As of 2022, Bangladesh has a total installed solar power capacity of approximately 1.06 GW, which accounts for around 5% of the country's total installed power capacity [7]. The majority of this capacity comes from off-grid solar systems, which are used to provide electricity to rural households and businesses that are not connected to the national grid. In recent years, the Bangladesh government has implemented several large-scale solar power projects, including a 50 MW solar power plant in Feni, a 28 MW [8]solar power plant in Cox's Bazar, and a 75 MW solar power plant in Chattogram [8].

Additionally, several other solar power projects are under construction or in the planning stages, including a 100 MW solar power plant in Gaibandha [9] and a 200 MW solar power plant in Mymensingh [10]. The government has also implemented a net metering system, which allows consumers to sell excess solar energy generated by their rooftop solar systems back to the national grid. This has incentivized the installation of rooftop solar systems, particularly in urban areas. Despite these developments, the deployment of solar energy in Bangladesh still faces several challenges, including high initial costs, limited access to financing, and the lack of a well-developed supply chain for solar products.

However, with the government's commitment to increasing the share of renewable energy in the country's energy mix, and the declining cost of solar technology, the future of solar energy in Bangladesh looks promising. The amount of power generation using the solar system is currently about 401.26 MW. In addition, there are some poultry and dairy farms in which bio-gas plants are being set up and this biogas is used for cooking and power generation. The amount of power generation from such plants is currently about 1.03 MW. Renewable energy resources could assist in the energy security of Bangladesh and could help reduce the natural gas demand.

Regions of the country without supply or access to natural gas or the electric grid use biomass for cooking and solar power and wind for drying different grains and clothes. Biomass is currently the largest renewable energy resource in use due to its extensive noncommercial use, mainly for cooking and heating. Biomass comprises 27 percent of the total primary energy use in Bangladesh. The country has a huge potential for generating solar power. Moreover, the use of renewable energy has become popular worldwide in view of the depleting reserves of non-renewable fossil fuels. Renewable energy is environmentally friendly. Renewable energy resources used in Bangladesh can be divided into three main categories

Types- (I) Traditional biomass fuel, (ii) Conventional hydropower, (iii) New-renewable resources of energy (Solar PV, Wind, Biogas, etc.). But now we want to introduce another new energy, floating solar power. It is called the third pillar of renewable energy [11].

Energy Consumption in Bangladesh

Electricity is a basic need of human life and today's 20 trillion kWh of electricity is consumed around the world. Currently, Bangladeshi gas is being consumed by power (41%), Fertilizer (7%), Industry & Tea-Estate (17%), Captive Power (17%), CNG (5%), Commercial (01%), & Domestic (12%) and advancing with 2.5 million consumers in Bangladesh. Whereas sector wise electric power consumed by domestic, industry, commercial, irrigation, and others is 50.07%, 34.47%, 9.09%, 4.58%, and 1.79% respectively this is shown in Figure 2 [6].

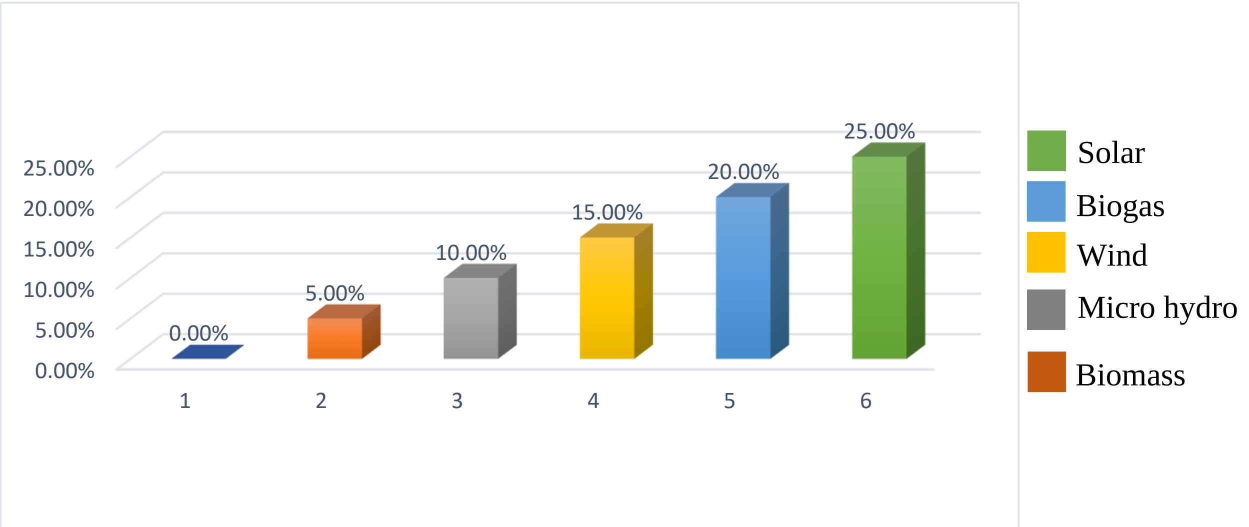


Fig 2.1: The contribution of different instigated renewable sources in Bangladesh [6]

CHAPTER 3
SYSTEM DESIGN & 3D MODEL

3.1 Introduction

Utilizing the PVSyst software for system design and harnessing the capabilities of SketchUp software for 3D modeling, this chapter will provide a comprehensive guide to the intricacies of designing and creating a 10MW floating solar power plant. We will delve into the process of obtaining detailed parameters and conducting a thorough output analysis for this cutting-edge renewable energy facility.

3.2 3D modeling

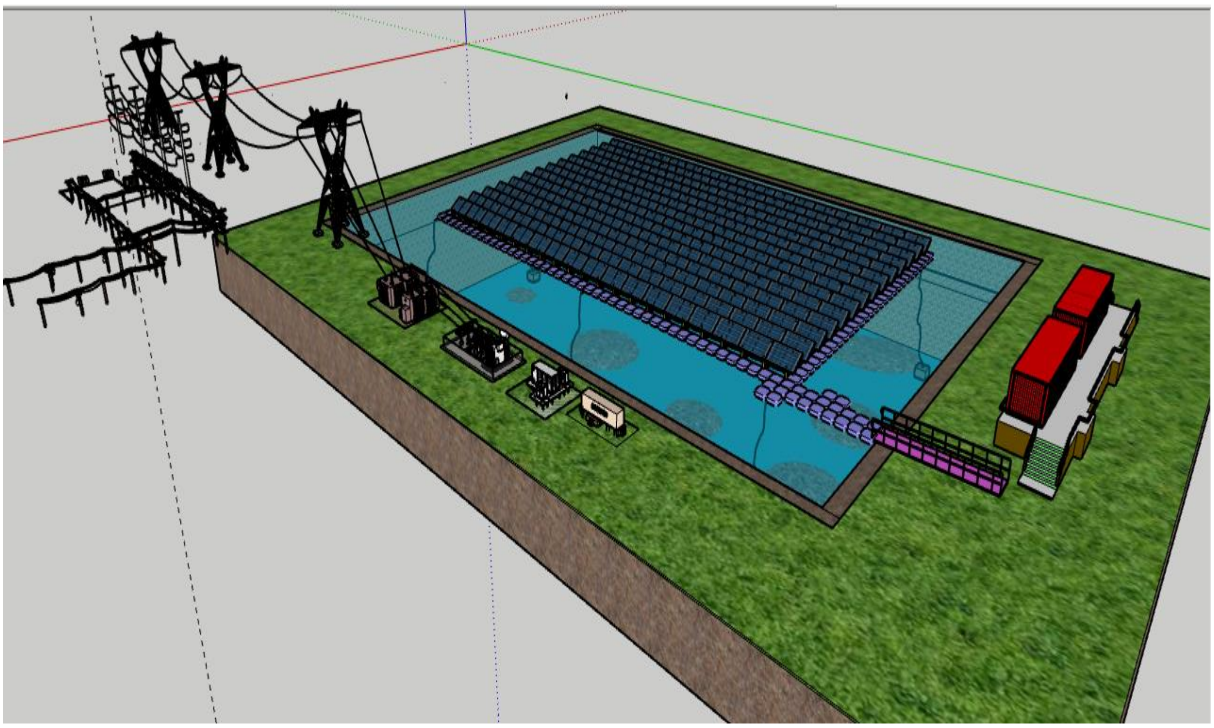


Fig 3.1: Floating Solar Power Plant

Major components of floating solar PV: The design of a Floating Solar Photovoltaic (FSPP) system shares similarities with conventional solar PV systems, albeit with the unique requirement of being adapted to float on water surfaces [12]. The standard floating structure accommodates PV arrays, inverters, combiner boxes, lighting arresters, and related components on a buoyant platform. This platform, crafted from materials like fiber-reinforced plastic (FRP), high-density polyethylene (HDPE), or metallic structures, rests upon the water while being supported by anchoring and mooring systems to ensure stability. A detailed description of floating solar components is given below [13]:

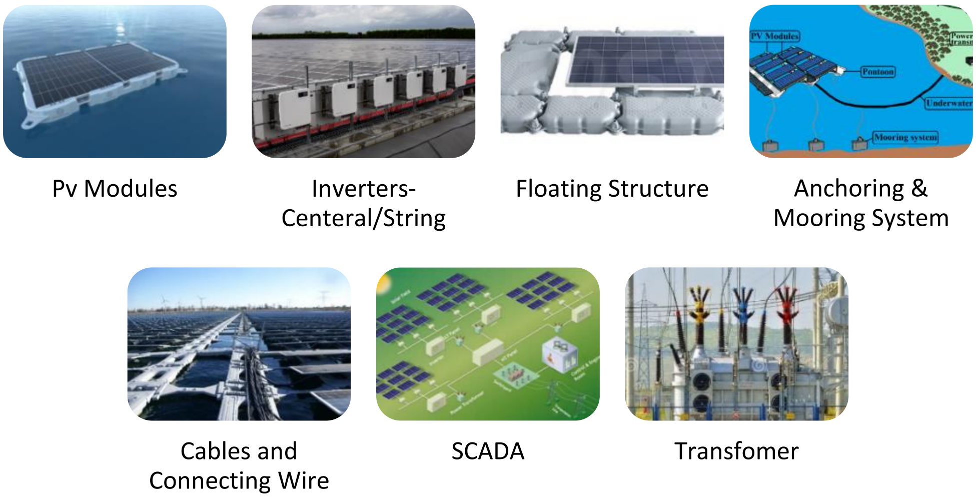


Fig 3.2: Major components of floating solar PV [13]

3.3 Design Specifications, Standards and Constraints (Floating solar power plant)

PVsyst- Simulation Report

Grid-Connected System

Project: 10 MW Floating Solar Power Plant

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 10.00 MWp

Kaptai Lake – Bangladesh

Our system is designed in such a way that if we install this 10 MW floating solar power plant near Kaptai Lake, we can use 2 power plants in a hybrid system with the Karnaphuli hydropower plant, which will benefit the public a lot.

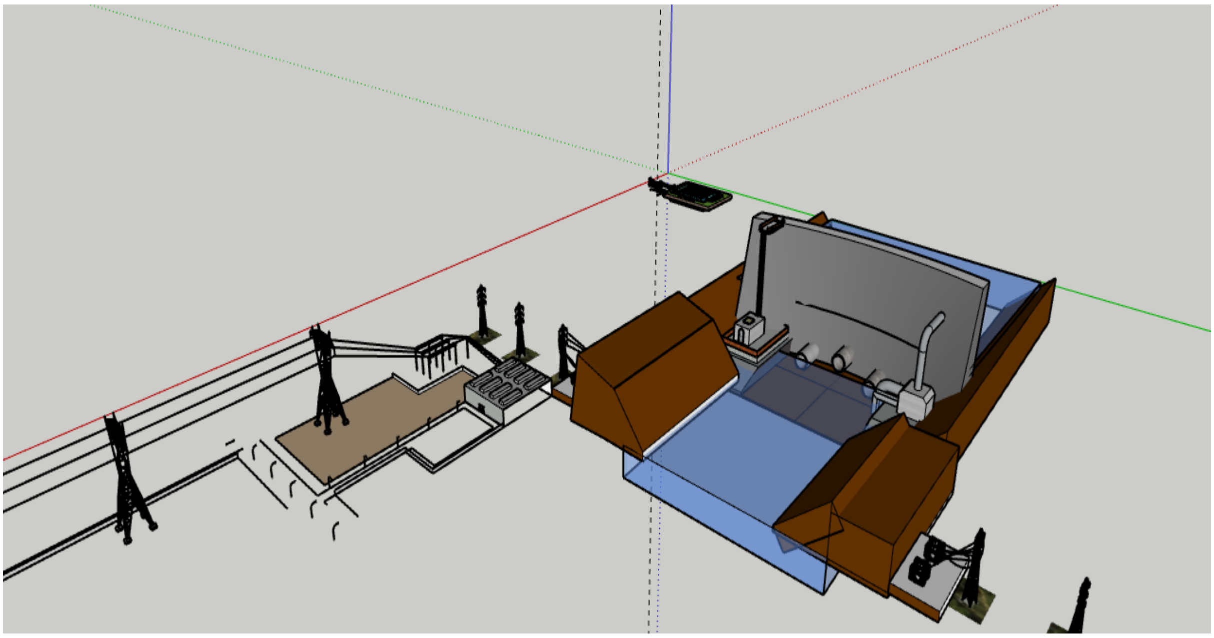


Fig 3.3: Karnaphuli hydropower plant

System information PV Array

Nb. of modules: 29412 units

Pnom total: 10.00 MWp

Inverters

Nb. of units:181 units

Pnom total: 9955 kWac

Pnom ratio: 1.005

Results summary

Produced Energy: 13241859 kWh/year	Specific production:1324 kWh/kWp/year
Perf. Ratio PR:77.53 %	

Table 3.1: Results summary

PV Array Characteristics

PV module	At operating cond. (50°C)
Manufacturer: Generic	Pmpp: 9054 kWp
Model: STP-340-72-Vfh	U mpp: 620 V
(Custom parameters definition)	I mpp: 14610 A
Unit Nom.Power:340Wp	**Total PV power**
Number of PV modules: 29412 units	Nominal (STC): 10000 kWp
Nominal (STC): 10.00 MWp	Total: 29412 modules
Modules: 1634 Strings x 18 In series	Module area: 59177 m²
	Cell area: 51247 m²

Table 3.2: PV Array Characteristics

PV Array Characteristics

Inverter

Manufacturer: Generic

Model: SG50-CX

(Original PVsyst database)

Unit Nom.Power: 55.0 kWac

Number of Inverter: 181 units

Total Power: 9955 kWac

Operating voltage: 200-850 V

Total inverter power

Total power: 9955 kWac

Number of inverters: 181 units

Pnom ratio: 1.00

Table 3.3: PV Array Characteristics

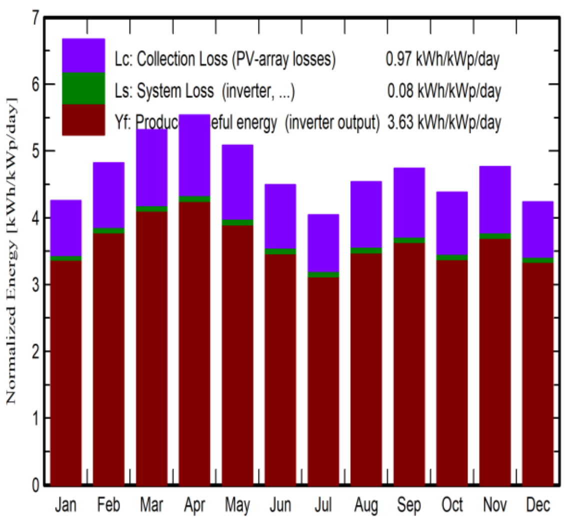
Main results

System Production

Produced Energy: 13241859 kWh/year

Specific production: 1324 kWh/kWp/year

Performance Ratio PR: 77.53 %



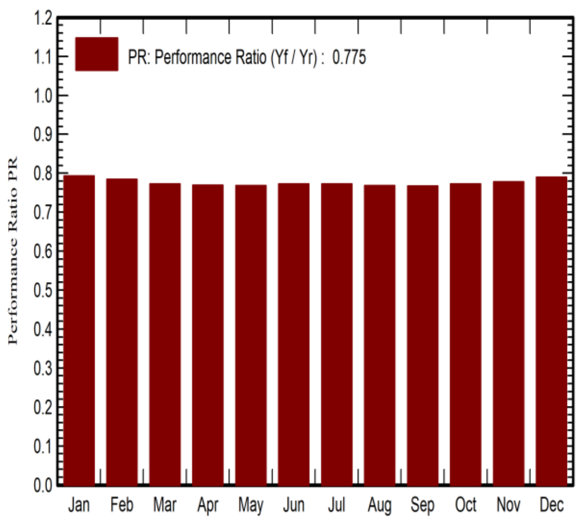


Table3.4: Main results

Loss Diagram

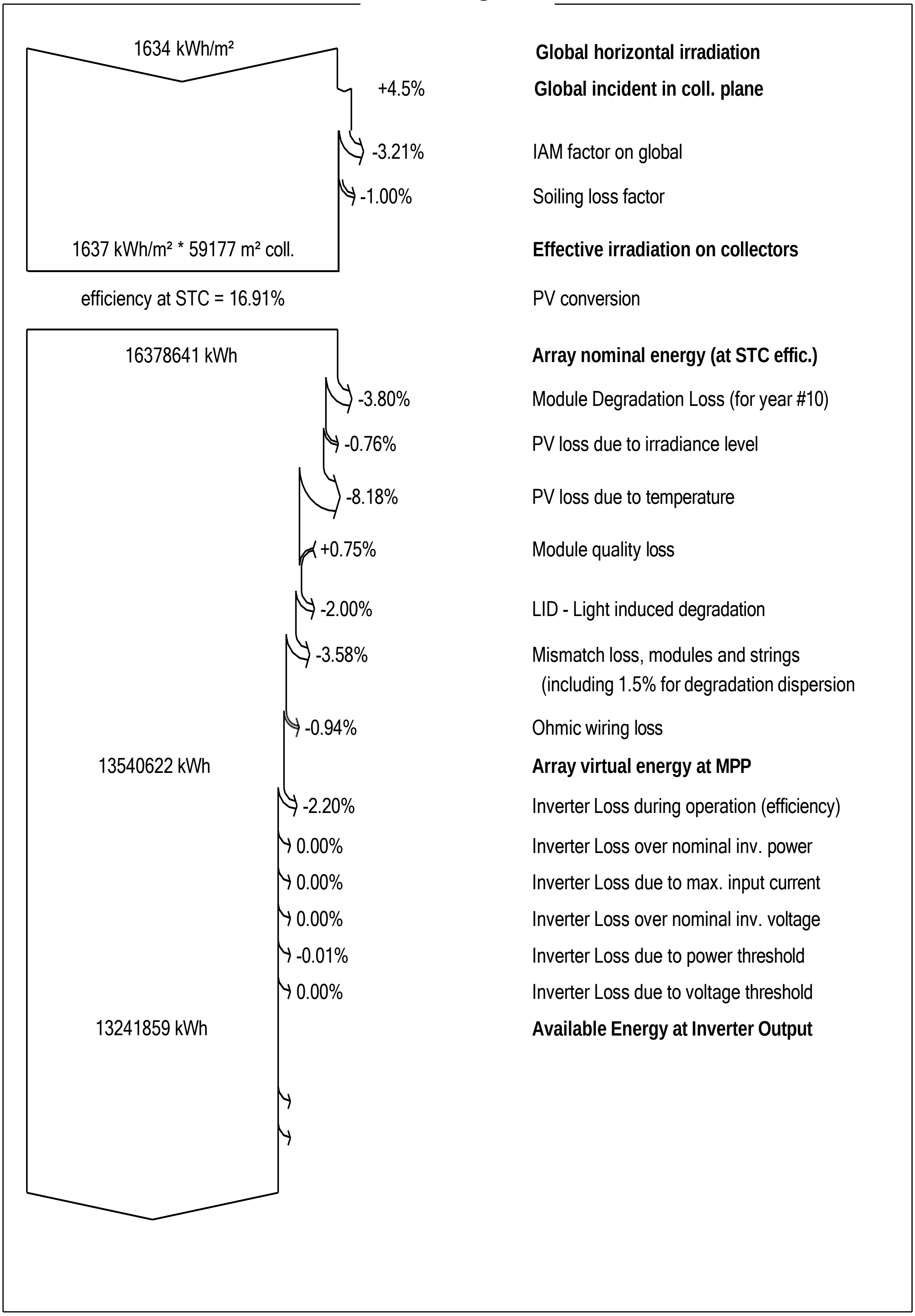


Table 3.5:Loss Diagram

P50 - P90 evaluation

Annual production probability

Probability distribution: 239 MWh

P50: 13884 MWh

P90: 13563 MWh

P95: 13473 MWh

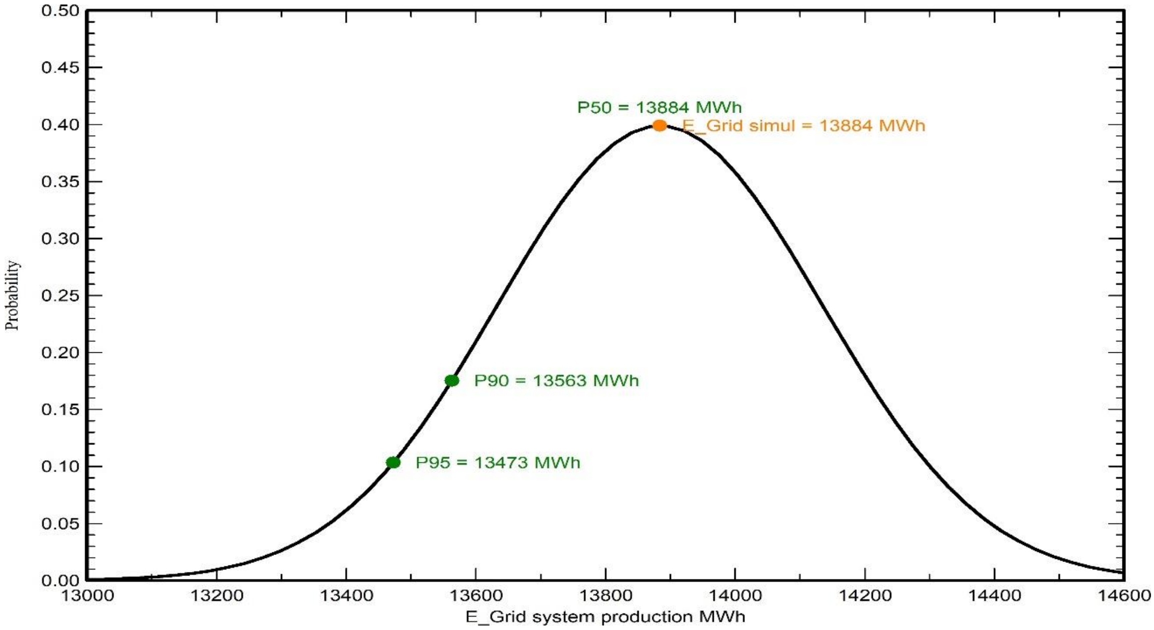


Table 3.6: P50 - P90 evaluation

P50-P90 assessment holds a multifaceted significance during the solar system design process, influencing various aspects of the project. The P50-P90 values indicate the projected range of power generation potential from the system.

For instance:

P50 estimation points to an expected power generation of 13884 MWh.

P90 prediction suggests a slightly conservative estimate at 13563 MWh.

Additionally, considering the P95 value of 13473 MWh further refines the understanding of potential outcomes.

These figures not only guide energy yield expectations but also inform critical decisions related to system sizing, financial planning, and risk assessment within the solar project's development and operational phases.

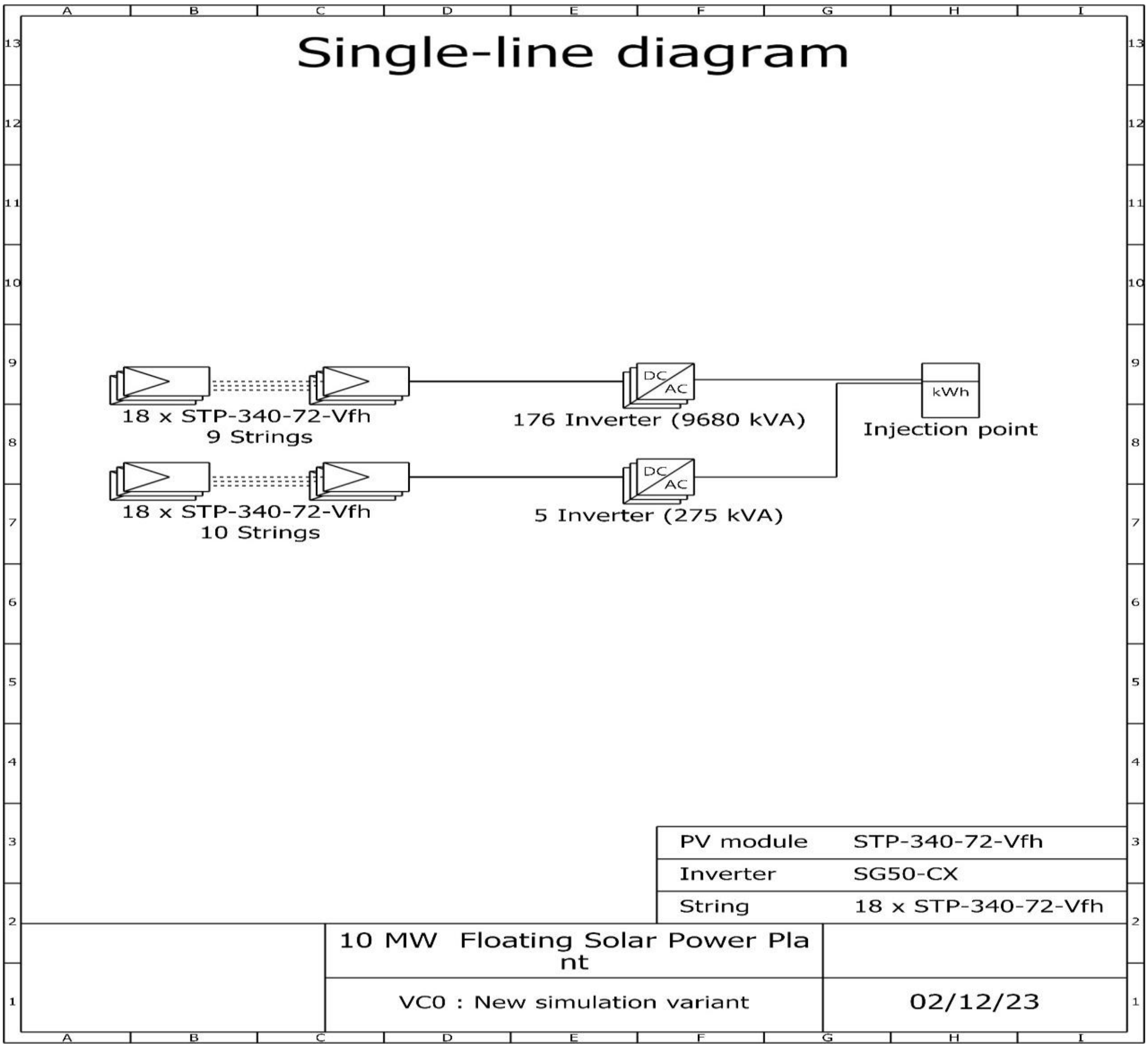


Fig 3.4: Singel line diagram of 10 MW floating solar power plant

Scenario 1:

Photovoltaic Panels: There are 18 solar panels, each of the STP-340-72-vfh model.
String Configuration: The 18 panels are grouped into 9 strings, which means there are 2 panels in each string.

Inverter: In this setup, a single inverter with a capacity of 176 kW (9680 KVA) is used. This inverter is responsible for converting the direct current (DC) generated by the panels into alternating current (AC).

Power Conversion: The DC power generated by the panels is aggregated in the strings and then fed into the single inverter. The inverter converts the combined DC power from the strings into AC power.

Injection Point: The converted AC power is injected into the grid at a designated point. This point represents the location where the solar-generated electricity is integrated into the existing electrical grid.

Scenario 2:

Photovoltaic Panels: Similarly, there are 18 solar panels of the STP-340-72-vfh model. String Configuration: In this scenario, the 18 panels are divided into 10 strings. This means that some strings might contain 1 panel while others have 2 panels, depending on how the configuration is organized.

Inverter: Unlike Scenario 1, this setup employs 5 separate inverters, each with a capacity of 5 kW (275 KVA). These smaller inverters collectively handle the conversion of DC to AC.

Power Conversion: The DC power generated by the panels is distributed among the 10 strings. Each string's DC power is then converted to AC power by one of the five inverters.

Injection Point: Similar to Scenario 1, the converted AC power from the five inverters is injected into the grid at the same designated point.

In both scenarios, the end goal is to generate solar power and integrate it into the electrical grid. The key differences between the scenarios lie in the string configuration and the inverter setup. Scenario 1 uses a single large inverter to handle all the DC-to-

AC conversion, while Scenario 2 employs multiple smaller inverters to handle the conversion in a distributed manner.

3.4 System Analysis or Design Analysis

We are engaged in the conceptualization and intricate three-dimensional modeling of a state-of-the-art 10-megawatt (MW) floating solar power plant. The fundamental objective of this facility is to harness renewable energy from the sun's rays and convert it into usable electricity.

With a remarkable annual production capacity of 13,241,859 kilowatt-hours (kWh), this solar power plant demonstrates its capability to contribute significantly to sustainable energy. To achieve this impressive output, a total of 29,412 photovoltaic (PV) modules are meticulously integrated into the design. These PV modules serve as the essential components responsible for capturing sunlight and transforming it into electrical energy through the photovoltaic effect.

Furthermore, the effective operation of this solar power plant is enabled by a network of 181 inverters. These inverters play a pivotal role in converting the direct current (DC) generated by the PV modules into alternating current (AC), which is the standard form of electricity used for most applications.

A noteworthy aspect of this solar power plant is its Performance Ratio (PR) of 77.53%. The Performance Ratio is a critical metric that evaluates the overall efficiency of the system. It takes into account various factors such as shading, temperature variations, and system losses to provide an accurate representation of how effectively the solar panels convert sunlight into electricity. A PR of 77.53% indicates a high level of efficiency and optimal utilization of available solar resources.

In essence, this meticulously designed and 3D modeled floating solar power plant showcases the integration of advanced technologies and engineering expertise to harness renewable energy, contribute to the reduction of carbon emissions, and pave the way for a greener and more sustainable future.

3.5 Design Specifications, Standards, and Constraints (Ground-mounted solar power plant)

PVsyst- Simulation Report

Grid-Connected System

Project: 10 MW Ground-mounted solar power plant

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 10.00 MWp

Jamalpur– Bangladesh

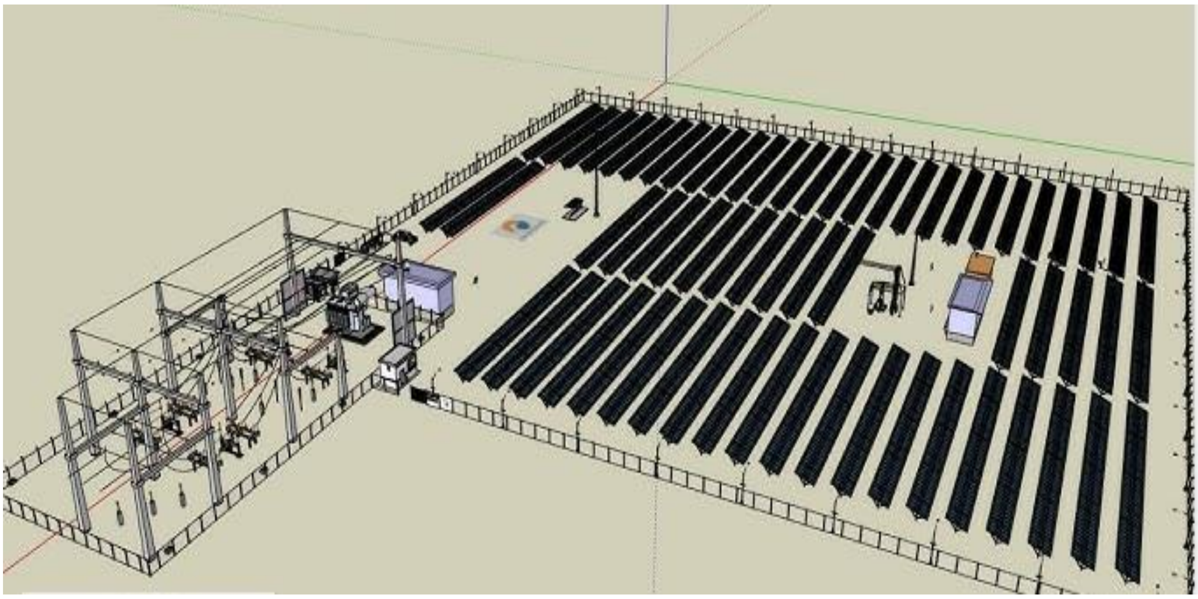


Fig 3.5: Ground-mounted solar power plant

System information PV Array

Nb. of modules: 29412 units

Pnom total: 10.00 MWp

Inverters

Nb. of units:181 units

Pnom total: 9955 kWac

Pnom ratio: 1.005

Results summary

Produced Energy: 12707840 kWh/year	Specific production:1271 kWh/kWp/year
Perf. Ratio PR:77.46 %	

Table 3.7: Results summary

PV Array Characteristics

PV module	At operating cond. (50°C)
Manufacturer: Generic	Pmpp: 9091 kWp
Model: STP-340-A21-Wnhb	U mpp: 650 V
(Custom parameters definition)	I mpp: 13433A
Unit Nom.Power:340Wp	**Total PV power**
Number of PV modules: 29412 units	Nominal (STC): 9996 kWp
Nominal (STC): 10.00 MWp	Total: 29412 modules
Modules: 1400 Strings x 21 In series	Module area: 51906 m²
	Cell area: 44823 m²

Table 3.8: PV Array Characteristics

PV Array Characteristics

Inverter	
Manufacturer: Generic	**Total inverter power**
Model: SG50-CX	Total power: 9955 kWac
(Original PVsyst database)	Number of inverters: 181 units
Unit Nom.Power: 55.0 kWac	Pnom ratio: 1.00
Number of Inverter: 181 units	
Total Power: 9955 kWac	
Operating voltage: 200-850 V	

Table 3.9: PV Array Characteristics

Main results

System Production

Produced Energy: 12707840 kWh/year

Specific production: 1271 kWh/kWp/year

Performance Ratio PR: 77.46 %

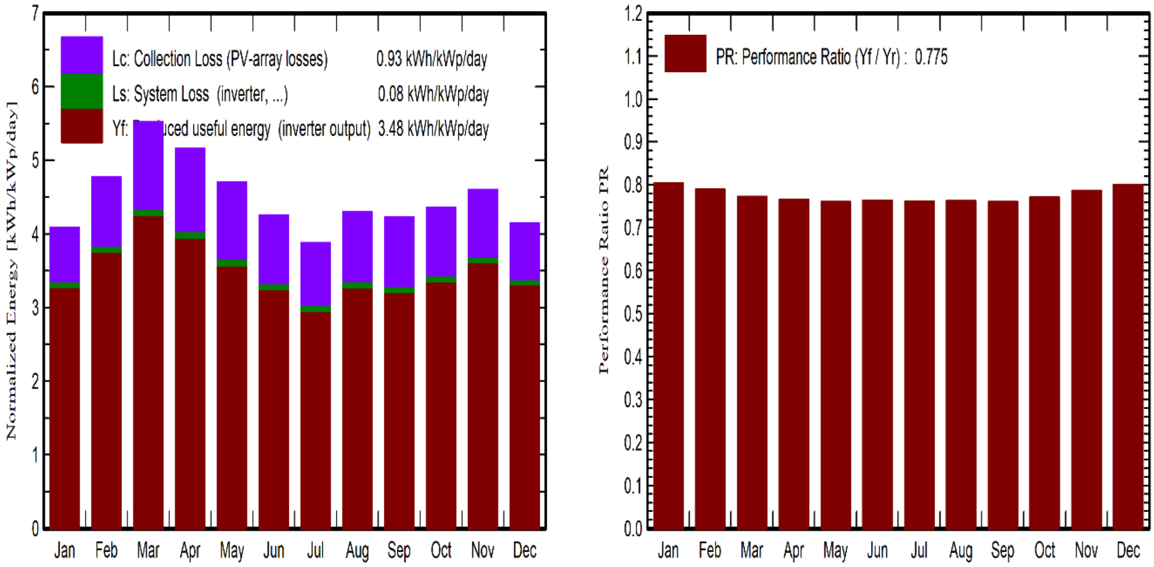


Table3.10: Main results

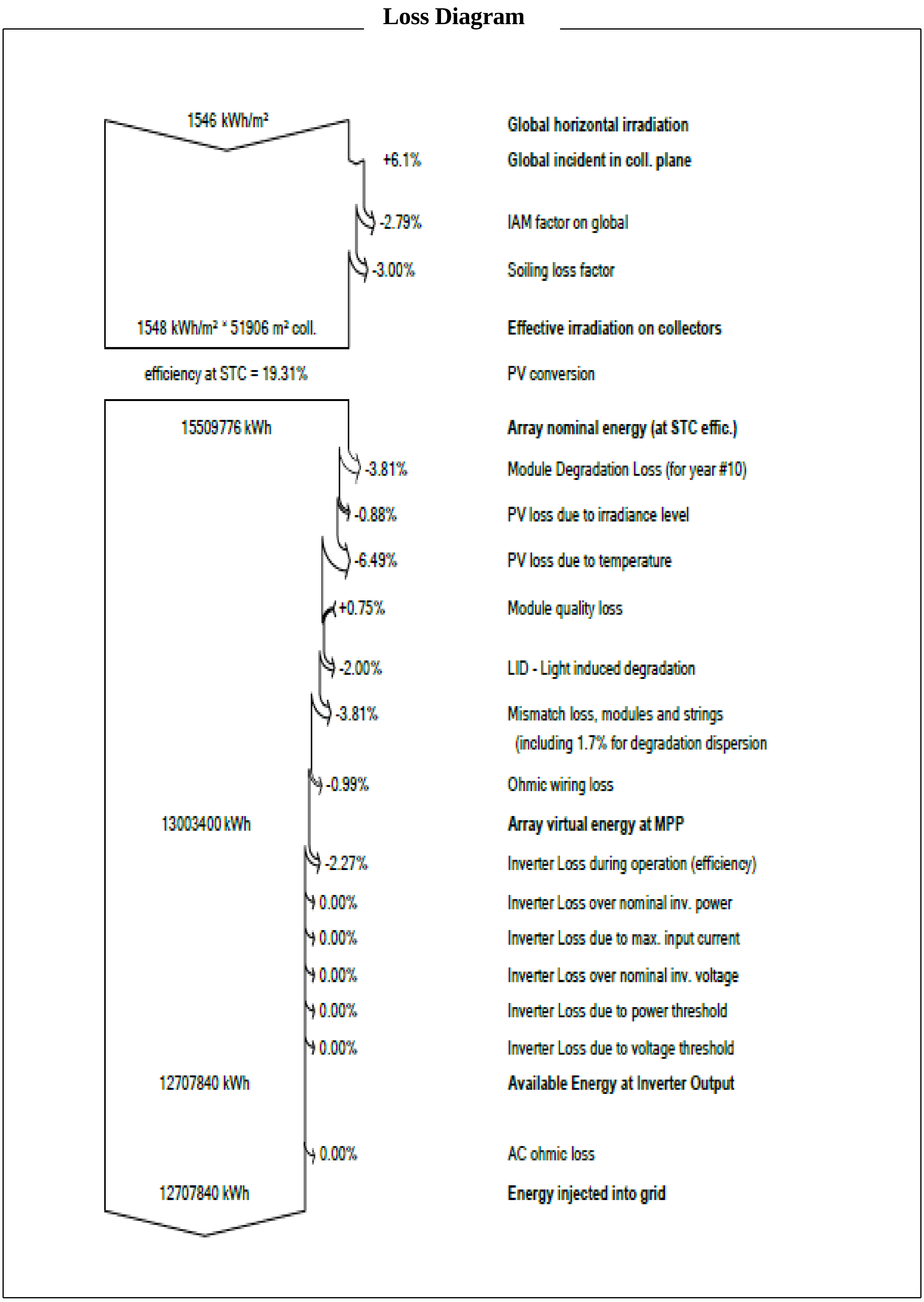


Table 3.11: Loss Diagram

P50 - P90 evaluation

Annual production probability

Probability distribution: 239 MWh

P50: 13242 MWh

P90: 12936 MWh

P95: 12850 MWh

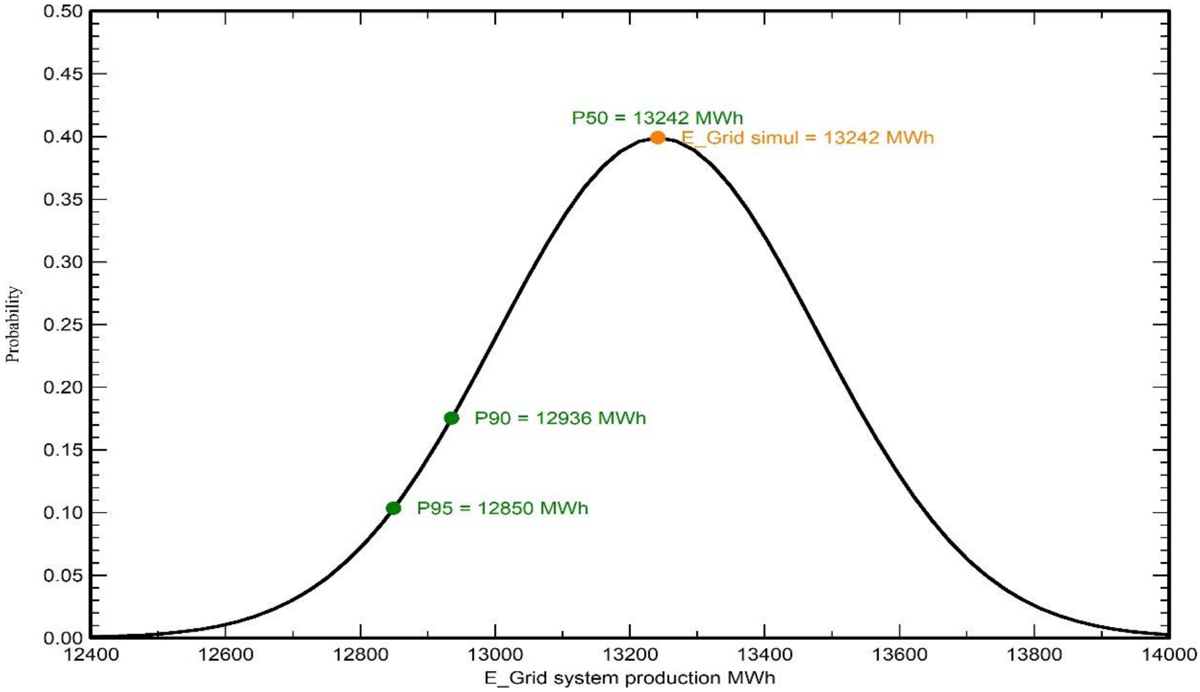


Table 3.12: P50 - P90 evaluation

P50-P90 assessment holds a multifaceted significance during the solar system design process, influencing various aspects of the project. The P50-P90 values indicate the projected range of power generation potential from the system.

For instance:

P50 estimation points to an expected power generation of 13242 MWh.

P90 prediction suggests a slightly conservative estimate at 12936 MWh.

Additionally, considering the P95 value of 12850 MWh further refines the understanding of potential outcomes.

These figures not only guide energy yield expectations but also inform critical decisions related to system sizing, financial planning, and risk assessment within the solar project's development and operational phases.

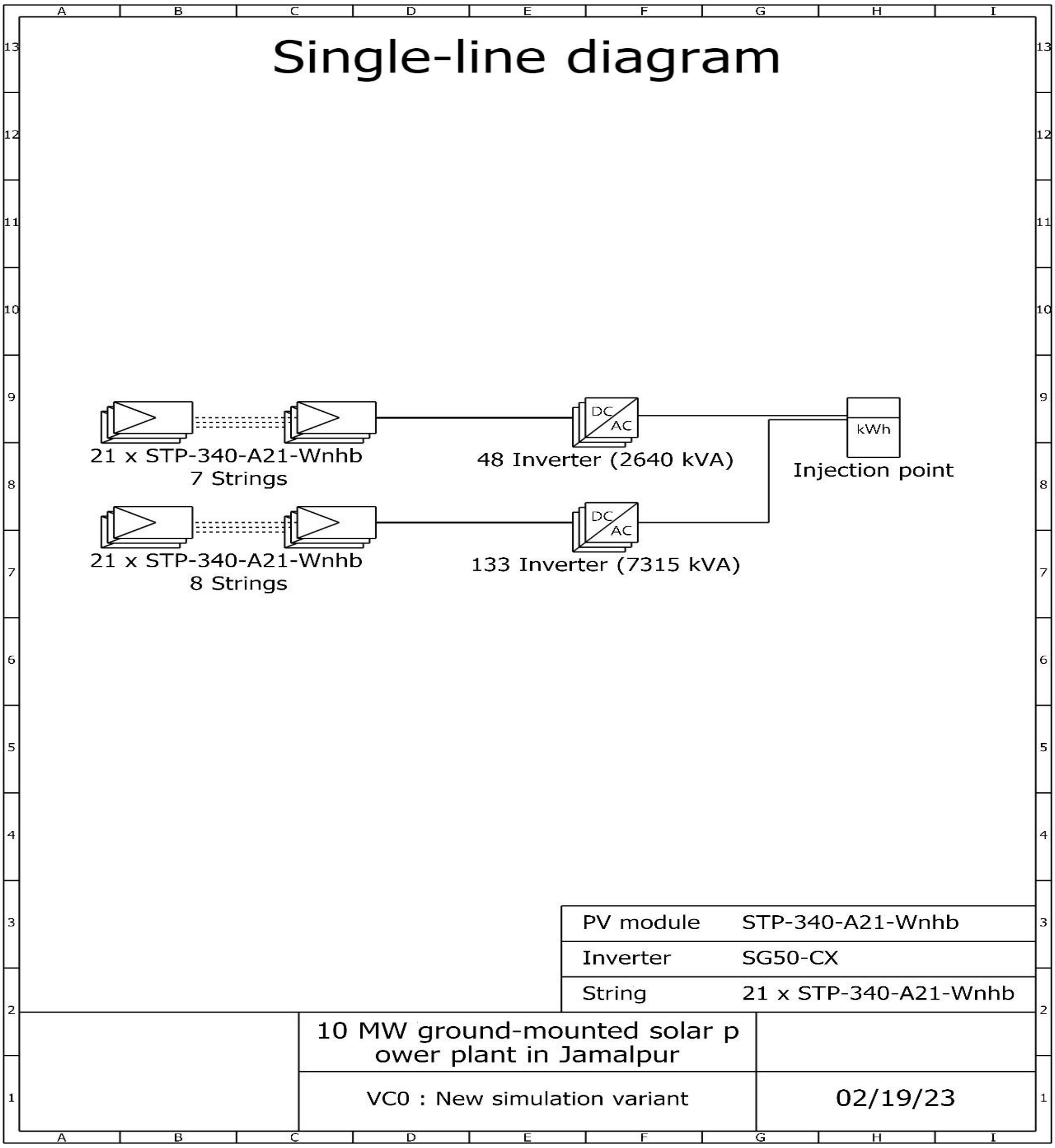


Fig 3.6: Singel line diagram of 10 MW Ground-mounted solar power plant

Scenario 1:

Photovoltaic Panels: There are 21 solar panels, each of the STP-340-A21-wnhb model.

String Configuration: The 21 panels are arranged into 7 strings, which means there are 3 panels in each string.
Inverter: In this configuration, a single inverter with a capacity of 48 kW (2640 KVA) is used. This inverter is responsible for converting the direct current (DC) generated by the panels into alternating current (AC).

Power Conversion: The DC power produced by the panels is aggregated within the strings and then sent to the single inverter. The inverter converts the combined DC power from the strings into AC power.

Injection Point: The converted AC power is injected into the grid at a designated point. This is the point where the solar-generated electricity is integrated into the existing electrical grid.

Scenario 2:

Photovoltaic Panels: Similarly, there are 21 solar panels of the STP-340-A21-wnhb model.
String Configuration: In this scenario, the 21 panels are divided into 8 strings. The arrangement of panels in each string might vary, possibly resulting in some strings having 2 panels and others having 3 panels, depending on how they are configured.

Inverter: Unlike Scenario 1, this setup employs a larger inverter with a capacity of 133 kW (7315 KVA). This inverter is responsible for converting the DC power generated by the panels into AC power.

Power Conversion: The DC power generated by the panels is distributed across the 8 strings. Each string's DC power is then converted to AC power by the single, larger inverter.

Injection Point: Similar to Scenario 1, the converted AC power from the larger inverter is injected into the grid at the same designated point.

In both scenarios, the fundamental objective is to harness solar energy and integrate it into the electrical grid. The primary distinctions between the scenarios lie in the string arrangement and the inverter configuration. Scenario 1 employs a single smaller inverter to handle the DC-to-AC conversion, while Scenario 2 opts for a larger inverter to manage the conversion. The choice between these scenarios might be influenced by factors such as system efficiency, scalability, maintenance considerations, and cost-effectiveness.

3.6 Summary

In this section, we discuss the process of conceptualizing a floating solar power plant, highlighting the modeling steps required. A comprehensive outline of the materials needed to build floating solar panels is provided.

Additionally, we extensively explore the intricacies of the design parameters established by PVsyst, highlighting their significance and impact on the overall system.

CHAPTER 4
COST ANALYSIS

4.1 Introduction

In this chapter, we will conduct a comprehensive cost analysis of two distinct solar power plant setups, with a focus on comparing their financial implications. Specifically, we will examine the cost disparity between a 10 MW Ground Mounted solar power plant and a 10 MW Floating solar power plant. Our objective is to determine not only which installation demands a higher investment, but also whether the additional expenditure translates into a proportional increase in electricity generation.

Let's delve into the specifics of each installation:

1. 10 MW Ground Mounted Solar Power Plant:

This traditional solar power plant configuration involves the installation of solar panels on the ground, utilizing open land space. The costs associated with this setup encompass land acquisition, structural foundations, mounting structures, electrical systems, and labor. We will meticulously break down these expenses and quantify the total cost of establishing and operating the 10 MW Ground Mounted solar power plant.

2. 10 MW Floating Solar Power Plant:

In contrast, the Floating solar power plant showcases a unique design by positioning solar panels on water bodies such as lakes, reservoirs, or ponds. This innovative approach necessitates specialized floating platforms, anchoring mechanisms, water-proofing measures, electrical components, and assembly procedures. Our assessment will methodically evaluate these costs to ascertain the total investment required to develop and maintain the 10 MW Floating solar power plant.

Comparative Analysis:

Having outlined the individual costs for each power plant, we will perform a side-by-side comparison to determine the financial contrast. While the Floating solar power plant may entail a higher initial investment due to its distinctive requirements, we will closely examine whether this additional cost is justified by a corresponding escalation in electricity production. Our analysis will encompass efficiency considerations, sunlight exposure, maintenance expenses, and the projected lifespan of each installation.

By meticulously evaluating both cost and output factors, we aim to draw meaningful insights into the financial viability of these two solar power plant configurations. This analysis will aid stakeholders and decision-makers in making informed choices regarding their solar energy investments.

4.2 10 MW Ground Mounted solar power plant cost

Note that in solar we use the term peak. This means the installed solar system can generate a maximum power of the “peak” amount per hour at the optimum conditions. For example, I want to install a 10 MWp power plant [14]. This means the peak production capacity of the system will be 10MW per hour. Now depending on your geographical location, there is an annual average number of peak powers that will be generated. In Bangladesh, Jamalpur the average annual sun hour is 4.46 hours. This means a 10MWp system can generate 10 x 4.46 = 44.6MWh of energy per day [15]. This is the annual average. During the rainy season this can do down to 3 hours, during the sunny spring season it can do up to 6 hours. So, have to plan based on the annual average.

The annual average peak sun-hour data is publicly available based on Geo-location. let's calculate how much actual power will get by installing 10 MWp (I’m assuming) in Bangladesh. As explained above, it will be 44.6MWh per day [15]. This is the energy generated by the panels.

By the time this energy gets converted from DC to AC via the inverters and other system losses, you will get 80% of the total produced energy. So, your 44.6 MWh now comes down to 40.17 MWh per day. This is what you can push to the grid [15].

Now let's calculate how many dollars are needed to build a 10 MW ground-mounted solar power plant.

Land: The installation of 1 MW capacity solar PV requires approximately 20,000 sq. meters or 5 acres of land. 50 acres of land are required to build a 10 MW solar power plant.
If the price of land per acre = 1,200,000 Takas.
Then the price of 50 acres of land = 60,000,000 Takas.

PV Modules: A monocrystalline solar panel costs 106.20 takas per watt. So, a 340-watt solar module costs (340*159.29) =54,158.6Takas. modules required is 29000 if 3 modules are 1 panel = 29000/3=9666.6 panels.
Then the cost of panels = 54158.6*9666.6=523,529,522.8Takas.

Inverter: A 1-MW solar power plant requires a 1-MW central inverter. The current market price (ABB)of the set is 3,205,147.45 Takas.
So, for 10 MW = 10*3,205,147.45=32,051,474.5 Takas.

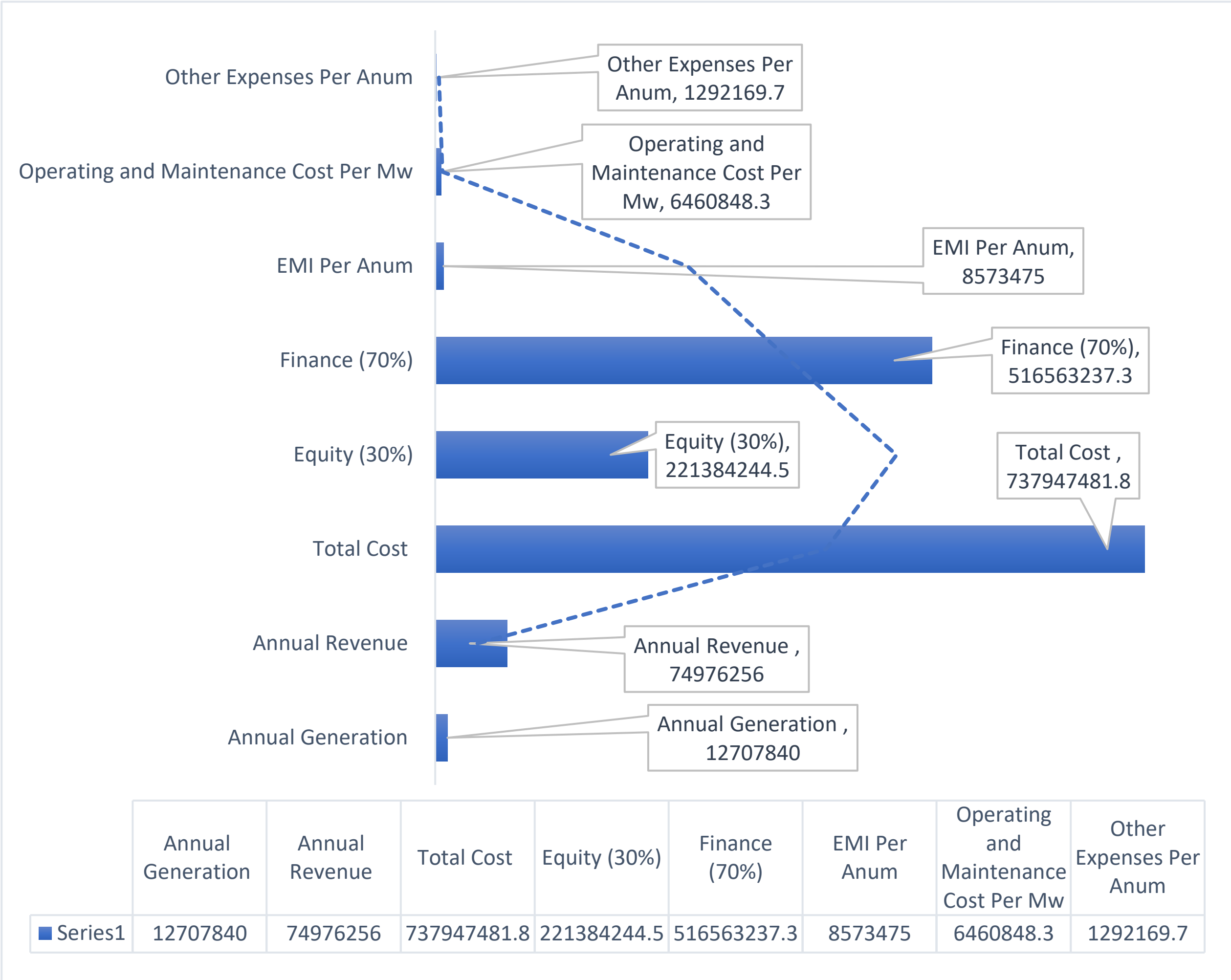
SCB & Cables etc: 1,922,932.36 Takas for SCB and cables etc for a 1-MW solar power plant.
So, for 10 MW= 10*1,922,932.36= 19,229,323.6 Takas.

Ground-mounted structure: 1 MW mounted structure will cost 3,202,710.26 Takas.
Then 10 MW= 10*3,202,710.26= 32,027,102.6 Takas and the cost will depend on the design.
Transformers and Substations: Transformers and substations per megawatts of the solar power plant will cost 3,231,827.05 Takas.
The cost for 10 MW = (10*3,231,827.05) = 32,318,270.5 Takas.

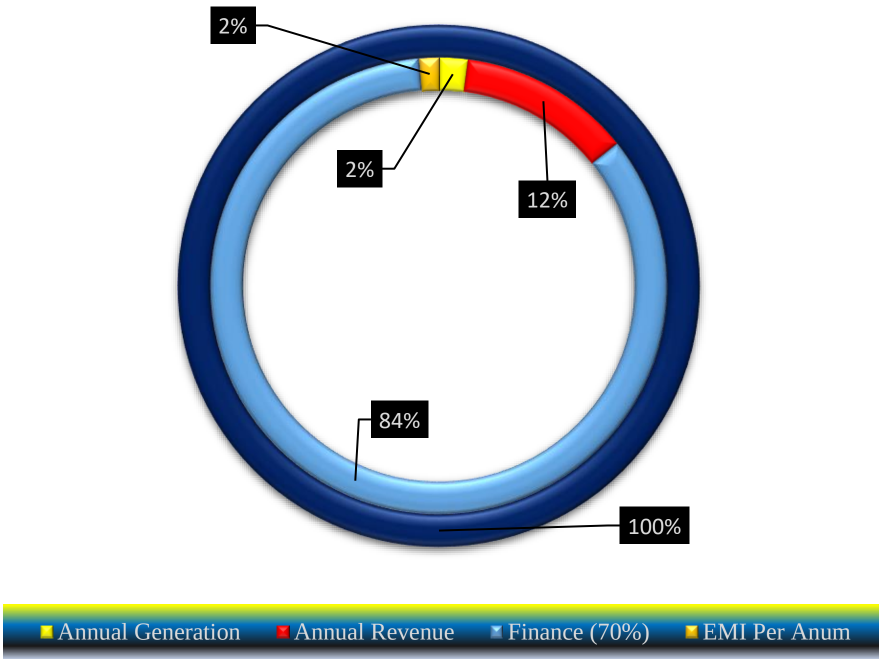
Transmission Lines & Fencing: Cost per mw 1,810,283.43 Takas.
Then the cost of 10 mw = 10*1,810,283.43= 18,102,834.3 Takas.
Installation and commissioning Other: Installation and commissioning Other costs will be 2,068,895.35 Takas per MW. Then the cost for 10 mw will be = 10 * 2,068,895.35= 20,688,953.5 Takas.

	Financial Model of 10 MW Solar Project	
Sr No	**Assumptions**	
1	Project Capacity (DC KWp)	10000
2	Project Capacity (AC KWp)	9955
3	PR (Performance Ratio)	77.46%
4	Annual Generation	12707840 kWh/year
5	Tariff Rate of Discom	5.90
6	Annual Revenue	74976256
7	25 Years Revenue	1874406400
8	**In this Degradation Not Considered**	
	Financial	
9	Cost Per (kWp)	73776
10	Total Cost	737947481.8
11	Equity (30%)	221384244.54
12	Finance (70%)	516563237.26
13	Rate of Interest	10%
14	Repayment Period of the loan	7 Years
15	EMI Per Anum	8573475.00
16	Operating and Maintenance Cost Per Mw	6460848.3
17	Other Expenses Per Anum	1292169.7
18	Return on Equity	26.96%
19	The payback time of Equity	9.28 years
20	The payback time of the loan	7 years

Table 4.1: Financial Model of 10 MW Gound-mounted solar power plant Project



Bar Chart 1: Cost Analysis of Ground-Mounted Solar Power Plant



Pie Chart 2: Cost Analysis of Ground-Mounted Solar Power Plant

4.3 10 MW Floating solar power plant cost.

The cost analysis covers investment costs and operation and maintenance costs [16].

Investment costs
Development and design costs
Soil preparation cost (including felling)
Solar PV Modules
inverter
Mounting system
Cables, junction boxes, and other materials
Installation cost
Conversion equipment and installation costs
Grid connection cost
Other expenses

Operation and maintenance costs
Daily operations management and monitoring costs
Weed removal
Cost of routine inspection (including statutory inspection)
Accident response/repair cost (including reserve for this purpose)
Insurance costs
Land Cost

Table 4.2: Cost components [16]

Floats or Pontoons: The cost of floats or pontoons for a 10 MW floating solar power plant will depend on a number of factors, including the size and type of the floats or pontoons, the design of the platform, the specific location and conditions of the water body, and the procurement and installation process [15].

However, as a rough estimate, the cost of floats or pontoons for a 10 MW floating solar power plant could range from approximately 105,050,124.00 Takas.

Mooring Line & Anchoring: The cost of the mooring lines and anchoring system for a

10 MW floating solar power plant will depend on various factors such as the type of anchoring system used, water depth, soil conditions, environmental factors, and location.
However, as a rough estimate, the mooring line and anchoring cost for a 10 MW floating solar power plant can range from 105,050,100.00 Takas or even more. This cost includes the design, engineering, installation, and maintenance of the mooring lines and anchoring system. It's important to note that the mooring line and anchoring system is a critical component of the floating solar power plant, as it provides stability and keeps the plant in place, even in adverse weather conditions. Therefore, it is essential to invest in a high-quality mooring line and anchoring system that is designed to withstand the environmental conditions of the location where the plant will be installed.

PV Modules: A monocrystalline solar panel costs 106.20 Takas per watt [16]. So, a 340-watt solar module costs (340*159.29) =54,158.6Takas. The modules required is 29000 if 3 modules are 1 panel = 29000/3=9666.6 panels.
Then the cost of panels = 54,158.6*9666.6=523,529,522.8Takas.

Inverter: A 1-MW solar power plant requires a 1-MW central inverter. The current market price (ABB) of the set is 3,205,147.45 Takas. So, for 10 MW = 10*3,205,147.45=32,051,474.5 Takas.

SCB & Cables etc: 1,922,932.36 Takas for SCB and cables etc for a 1-MW solar power plant. So, for 10 MW: 10*1,922,932.36= 19,229,323.6 Takas.

PV Mounting Structure: The cost of a 10 MW floating solar power plant's PV mounting structure can vary depending on several factors, such as the type of technology used, the location of the project, the size and weight of the PV modules, and the complexity of the installation process.

As a rough estimate, the cost of PV mounting structures for a 10 MW floating solar power plant could range from approximately 105,050,100.00Takas.
Transformers and Substations: Transformers and substations per megawatts of the solar power plant will cost 3,231,827.05 Takas.
The cost for 10 MW = (10*3,231,827.05) = 32,318,270.5 Takas.

It's worth noting that the cost of transformers and substations can also be affected by other factors such as the distance from the solar plant to the grid connection point, the local grid infrastructure, and any regulatory or permitting requirements [16]. Therefore, the actual cost can vary depending on the specific project conditions.

Transmission Lines & Fencing: The cost of transmission lines and fencing for a 10 MW floating solar power plant will depend on various factors such as the distance between the solar power plant and the point of interconnection, the type of transmission line and fencing used, and the specific site conditions.
As a rough estimate, the cost of transmission lines and fencing for a 10 MW floating solar power plant could range from approximately 105,050,100.00 Takas.

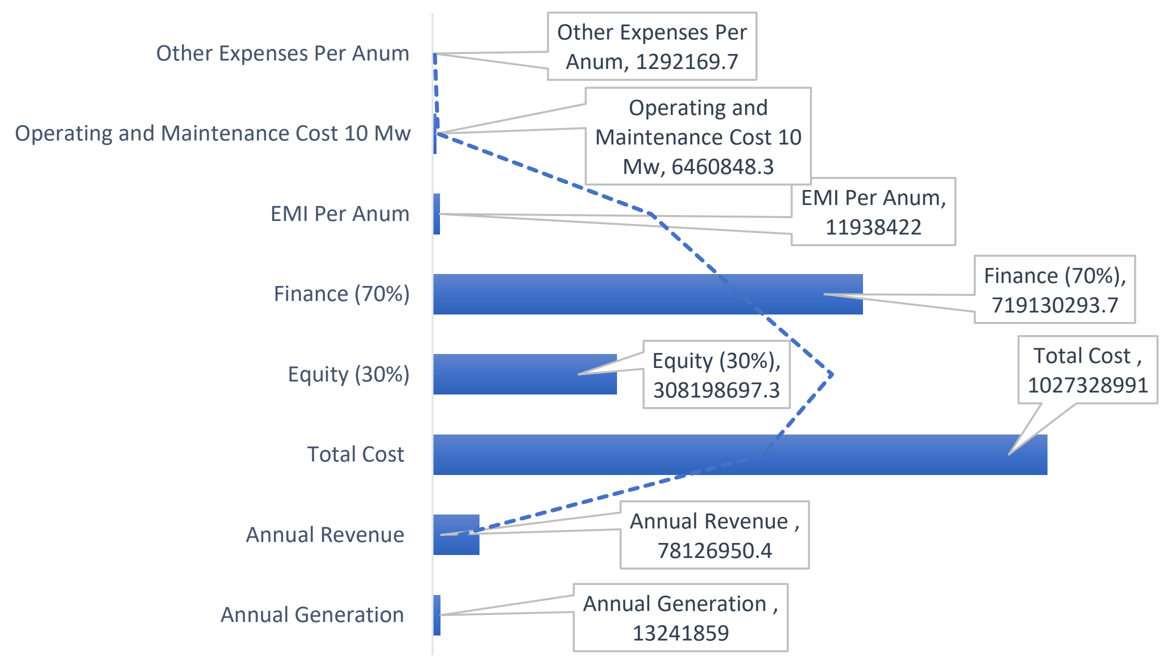
However, it's important to note that the cost of transmission lines and fencing is just one component of the total cost of a floating solar power plant.

Installation and commissioning Other: The cost of installation and commissioning for a 10 MW floating solar power plant will depend on various factors such as the complexity of the installation process, the specific site conditions, the availability of skilled labor, and other factors such as transportation and logistics.

As a rough estimate, the cost of installation and commissioning for a 10 MW floating solar power plant could range from approximately 105,050,100.00 Takas, based on industry estimates and past project costs.
However, it's important to note that the cost of installation and commissioning is just one component of the total cost of a floating solar power plant [16].

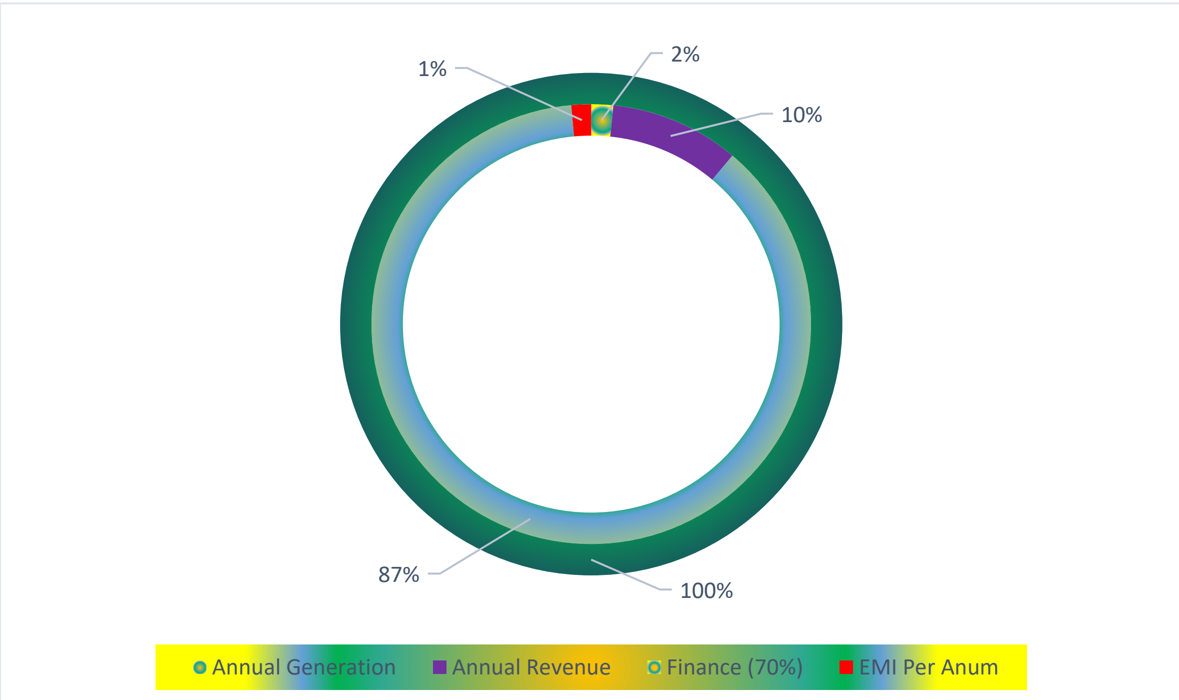
	Financial Model of 10 MW Solar Project	
Sr No	**Assumptions**	
1	Project Capacity (DC KWp)	10000
2	Project Capacity (AC KWp)	9955
3	PR (Performance Ratio)	77.53%
4	Annual Generation	13241859 kWh/year
5	Tariff Rate of Discom	5.90
6	Annual Revenue	78126950.4
7	25 Years Revenue	1953173760
8	**In this Degradation Not Considered**	
	Financial	
9	Cost Per (kWp)	102732.8
10	Total Cost	1027328991
11	Equity (30%)	308198697.3
12	Finance (70%)	719130293.7
13	Rate of Interest	10%
14	Repayment Period of the loan	8 Years
15	EMI Per Anum	11938422
16	Operating and Maintenance Cost 10 Mw	6460848.3
17	Other Expenses Per Anum	1292169.7
18	Return on Equity	23%
19	The payback time of Equity	5 Years
20	The payback time of the loan	8 years

Table 4.3: Financial Model of 10 MW Floating solar power plant Project



	Annual Generation	Annual Revenue	Total Cost	Equity (30%)	Finance (70%)	EMI Per Anum	Operating and Maintenance Cost 10 Mw	Other Expenses Per Anum
Series1	13241859	78126950.4	1027328991	308198697.3	719130293.7	11938422	6460848.3	1292169.7

Bar Chart 3: Cost Analysis of Floating Solar Power Plant



Pie Chart 4: Cost Analysis of Floating Solar Power Plant

CHAPTER 5
RESULTS AND DISCUSSIONS

5.1 Comparison between floating solar power and ground-mounted solar power.

I. FSP plants can generate 1.6 mw of power per hectare while the ground-mounted solar plant generates 1.33 mw per hectare.

Ii. With the water-cooling effect on PV module performance and reduction in the temperature of PV module, FSP plants yield higher energy compared to ground-mounted solar plants [17].

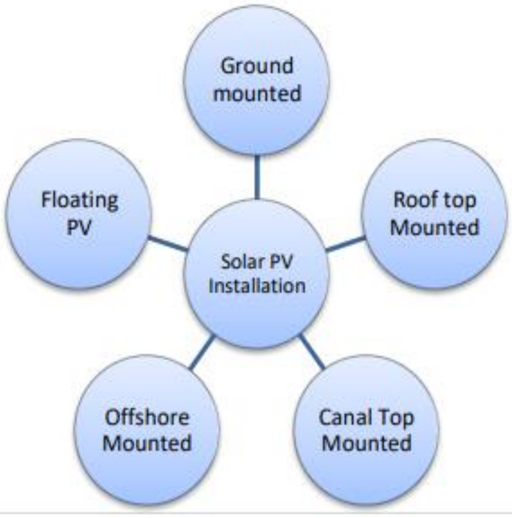
Iii. Fsp plants throw a shadow on the water's surface and reduce water evaporation. They also have an added advantage over ground-mounted solar plants, as there no water supply is required for cleaning PV modules [17].

Iv. Due to the close proximity of FSP plants to some water-based industries, along with the added advantage of the cooling effects it offers, many new projects, based around business models such as aquaculture and Agri voltaic, have been commissioned around the world. What ‘s interesting about FSP plants is that the electricity generation can be used locally for submerged data centers and can be quickly normed as a new emerging business model for giant companies in Cybernet.

V. Floating solar farms are more efficient than traditional systems in terms of energetic rentability. They can generate under specific conditions over 5% of additional electricity compared to a ground-mounted or roof-mounted system. This productivity increase is due to the cooling effect provided by the water which protects the structure from overheating.

5.2 Ground-mounted vs floating PV installation?

In addressing FPV, two-thirds of the world is covered with water, and according to solar power technology there are several classifications of PV installations, such as [18]



Ground-mounted and floating photovoltaic (PV) installations are two common methods of installing solar panels. Ground-mounted PV installations are installed directly on the ground and can be fixed-tilt or single-axis or dual-axis trackers that follow the sun's movement. They are usually used in large utility-scale projects, commercial buildings, and residential installations with a sufficient amount of land area. Ground-mounted PV installations are relatively simple to install and maintain, and they can be easily expanded by adding more panels to the array.

5.3 Advantage of floating solar power plant.

There are many advantages of floating PV systems in economic, technical, environmental, and preserving existing ecosystems [12].

Floating solar systems, also known as FPV, are any kind of solar power plant that floats on water. A floating PV system provides shading to the water surface and reduces evaporation [18]. It can be adapted for ponds, lakes, reservoirs, etc. It has many advantages, such as no need for land, power generation increase, ease of maintenance, and so on. So, let's talk about the specific advantages of floating solar.

I. A 10 MW ground-mounted solar power plant produced energy of 12707840 kwh/year, there from a floating solar power plant produced energy of 13241859 kwh/year.

II. A 10 MW ground-mount solar power plant has a perf ratio PR of 77.46%, while a floating solar power perf ratio PR is 77.53%.

III. A 10 MW ground-mount solar power plant efficiency STC (Standard Test Condition) is19.31%, whereas a floating solar power plant efficiency STC (Standard Test Condition) is 16.91%.

IV. A 10 MW ground-mount solar power plant has an inverter loss during operation (efficiency) of -2.27%, while a floating solar power plant has an inverter loss during operation (efficiency) of -2.27%.

V. No land acquisition is required.

VI. Protects ecologically sensitive areas and is very friendly to the environment.

VII. Drastically reduced installation time and associated costs.

VIII. Water for cleaning and cooling the panels is readily available Efficiency is improved.

IX. A 10 MW ground-mount solar power plant has a Module Degradation loss (for year#10) of -3.81%, while a floating solar power plant has a Module Degradation loss (for year#10) of -3.50%.

X. In hot conditions, it solves the dual purpose of power generation and prevents water from evaporating from beneath.

XI. Takes full advantage of sun rays during the day.

5.4 Discussions

In this section, we delve into the realm of floating solar power (FSP), a technology that harnesses water cooling and yields a remarkable (1.66 MW/ha) of energy, surpassing the (1.33 MW/ha) of ground-mounted solar installations. FSP is recognized for its eco-friendliness, promotion of innovative business models, and reduction in water evaporation. In contrast, ground-mounted solar proves more scalable, straightforward, and efficient. The selection between these approaches' hinges on the energy requirements, land availability, and environmental factors at play.

CHAPTER 6

IMPACT ASSESSMENT OF THE PROJECT

6.1 Economical, Society, and Global Impact.

Floating solar power plants are photovoltaic (PV) systems constructed on bodies of water, including lakes, reservoirs, ponds, and offshore areas. This innovative approach to harnessing solar energy delivers a range of advantages to society, the economy, and the environment:

<u>Impact on the economy:</u>

1. Enhanced Energy Production: Floating solar panels hold the promise of generating increased electricity compared to their land-based counterparts, thanks to the cooling benefits of water, which can boost panel efficiency.
2. Diminished Land Restrictions: Floating solar installations provide an alternative avenue for harnessing underutilized water surfaces for energy generation, without encroaching upon other land uses like agriculture or urban development.
3. Energy savings: The cooling effect of water serves as a safeguard against solar panels. overheating, thereby enhancing energy production efficiency and prolonging the lifespan of panels These advantages ultimately translate into reduced maintenance expenses.

4. Water Preservation: Certain floating solar systems are designed to minimize water evaporation from ponds or reservoirs. This aspect of water conservation can be particularly vital in regions facing water scarcity.
5. Adaptable Site Selection: Floating solar power facilities can be strategically placed nearer to regions with high energy demand, thereby decreasing transmission losses and the expenses linked to long-distance electricity transport.

Impact of society:

1. Fostering Local Employment: The installation, upkeep, and operation of floating solar power facilities generate job openings, particularly in proximity to aquatic environments. This has the potential to bolster local economies and communities.
2. Engagement of the Community: Through collaborative partnerships and educational programs, floating solar projects can actively involve local residents in meaningful dialogues about sustainability and renewable energy.
3. Land Conservation: Harnessing water surfaces for solar installations helps conserve precious land resources that can then be used for agriculture, housing, and various other purposes.
4. Advancing Renewable Energy: The deployment of floating solar technology extends the reach of renewable energy production, enhancing the diversity and resilience of our energy sources. This, in turn, reduces dependence on fossil fuels and aids in the fight against climate change.
5. Carbon Emissions Decrease: The production of electricity through floating solar panels leads to a decrease in greenhouse gas emissions, promoting cleaner air and a more sustainable environment.

Global Impact:

1. Combating Climate Change: Through the broader implementation of floating solar power installations, countries can effectively diminish their carbon footprints and attain their objectives for reducing greenhouse gas emissions.
2. Enhancing Energy Accessibility: Floating solar solutions can facilitate access to clean electricity in regions where there is limited available land for conventional solar installations, thus aiding in the electrification of remote and underserved areas.
3. Climate Change Resilience: Floating solar initiatives can aid nations in adapting to the consequences of climate change by making use of existing water bodies and mitigating the risk of flooding in specific regions.
4. Facilitating Technology Exchange: The advancement and utilization of floating solar technologies can be disseminated across nations, fostering technology transfer and international

cooperation in the global pursuit of transitioning to renewable energy sources. In conclusion, floating solar power plants present a myriad of advantages, spanning economic, social, and global realms They provide sustainable energy generation option, bolster local economies, curtail carbon emissions, and actively participate in worldwide endeavors to combat climate change and secure energy resources.

6.2 Environmental and Ethical Issues

Floating solar power plants, akin to all energy Generational technologies come with their own set of environmental and ethical concerns. Here are some noteworthy points to consider:

1. Ecological Consequences: The introduction of floating solar panels may have the potential to influence the aquatic ecosystems beneath them. them. This could entail changes in light penetration into the water, which can in turn, impact underwater plant and animal life. Nevertheless, judicious planning and thorough environmental assessments can aid in alleviating these repercussions.

2. Water Purity Concerns: The choice of materials incorporated into solar panels can raise apprehensions about water contamination. The presence of certain chemicals and materials in these panels particularly if not appropriately managed during disposal, holds the potential to jeopardize water quality.

3. Resource Allocation: Floating solar endeavors, while Reduced land demands do necessitate the utilization of water bodies that may serve alternative purposes like fishing, recreation, or even as a source of potable water. This dual use can precipitate conflicts over water resource allocation.

4. Ethical Sourcing Considerations: The manufacturing of solar panels frequently necessitates the extraction and processing of rare minerals, a factor that can give rise to ethical quandaries regarding labor conditions and environmental degradation within mining regions.

5. Lifecycle Conclusion: Similar to all technologies, Solar panels possess a finite lifespan and must ultimately be disposed of. Ensuring the appropriate recycling and disposal of solar panels is imperative in preventing environmental harm.

It is imperative that the planning and administration of floating solar ventures take these matters into careful account. This encompasses the execution of thorough environmental impact evaluations, active involvement with local communities, the adoption of sustainable materials and methodologies, and strategic preparations for the eventual disposal of solar panels. Ethical and environmental concerns form integral facets of conscientious renewable energy advancement.

6.3 Other Concerns

Beyond the previously highlighted environmental and ethical considerations, floating solar power plants introduce a spectrum of additional concerns:

1. Susceptibility to Weather Elements: Floating solar panels are susceptible to inclement weather, including storms, torrential rains, and robust winds. Ensuring the stability and durability of these installations necessitates meticulous engineering and design.

2. Navigating Maintenance Complexities: Managing and upkeeping floating solar panels can prove more intricate in contrast to their land-based counterparts. The necessity for regular inspections, cleaning, and repairs may demand the utilization of specialized equipment and skilled personnel.

3. Navigational and Safety Concerns: In regions characterized by substantial water traffic, the presence of floating solar panels can potentially create navigational hazards. It is imperative to implement comprehensive safety precautions, including the appropriate installation of markers and lighting, to avert accidents.

4. Local Ecosystem Disruption: Floating solar initiatives hold the potential to disturb indigenous ecosystems, impacting the natural habitat of aquatic flora and fauna. It is imperative to implement mitigation strategies and conduct

comprehensive environmental impact assessments to adequately address these concerns.

5. Financial Considerations: Although floating solar holds the promise of various advantages, the initial capital outlay can be substantial. The challenges lie in securing funding and realizing a viable return on investment, both of which can prove formidable tasks.

Mitigating these issues necessitates meticulous strategic planning, active engagement with stakeholders, strict adherence to regulatory frameworks, and the continuous vigilance of monitoring and maintenance efforts. Floating solar projects must strive to achieve an equilibrium between renewable energy generation and the preservation of environmental and societal well-being.

CHAPTER 7
CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The escalating demand for electricity in Bangladesh presents a pressing challenge as the nation grapples with inadequate electricity production. While ground-mounted solar power plants have emerged as a viable solution, their proliferation has inadvertently led to the destruction of arable land, exacerbating the delicate balance between energy generation and sustainable land use. This predicament necessitates a paradigm shift, and herein lies the promise of floating solar power plants, a pioneering alternative that can concurrently meet energy demands while preserving precious land resources.

Bangladesh's topography is punctuated by an intricate network of water bodies, including reservoirs, lakes, and ponds. These water bodies offer a unique opportunity for floating solar power plants, wherein solar panels are strategically installed on the water's surface, harnessing the power of the sun while minimizing land disruption. This innovative approach serves a dual purpose: it mitigates land-use conflicts and capitalizes on the large expanses of water, presenting a solution that harmonizes energy generation with sustainable land management.

The comparative advantages of floating solar power plants are manifold. Notably, the cooling effect of the water on which the panels float enhances their energy efficiency, leading to increased electricity production compared to traditional land-mounted solar systems. Furthermore, the water's surface mitigates overheating risks, thus enhancing the longevity and performance of the solar panels. This heightened energy yield not only contributes to bridging the electricity demand-supply gap but also augments the economic viability of floating solar power plants.

Crucially, the environmental implications of this alternative approach are remarkable. The introduction of floating solar power plants has the potential to offset carbon emissions significantly, fostering a cleaner and more sustainable energy landscape. The absence of land conversion safeguards valuable arable land, preserving it for agricultural use and safeguarding food security—an issue of paramount importance in a densely populated country like Bangladesh.

The profitability of floating solar power plants in Bangladesh is underscored by factors such as reduced transmission losses due to proximity to demand centers and the option to utilize existing water infrastructure for power evacuation. By strategically selecting suitable water bodies across different regions of the country, Bangladesh can tap into the immense potential of floating solar power, transforming its energy sector into a dynamic and environmentally conscious domain.

To maximize the profitability and efficacy of floating solar power plants, a robust policy framework is essential. This involves incentives that attract investments, streamlined regulatory processes, and partnerships between governmental bodies, private enterprises, and local communities. Furthermore, technological advancements in floating platform design, anchoring mechanisms, and energy storage integration will play a pivotal role in enhancing the efficiency and reliability of these systems.

In conclusion, the trajectory of Bangladesh's electricity sector is at a pivotal juncture, demanding innovative solutions that reconcile energy generation with land conservation imperatives. Floating solar power plants emerge as a beacon of promise, aligning with the nation's water-rich topography to generate electricity sustainably while safeguarding arable land. By harnessing the enhanced energy yield and adopting a holistic approach, Bangladesh can usher in a new era of energy security, environmental stewardship, and economic growth.

7.2 New Skills and Experiences Learned

Undoubtedly, not all knowledge comes effortlessly; this project demanded substantial time and effort. The journey, though challenging, proved immensely educational. It encompassed mastering the intricacies of constructing floating solar power plants, encompassing design, modeling, and more. This process unearthed invaluable insights, fostering expertise in two software platforms with enduring relevance. As the project culminated, it left us enriched and equipped with newfound skills poised to shape our future endeavors.

7.3 Future Recommendations

Looking ahead, the implementation and advancement of floating solar power plants hold significant promise. Here are some future recommendations to consider:

- Research and Development
- Technological Integration
- Hybrid Systems
- Water Management
- Economic Viability
- Policy Framework
- Community Engagement
- Capacity Building
- Educational Outreach
- International Collaboration
- Long-Term Sustainability

Incorporating these recommendations will contribute to the growth, innovation, and sustainable development of floating solar power plants, helping to address energy needs while minimizing environmental impact and fostering economic growth.

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