Report on Industrial Visit to West Kallada Floating Solar Power Plant

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Introduction

India has been steadily increasing its renewable energy capacity to meet growing electricity demand while reducing dependence on fossil fuels and minimizing environmental impacts. In this context, solar energy has emerged as one of the most viable and rapidly expanding sources of clean power. However, in states like Kerala, the availability of large contiguous land parcels for utility-scale solar projects is limited due to high population density, agricultural dependence, and ecological sensitivity.

Floating Solar Photovoltaic (FSPV) technology offers an innovative solution to this challenge by utilizing water bodies and waterlogged areas for power generation. By installing solar panels on floating platforms, this technology enables efficient land utilization, reduces evaporation losses from water surfaces, and improves module performance due to the natural cooling effect of water.

The West Kallada Floating Solar Power Project, located in Kollam District, Kerala, is one of the significant large-scale floating solar initiatives in the state. With an installed capacity of 50 MW, the project demonstrates the practical application of advanced solar technologies, structured power evacuation planning, and community-inclusive development models. The project is developed on waterlogged paddy land through a revenue-sharing mechanism with local landowners, thereby integrating renewable energy generation with socio-economic benefits.

The industrial visit to this project provided valuable exposure to the design, construction, and operational planning of a grid-connected floating solar plant. It offered insights into solar module configuration, electrical systems, power evacuation through a 110 kV switchyard, and the regulatory framework governing renewable energy projects in Kerala.

This report presents a detailed overview of the project’s technical specifications, implementation status, grid connectivity arrangements, and key learning outcomes derived from the visit.

Chapter 2

Project Overview

The West Kallada Floating Solar Power Project is a 50 MW grid-connected floating solar PV plant, developed to supply power to Kerala State Electricity Board Ltd. (KSEB). The project is implemented on 291.68 acres of waterlogged paddy land leased from West Kallada Non-Conventional Energy Promoters Pvt. Ltd. (WKNCEPPL), which represents local landowners.

Instead of conventional lease rental, a revenue-sharing model has been adopted, wherein 3% of the project revenue is shared with the landowners. This model ensures social inclusiveness while converting otherwise unproductive land into a sustainable clean energy asset.

fig 2.1: Plant site

The key stakeholders involved in the development, execution, regulation, and operation of the West Kallada Floating Solar Power Project are listed in the table below.

Stakeholder	**Role**	**Designation / Description**
NHPC Limited	Developer	Joint Developer (Navratna Enterprise)
Apollo Green Energy Limited (AGEL)	EPC Provider	Joint Developer and Engineering Lead
WKNCEPPL	Landowner Entity	Special Purpose Vehicle (Landowners' Company)
KSEB (Kerala State Electricity Board)	Off-taker	State Utility / Power Purchaser
MNRE	Central Government	Authority for Central Financial Assistance (CFA)
KSERC	Regulatory Body	Commission for Tariff & PPA Approval

Table 2.1:Stakeholders and Framework

Chapter 3

Key Technical and Financial Details

The key technical and financial parameters of the West Kallada Floating Solar Power Project are presented in Table 3.1 below

Sl No	Parameter	Details
1	Type of Plant	50 MW Grid-Connected Floating Solar PV
2	DC Capacity	65 MWp
3	AC Capacity	50 MW
4	Project Cost	₹249.42 crore
5	Tariff	₹3.04 per kWh (25 years)
6	PPA Date	01.01.2025
7	Commercial Operation Date (COD)	04.02.2026
8	Off-taker	Kerala State Electricity Board Ltd.
9	First-Year Energy Generation	99.909 million units
10	Capacity Utilization Factor (CUF)	22.79%

Table 3.1: Technical and Financial Parameters

Chapter 4

Major Plant Components

The visit offered insights into the scale and complexity of the floating solar installation. The major components include:

- **Solar Modules:**
    - TOPCon Bifacial
        - TOPCon (Tunnel Oxide Passivated Contact) technology reduces electrical losses, resulting in higher cell efficiency.
        - Bifacial modules generate electricity from both the front and rear sides.
        - Reflected sunlight from the water surface leads to an efficiency gain of about 5–15% due to the bifacial effect in floating solar installations.
        - The modules exhibit lower degradation and better performance under tropical climatic conditions.
    - 590 Wp modules
    - Approx. 1.10 lakh modules

- **Inverters:**
    - 4.4 MVA – 10 numbers
    - 3.3 MVA – 2 numbers

- **Inverter Duty Transformers (IDT):**
    - 8.8 MVA – 5 numbers
    - 6.6 MVA – 1 number

- **Power Transformers:**
    - 31.5 MVA, 33/110 kV – 2 numbers

- **Array Configuration:**
    - 11.663 MWp – 4 arrays
    - 5.154 MWp – 2 arrays

- 4.080 MWp – 2 arrays

The plant consists of 6 floating barges, each having similar array configuration.

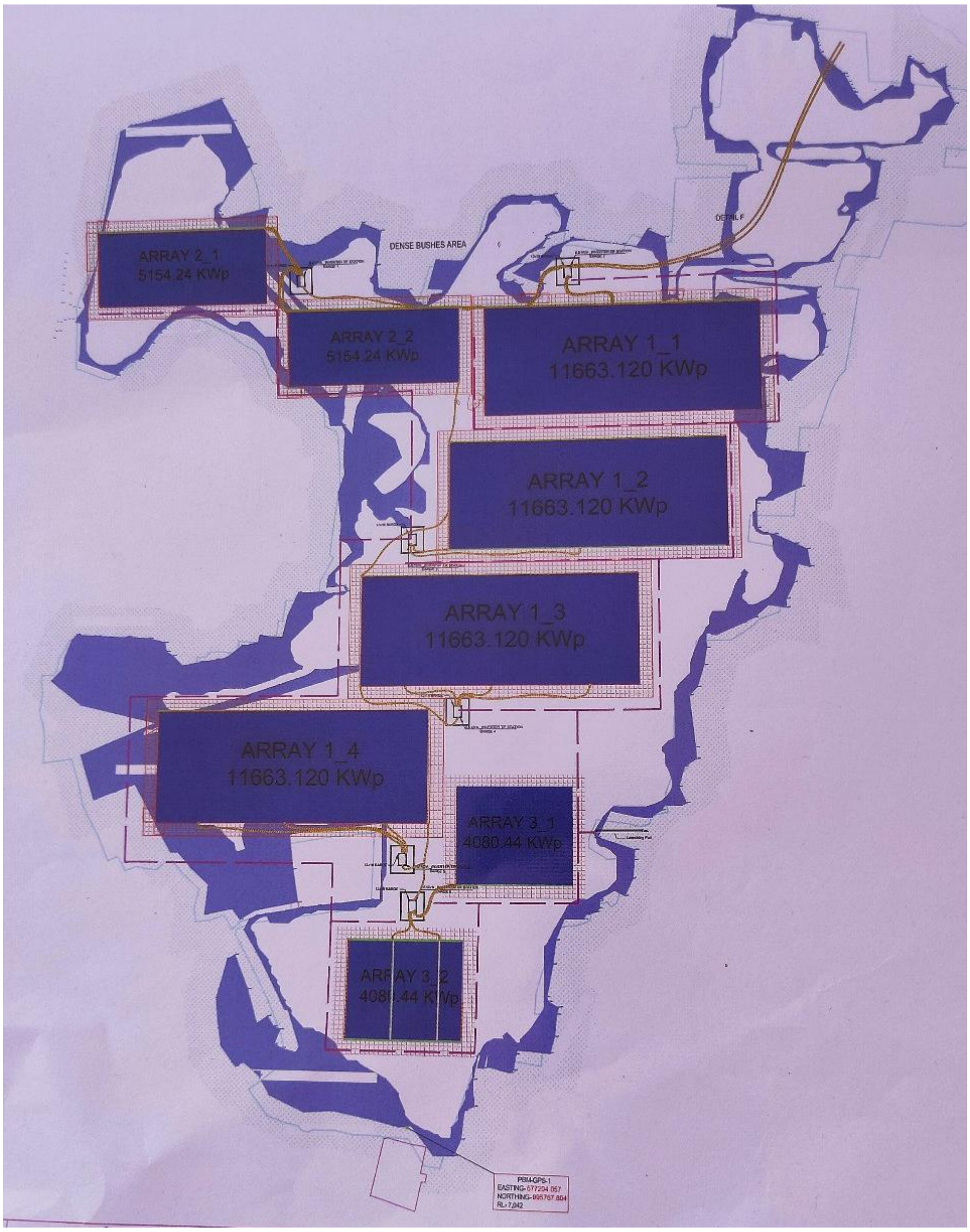
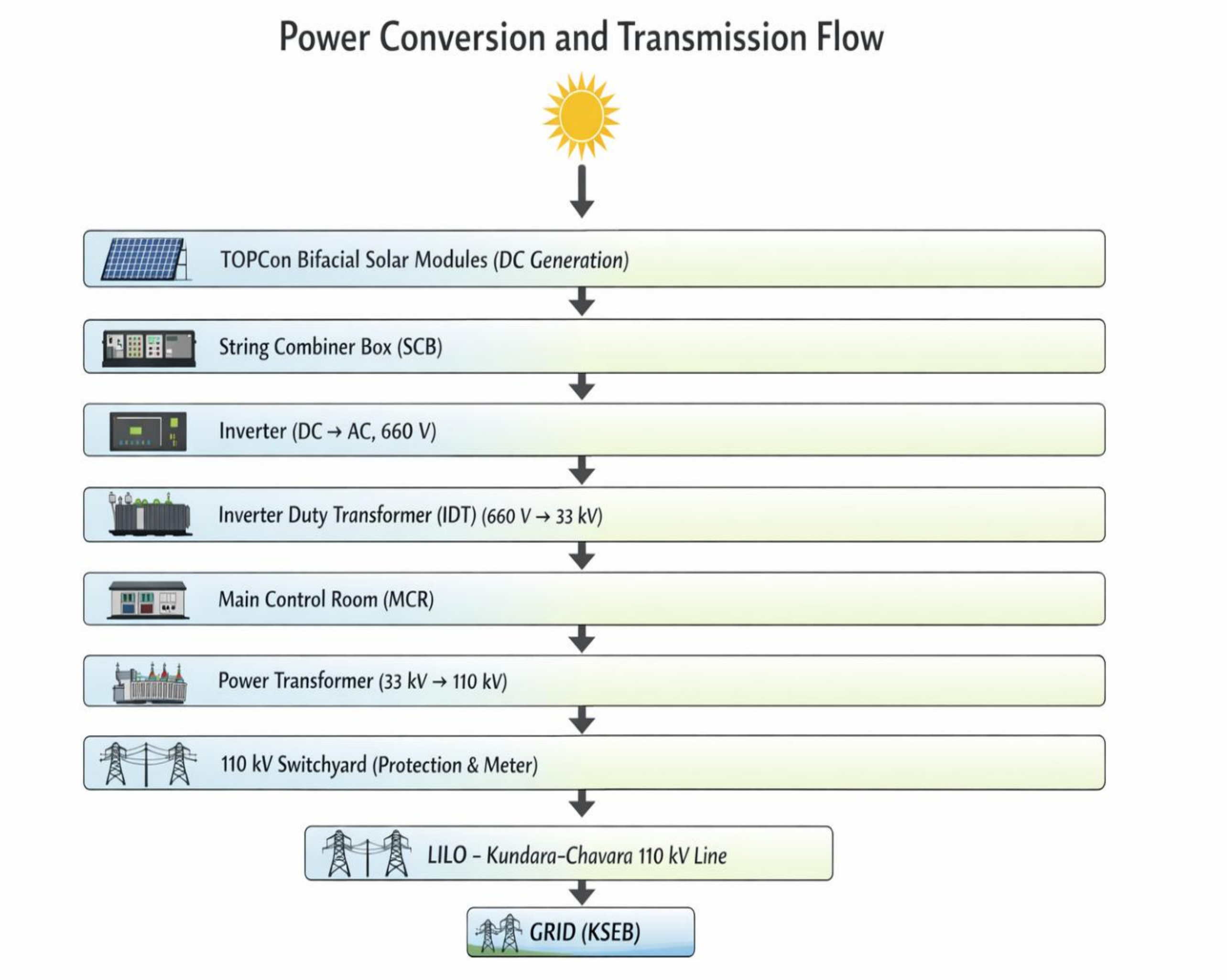


fig 4.1: Arrangement of Solar Arrays at the Plant Site

Chapter 5

Working Principle



The working of the plant in a step-by-step manner:

- Each solar module has an output voltage of approximately 40 V.
- Each string consists of 28 solar modules connected in series (approximately 1200 V DC), with two such strings connected in parallel to increase current capacity.
- The combined DC output is fed into a String Combiner Box (SCB).
- DC power (approximately 1200 V) is then supplied to the inverter, where it is converted into 660 V AC.
- Two inverters feed a single Inverter Duty Transformer (IDT), which steps up the voltage to 33 kV.

- The plant consists of 6 barges (floating stations) of similar array configuration.
- Power from all floating stations is collected at the Main Control Room (MCR).
- From the MCR, power is stepped up to 110 kV using 33/110 kV power transformers for grid evacuation.

This systematic layout ensures efficient power conversion and minimal transmission losses.

Chapter 6

Water Level Management and Anchoring System

6.1. Water Level Management (Draining & Bund System)

The project site is protected by a bund system, which is connected to the Kallada River and Ashtamudi Lake system.

This system:

- Regulates inflow and outflow of water between the site and the connected water bodies
- Maintains stable operational water depth
- Maintains the maximum water level up to 6.2 meters
- Prevents flooding during heavy rainfall or tidal influence
- Ensures uniform buoyancy of floating platforms

Proper drainage and water level regulation through the bund system, considering its connection to the Kallada River and Ashtamudi Lake, are essential for ensuring structural stability and long-term operational reliability of the floating solar plant.

fig 6.1: Water Level Indicator

6.2. Anchoring System

The floating platforms are secured using a combination of polyethylene ropes and helical anchors (also known as screw piles or earth anchors).

The helical anchors are embedded into the soil beneath the water body to provide firm anchorage, while polyethylene ropes connect the floating structures to these anchors.

Advantages of the anchoring system:

- High tensile strength
- Corrosion resistance
- Flexibility
- Lightweight construction
- Strong holding capacity due to helical anchor embedment

The flexible polyethylene rope system allows controlled movement of the floating platforms during seasonal water level variations, wind loads, and minor wave action without causing structural stress. The use of helical (screw pile) anchors ensures stability while maintaining adaptability to changing water conditions.

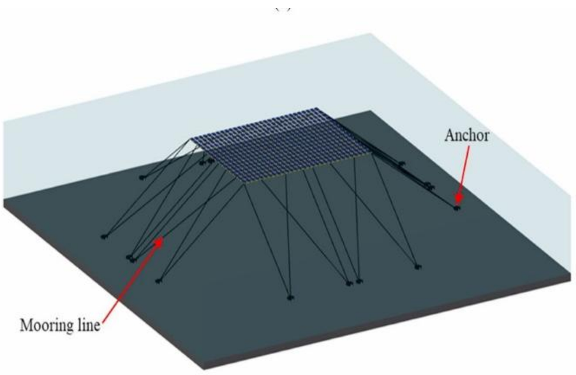


fig.6.2(a): Anchoring System

fig.6.2(b): Helical anchors

Chapter 7

Grid Connectivity and Power Evacuation

A dedicated 110 kV switchyard with:

- Two incomer bays and
- Two outgoing bays

to ensure reliable and flexible power evacuation.

LILO Arrangement (Kundara–Chavara Line)

Power evacuation is carried out through a "LILO" (Line-In Line-Out) arrangement on the existing 110 kV Kundara–Chavara transmission line. In this configuration, the transmission line is looped into the project switchyard and then looped out, allowing power to be injected into the grid without constructing a completely new transmission corridor.

In the event of failure of one evacuation path, power can be evacuated through the alternate bay, ensuring grid reliability and operational continuity.

Chapter 8

Current Status of Work at the Project Site and Key Challenges

- Anchoring works for the floating solar platforms are currently in progress to ensure stability against water level variations and environmental forces.
- Bed leveling activities using JCB machinery are ongoing to improve site accessibility and facilitate construction activities.
- The originally identified switchyard location is proposed to be changed due to marshy soil conditions at the foundation level.
- Geotechnical assessment revealed that piling up to 20–30 meters would be required to reach rock strata at the earlier location.
- Such deep piling was found to be economically unviable, leading to a search for an alternative site.
- The project team is currently identifying a new switchyard location with better soil bearing capacity.

fig 8.1: Various works at project site

Chapter 9

Switchyard Layout and Design

During the visit, the electrical layout plan of the 110 kV switchyard was shown and explained. The drawing illustrates:

Sl No.	Description of Parameter	Data
1	Nominal System Voltage	110kV
2	Highest System Voltage	123kV
3	Lightning Impulse Withstand Voltage	550kVp
4	Power Frequency Withstand Voltage	230kVp
5	Maximum Fault Level For 1 Second	31.5kA
6	Creepage Distance	25mm/kV

- Arrangement of 110 kV circuit breakers, isolators, current transformers (CTs), and potential transformers (PTs).
- Clearances maintained for phase-to-phase, phase-to-earth, and ground safety, as per statutory standards.
- Placement of 33/110 kV power transformers connected to outgoing feeders.
- Provision for two incomers and two outgoing bays, ensuring operational flexibility.
- Adequate space allocation for future maintenance and safe movement of personnel.

The layout reflects compliance with electrical safety regulations and good engineering practices.

Chapter 10

Learning Outcomes from the Visit

The industrial visit to the West Kallada Floating Solar Power Plant provided valuable practical exposure and technical insights. The key learning outcomes are as follows:

- Gained understanding of floating solar photovoltaic (FSPV) technology and its advantages over conventional land-based solar installations.
- Learned about the application of TOPCon bifacial solar modules and their efficiency enhancement due to water surface reflection.
- Understood the complete power conversion process, from DC generation to 110 kV grid evacuation.
- Acquired knowledge of grid integration through LILO (Line-In Line-Out) arrangement on the Kundara–Chavara transmission line.
- Observed the design and safety aspects of a 110 kV switchyard, including electrical clearances and fault levels.
- Gained insight into water level management using bund systems connected to the Kallada River–Ashtamudi system.
- Understood the working of anchoring mechanisms using polyethylene ropes and helical (screw pile) anchors for stability under varying water levels.
- Learned about the regulatory framework, including PPA approval, tariff structure, and stakeholder coordination.
- Developed practical knowledge of challenges involved in site development, such as marshy soil conditions and switchyard foundation issues.

Chapter 11

Conclusion

The industrial visit to the West Kallada Floating Solar Power Plant provided comprehensive insight into the design, execution, and operational planning of a large-scale floating solar installation. The project demonstrates how innovative engineering solutions can effectively address land constraints while promoting sustainable energy generation.

By utilizing waterlogged paddy land through a community-inclusive revenue-sharing model, the project integrates environmental sustainability with socio-economic development. The adoption of advanced TOPCon bifacial modules, efficient power conversion systems, structured 110 kV grid connectivity through a LILO arrangement, and robust switchyard design ensures technical reliability and long-term operational stability.

The implementation of a bund-based water level management system connected to the Kallada River–Ashtamudi system, along with flexible anchoring using polyethylene ropes and helical anchors, further highlights the engineering considerations involved in floating solar projects.

Overall, the West Kallada Floating Solar Power Project stands as a scalable and replicable model for floating solar development in water-rich regions of Kerala and across India. The visit enhanced practical understanding of renewable energy systems, grid integration, and regulatory mechanisms, making it a valuable learning experience.