Port’s Net Zero Check List:
Utilising New Energy Sources and Facilitate Electrification for Onshore Power Supply within the Port

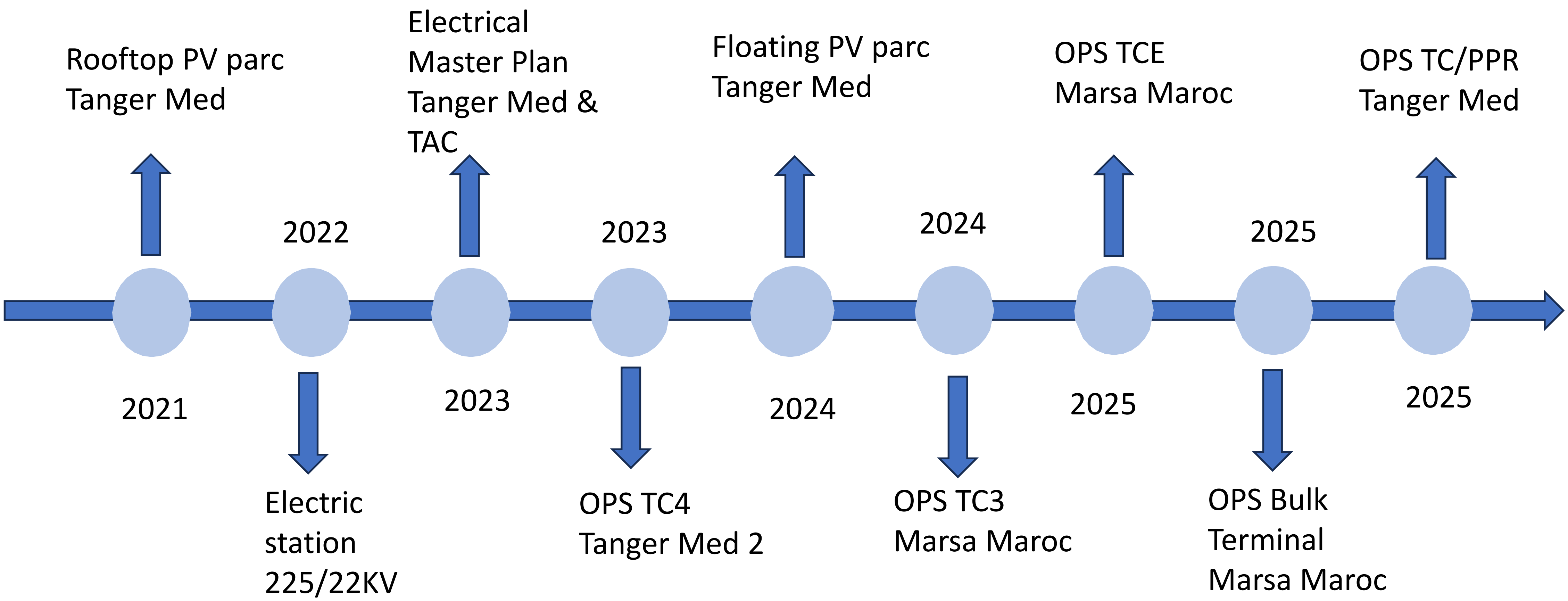
Who are we ?

- Tanger Med Engineering (TME) is an engineering company specializing in the planning, design, construction management and ports asset management, maritime facilities, as well as in logistics and industrial buildings zones.

- The Energy Division of TME provides end-to-end engineering solutions for **Renewables Energy projects**, **OPS and Port and Terminals electrification**, from design through operation, with a strong focus on efficiency, sustainability, and decarbonization.

TANGER MED ENGINEERING

Track Record



Onshore Power Supply :Definition & Standardization

The deployment of Onshore Power Supply (OPS) is transforming port operations, enabling vessels to shut down their auxiliary engines while at berth and connect to a clean, stable shore-side electrical network.

OPS operations involve critical coordination between the terminal, the vessel's crew, and the carrier to ensure safe electrical connection, synchronization, and power transfer.

The applicable standard for the Shore Power are:

- IEC80005-1: High Voltage Shore Power
- IEC80005-3: Low Voltage Shore Power
- IEC80005-2: Data interfaces for Shore Power systems


IEC ISO IEEE

IEC/IEEE 80005-1

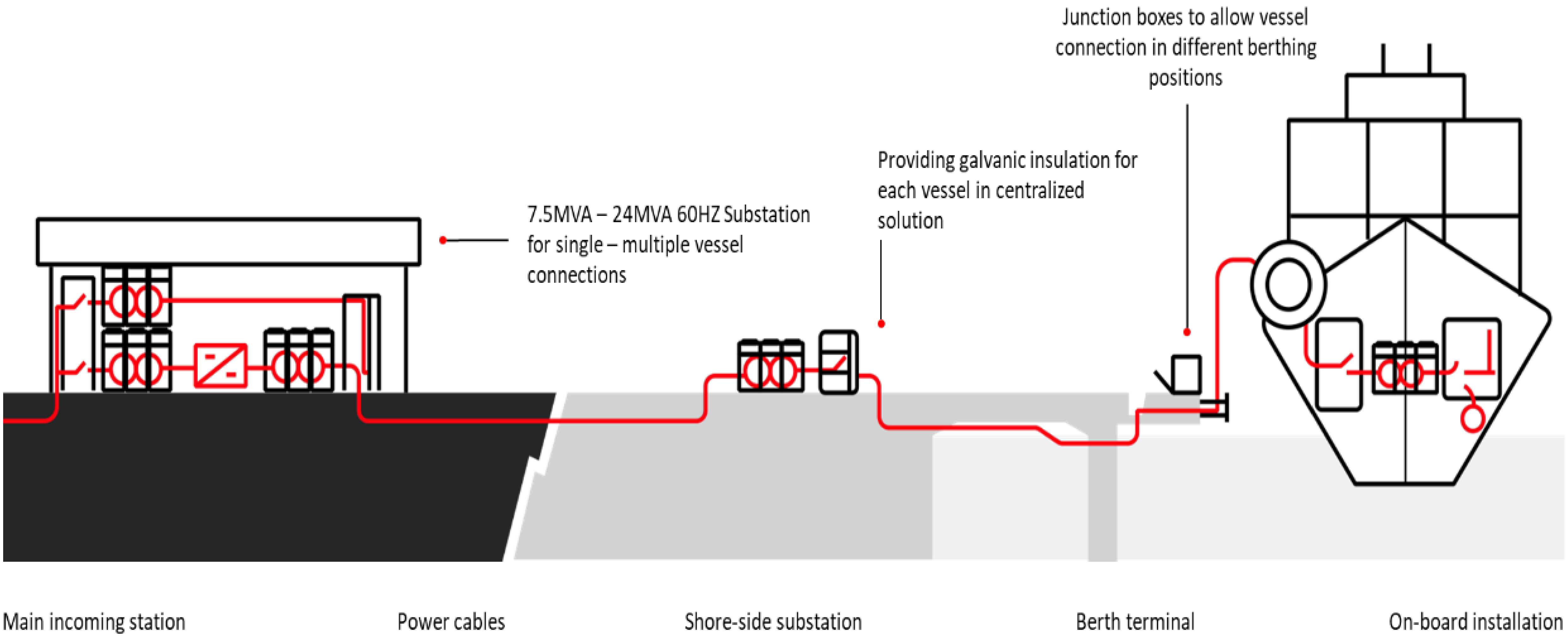
Edition 2.1 2022-02
CONSOLIDATED VERSION

INTERNATIONAL
STANDARD

colour inside

Utility connections in port –
Part 1: High voltage shore connection (HVSC) systems – General requirements

Onshore Power Supply for Containers Vessels : High Voltage Shore Connection



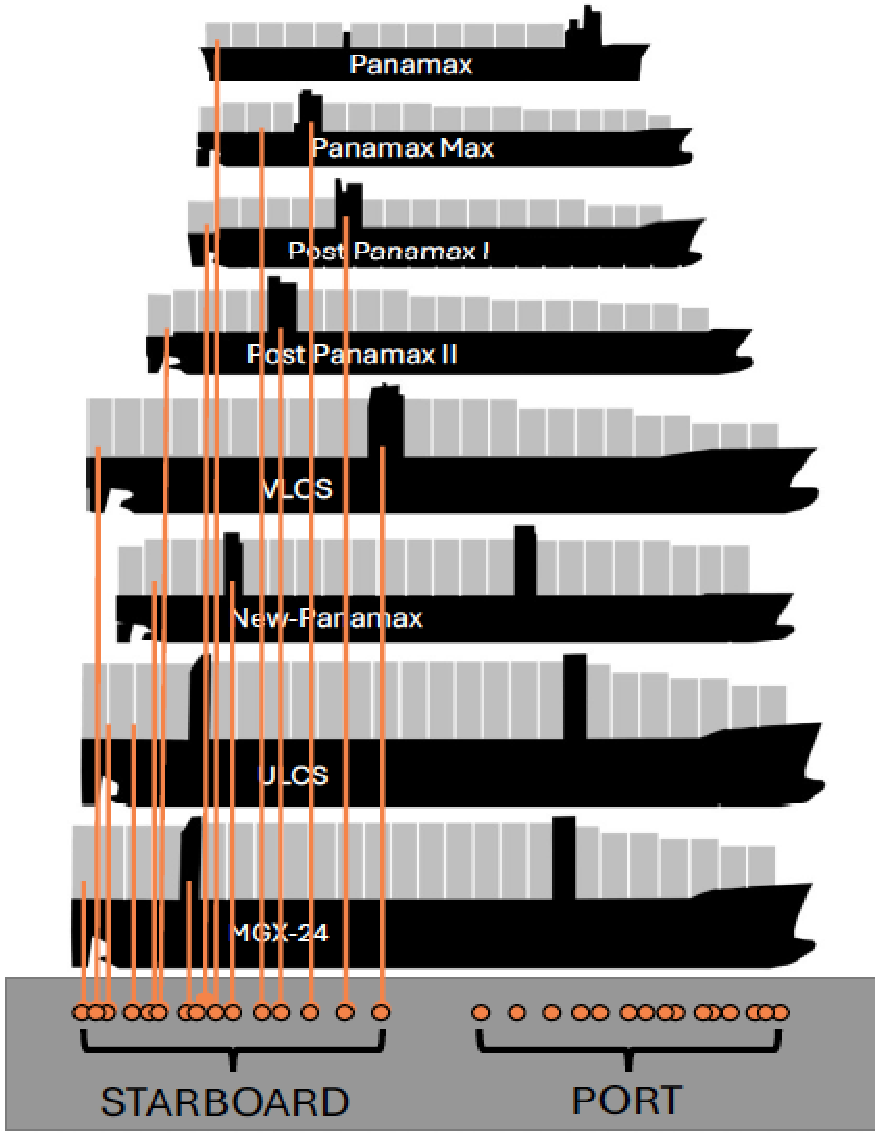
High Voltage Shore connection standard: **IEC/ISO/IEEE 80005-1**

Shore power system demand

- Expected power demand per ship
- Fluctuations of power demand,
- Berthing schedule (Connexion and Total power)
- Power sourcing Internal or external supply
- Grid congestion, reability
- Renewable power and BESS.

OPS Design: Challenges

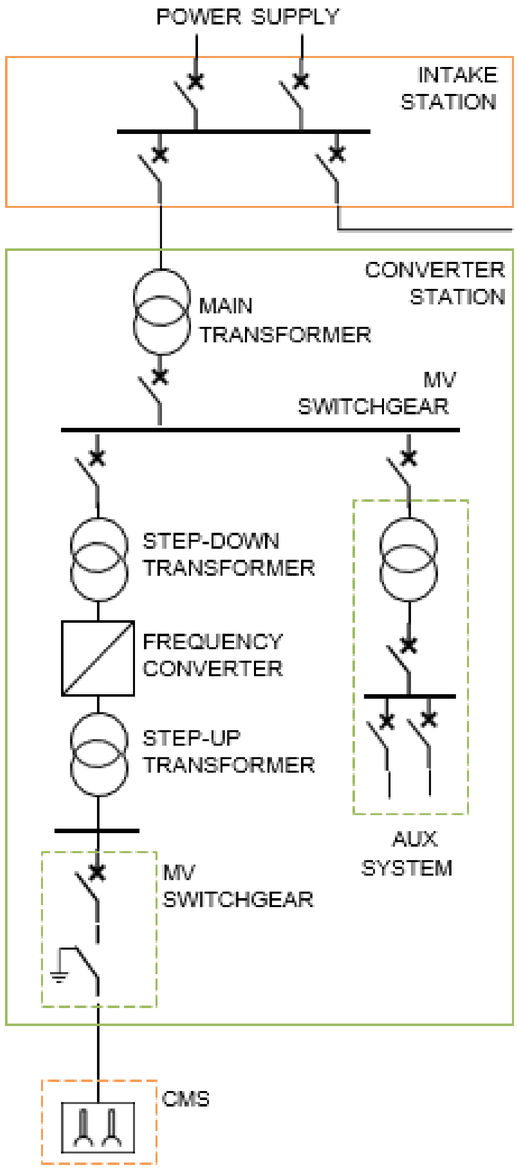
- Fender system, Bollards and guiding rail
- Range of movement / service range
- Crane operating area, Operational considerations
- Moor master dimensions (sectional view)
- Selection of appropriate system type/style and mounting location
- Concept proposal and preliminary system sketch
- Review of working concept and budget proposal
- The IEC Standard – Design and Safety Requirements



OPS Design: Electrical Infrastructure

Key components:

- ✓ Grid connection
- ✓ Intake station
- ✓ Converter station
- ✓ Power transfer system
- ✓ Cable Management System (CMS)



Converter station

- Building or modular structure
- Frequency adjustment?
- LV / MV conversion
- Single or bidirectional conversion
- Combined / dedicated conversion

OPS Design: Cable Management System

Cable chain

Cable extend

Fixed reel

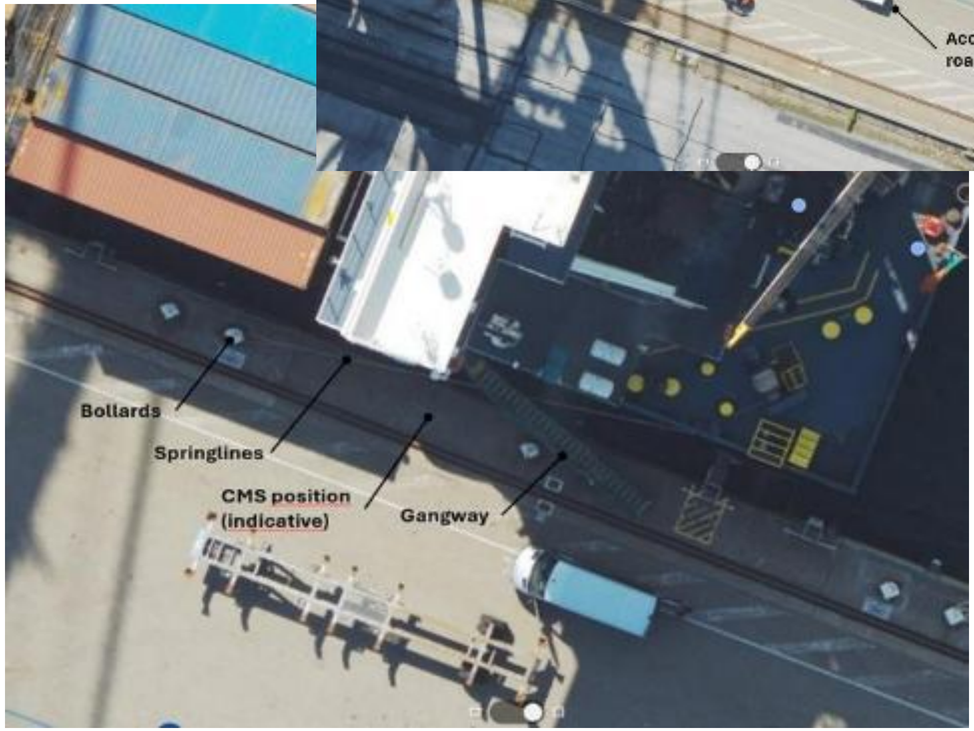
Movable reel

OPS Design: Cable Management System

System Type	Key Strengths	Limitations
Reel-based CMS / Automatic Connection	Proven global leader, fully automated connection, high reliability, marine-grade components	Limited to shorter cable lengths
Energy chain / flexible track system	Lightweight, modular, easy installation, low maintenance	Higher CAPEX
Integrated shore connection modules with reels	Strong integration with converters/SCADA, robust industrial design	Less modular than Cavotec, fewer marine references in CMS
Retractable cable reel systems	Heavy-duty design, strong reliability	Large footprint, higher mechanical complexity

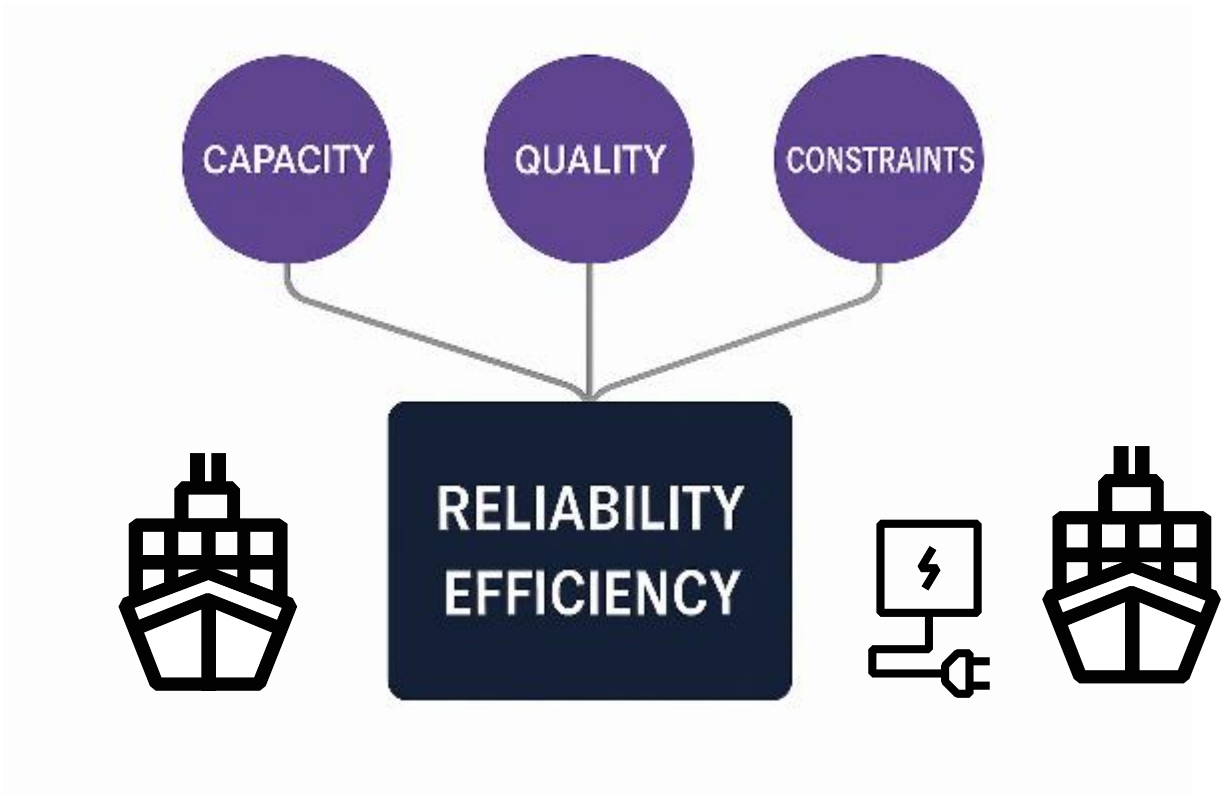
OPS Design: Civil Infrastructure

- Underground pipe ducts
- Converter station / Intake station building
- Quay wall structures – Integration of Cable Management System
- Escape routes
- Interference with existing structures
- Interference with operations:
  - Bollards
  - Shore tensioning
  - Gangways
  - Service vehicles



OPS: Grid Impact

The deployment of an Onshore Power Supply (OPS) system is highly dependent on the characteristics and performance of the electrical grid. Grid capacity, energy quality, and operational constraints directly influence the reliability and efficiency of shore power services provided to vessels at berth.

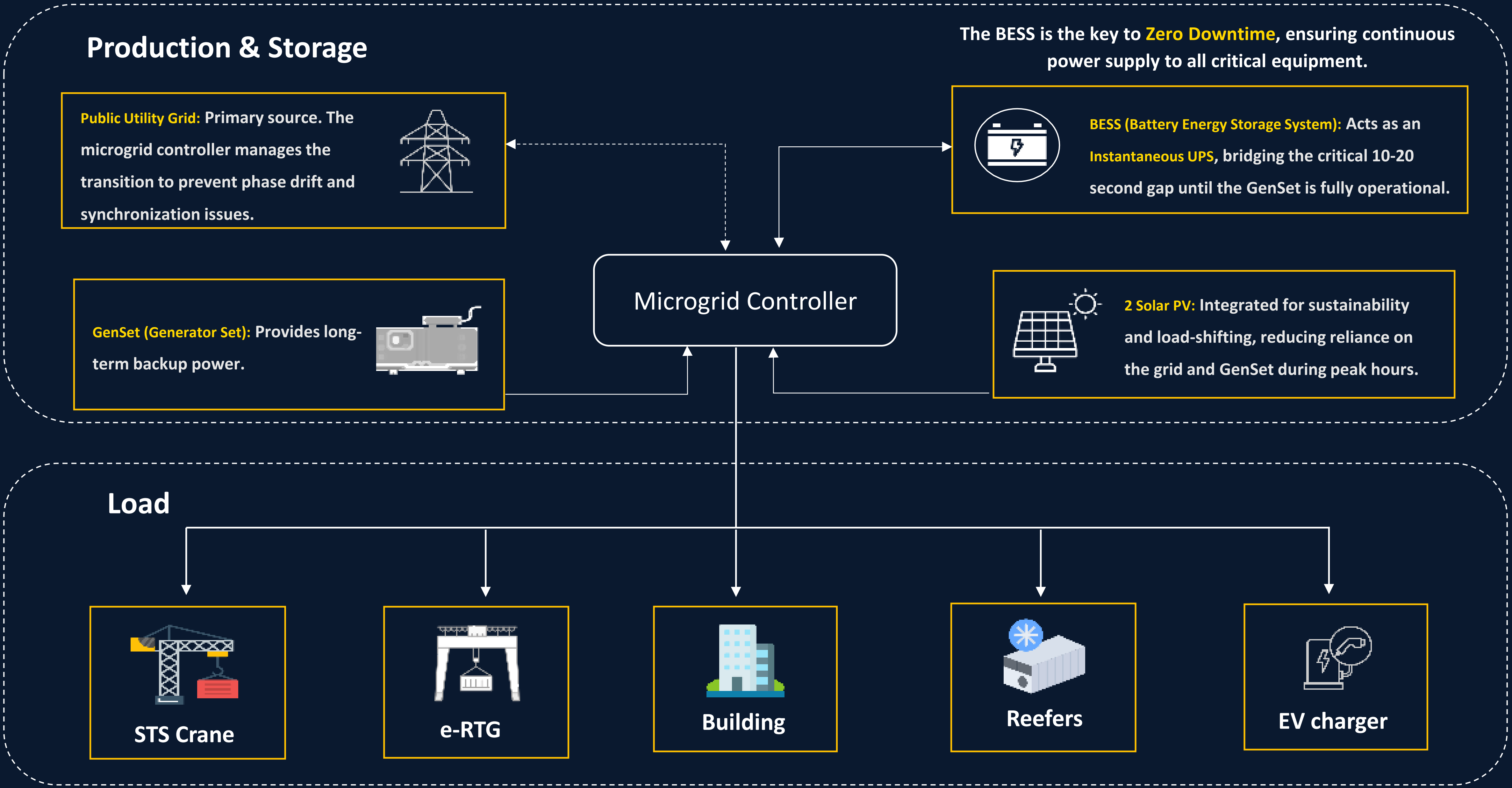


Electrification: The Foundation for Modern Port Operability

Electrification is no longer a choice but a strategic necessity for competitive, sustainable, and continuously operational ports.

Aspect	Description	Terminals Context
Sustainability	Reduces carbon footprint and local air pollution	Solar Farms + EV Charging+ and future OPS is under discussion
Efficiency	Higher performance and faster cargo handling	new STS + new RTG + new Reefer Plugs
Continuity	Robust, reliable, redundant power supply	A BESS system and a diesel generator to cover downtime.

Microgrid: Ensuring an electric and resilient grid



Solution Methodology: From Client Input to Optimized Design

Phase 1: Client Inputs & Data Acquisition

- Review of **Client Requirements** (New STS, Reefers, EV Charging).
- Analysis of **As-Built Documentation** and existing Single-Line Diagrams (SLD).
- Detailed **Site Visit** to assess physical and operational constraints.
- Gathering of technical specifications for existing equipment.

→

Phase 2: Technical Analysis & Modeling

- Power balance and Load Analysis Calculations.(simultaneity and utilisation factor).
- Load Flow and Short Circuit Analysis for all operating scenarios .
- Identification of network weaknesses (e.g., non-redundant branches).

→

Phase 3: Optimized Solutions & Deliverables

- Design for **Redundancy** and operational continuity (Revised HV Layout).
- Integration of **BESS** , renewables micro grid.

Core Principle: Proposing Optimized Solutions to ensure Non-Interruption of Port Operations during implementation.

Methodology: Tools and Criteria

Modules used in simulation

- Power flow analysis (Load Flow)
- Short-circuit analysis

Load Flow Criteria

NF C 13-200 : Admissible variation ±7.5% (18.5 kV to 21.5 kV)
NF C 52-100 : Standard operation at 100% of transformers nominal power

The cable must carry no more than its admissible current rating under the installation conditions

Short-Circuit Criteria

IEC 60909 defines the requirements for sizing electrical equipment by considering thermal, dynamic, and functional constraints caused by short-circuit currents. The standard focuses on two key short-circuit values:

- **Peak Short-Circuit Current (Ip):** Used to verify the mechanical withstand capability of equipment under electrodynamic forces.
- **Steady-State Short-Circuit Current (Ik):** Ensures that equipment does not overheat during a sustained fault.

Study Scenarios

Load Flow Study

- **Case N°1: Normal Operation**

Supply by the MV network, generation sets out of service

Scenario 1: Feeders S1H1 and S1H2 in service with PV generation
Scenario 2: Feeders S1H1 and S1H2 in service without PV generation
Scenario 3: Feeder S1H1 out of service, loads supplied via S1H2
Scenario 4: Feeder S1H2 out of service, loads supplied via S1H1

- **Case N°2: Islanding**

Total loss of external network, commissioning of generation sets

Short-Circuit Study

- **Normal Scheme**

Feeders S1H1 and S1H2 in service with PV generation
Generation sets out of service

- **Worst-Case Scenario**

Closing of the coupling circuit breaker at MV switchgear
Both feeders and generation sets in service

Key Results - Load Flow

Voltages

Compliance : All busbars comply with admissible ranges (±7.5%) in all scenarios

Transformers

Anomaly : Transformer **TR46** shows a critical overload of **114.87%**

MV Cables

Severe Overload : Feeder cables (cable from public utility) are severely overloaded

Normal operation: up to **143%**

N-1 situation (feeder loss): up to **278%**

Key Results - Short-Circuit

Withstand Capability

Full Compliance of Equipment

Circuit breakers comply with criteria (I''k, I_p)

Busbars conform to IEC 60909 standards

Switches correctly rated

Components rated for prospective fault level

Islanding Operation

Required backup power: **35.25 MVA**

Continuity of supply in case of external network loss

Recommendation: Add generator sets

Recommendations

1 Transformer TR46

Critical overload detected at 114.87%
Action: Replace with a 3000 kVA model

2 MV Cables (Feeders)

Severe overload (143% normal, 278% N-1)
Action: Reinforce cross-sections or add feeders

3 Islanding (Continuity)

Backup power required: 35.25 MVA
Action: Add 6 genset of 5.875 MVA

Conclusion

The study confirms the network's robustness against short-circuit constraints and voltage compliance under normal operation. Equipment complies with fault withstand criteria. However, the overload of transformer TR46 and feeder cables represents a major operational risk requiring immediate action.

1. Implementation of TR46 replacement
2. Reinforcement of MV cables
3. Validation of islanding solution

Floating Solar Park

Project objective
Design study, technical assistance, and supervision of construction of the floating PV plant at the Tanger Med dam

- Studies: Solar resource assessment and site feasibility
- Design: Engineering, sizing, and validation of anchoring systems
- Optimization: System performance and reliability enhancement
- Monitoring: Performance tracking and operational optimization

Floating Solar Park: Technical Services Overview

PLANNING & DESIGN

UP TO 3-5 YEARS

Prospection → Feasibility → Concept → Permitting → Basic → Detailed

acts for all design and development phases with IPPs, Owners and EPCs
as Owner's engineers, and/or independent engineering, and/or technical advisory and consultancy

Typical FPV Development Studies Services

Market studies
Site screening
Site visits
Site characterisation
Development strategy

Red flags / risk analysis
Feasibility studies
- Mooring and anchoring
- Layout definition
- Solar resource / Yield assessment / Performance
- Grid integration
- CAPEX/OPEX estimations

Studies/surveys recommendations

Component selection
Installation requirements
Planning
O&M strategy / LCOE
Decommissioning

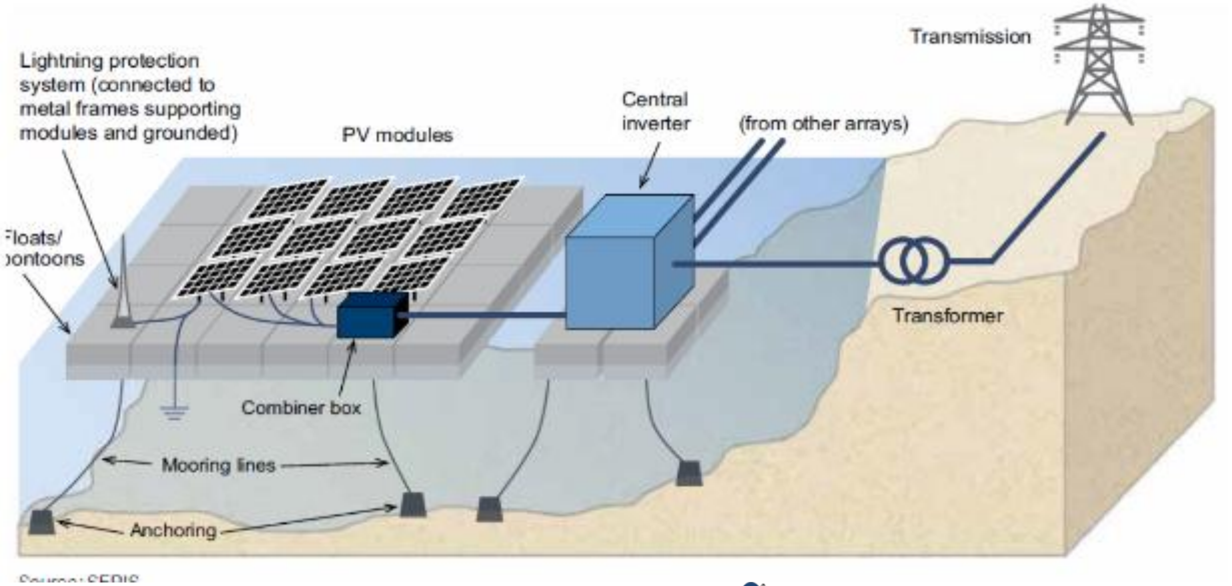
Tender design and documentation
(Management, Strategy, Design, Specifications, RFP)
Bid evaluation

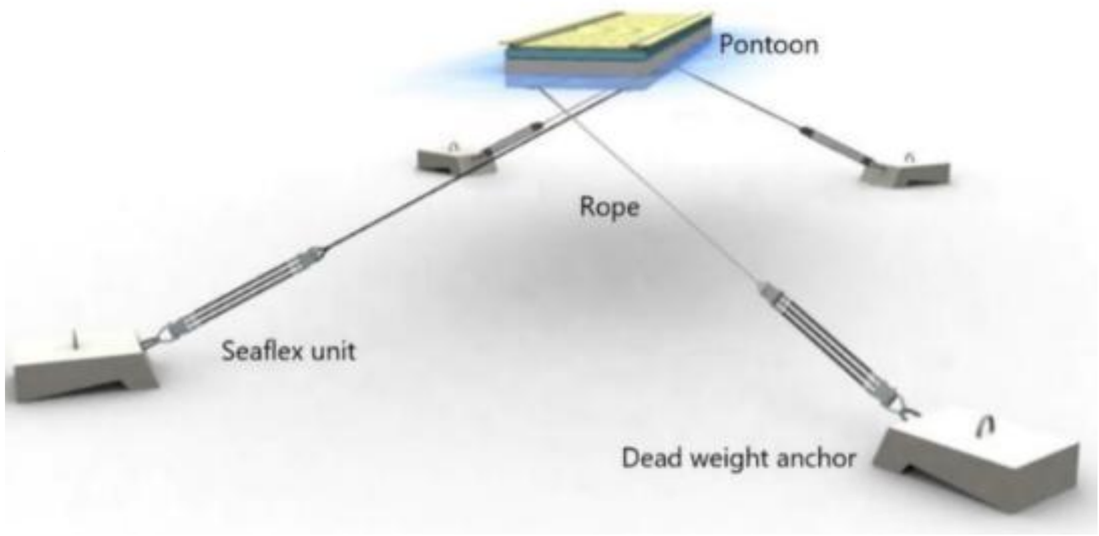
Technical due diligence
Detailed engineering studies
- Mooring and anchoring
- Assembly & Installation method statement
- Geoscience

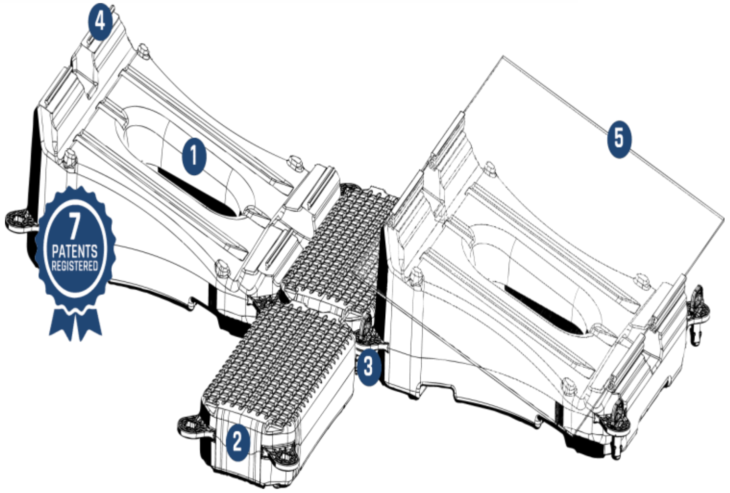
Owner's engineering
Supervision and advisory
Third party review
Lenders technical advisory

Floating Solar Park: Design review

- Global loads from environmental actions
- Mooring design, loading and capacity
- Anchor design, loading and capacity
- Simulating Fatigue loading
- Reviewing of Installation procedures a
- PV panels
- Electrical design







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Process for Anchoring and mooring design

Geophysics

- Bathymetry (by MBES) and initial risk analysis (slope zonation, identification of obstacles,...)
- Sub Bottom Profiler (SBP) to define thickness of sediments. Survey mainly important at location of anchors
- UXO (unexploded ordonnance): if no risk, no survey needed. On the contrary, complex management with magnetometer

Geotechnics

- To get mechanical characterisation of the different soil (or rock) types present in each different zone
- To validate sediment thickness

Design

- Anchor design based on mooring solicitation (loads, angles of tensions) and soil conditions (bathymetry and soil characteristics)
- Anchor design is strongly dependent on soil type (sand or clay) and its mechanical features

POT Validation

- Representatives and worse situations to be tested against anchor design: representatives combinations of slopes, soil types and mooring lines tensions and angles
- All different situations must be validated

POT Verification

- During anchors installation, regular anchors are to be tested during the installation

Floating Solar Park: Cable rooting

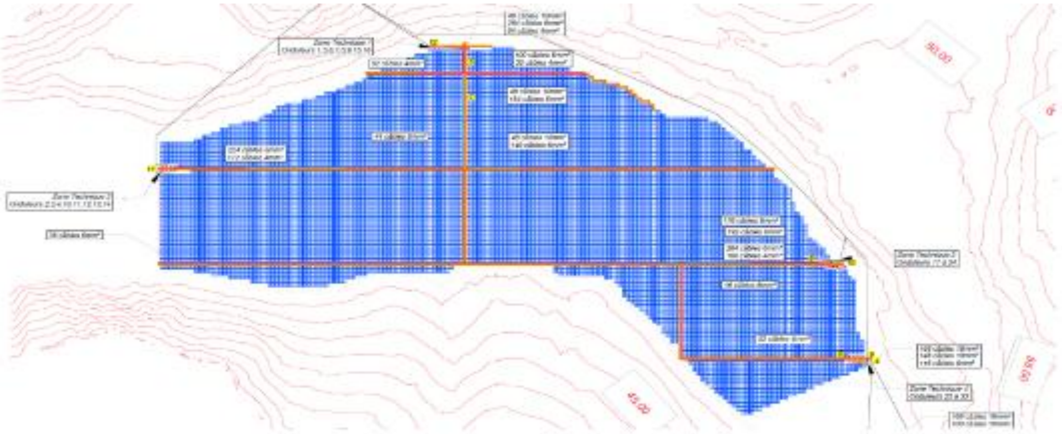
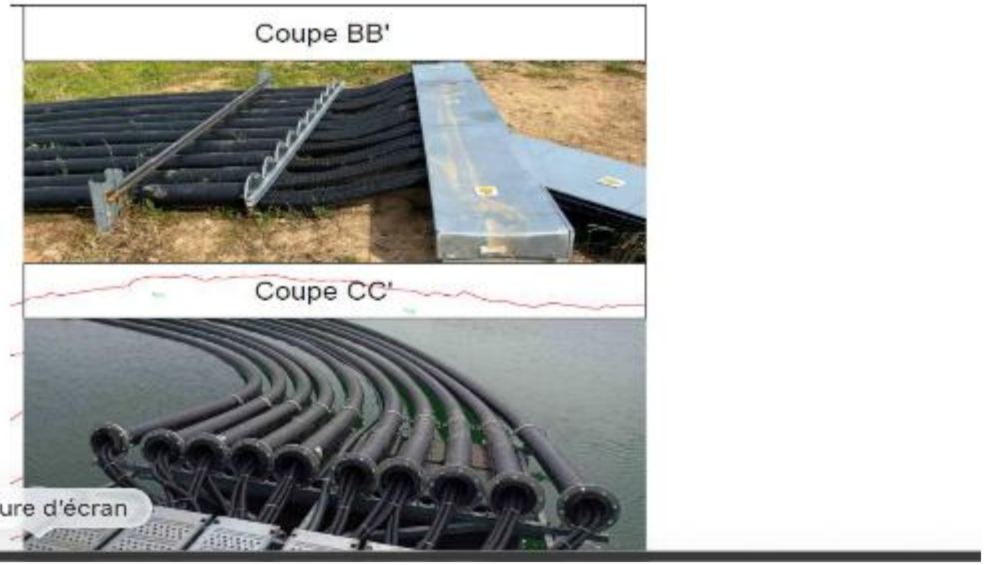


Figure 5-6 Cables' path



The cable routing is constrained by the floater-to-land transition and by trench geometry on land. Conduit spacing, burial requirements, and the integration of power, communication, and grounding systems further limit the available cable path, requiring a carefully optimized layout.

Floating Solar Park: Global Architecture

No standardization or applicable standards, except **DNV-RP-0584**.

Floating Solar Park: Main Challenges Identified

Construction challenges

- Site accessibility and logistics can be a strong challenge.
- Limited space might be available for storage on the valley banks.
- Limited space might be available for slipway preparation.
- Anchor positioning tolerances can be challenging to respect (water depth, stabilization of vessel, measurement device)

Specific challenges to dam lakes

- Site accessibility can limit the size of the installation means (marine assets) mobilized.
- Launching slope for barge, or marine spread

Installation process

- In significant water depth, the anchor installation speed can be drop up to ten-fold.

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