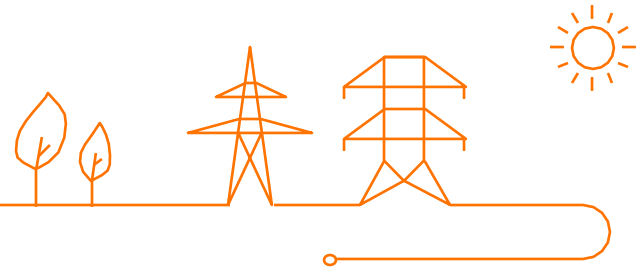
Modular Offshore Grid 2

Technical Workshop Windfarms

16/09/22 – Tomas Impens; Davy Verwilghen; Tom Trappeniers; Damien Rietjens

Agenda

1. Context
2. Single Line Diagram Inter Array Cable
3. GIS 66kV
4. Interface & Protection Concept
5. Cable Routing around Island
6. Cable Pull-in

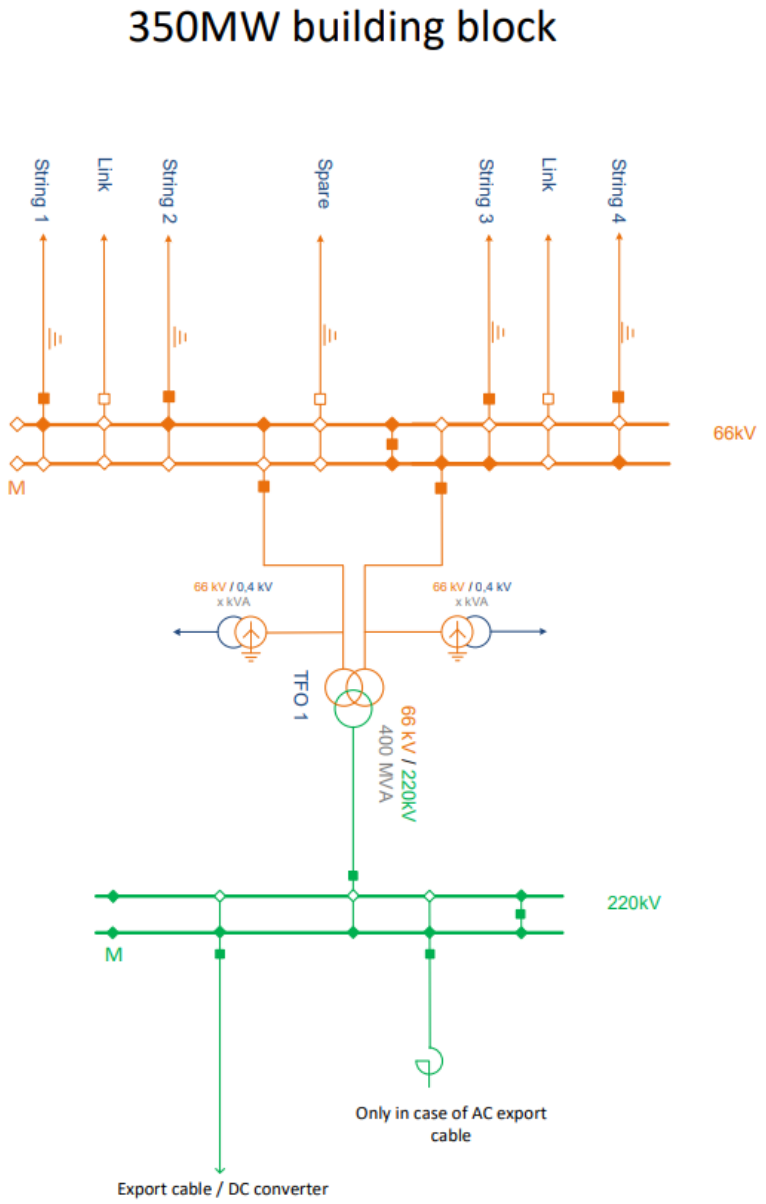


Energy Island Design: potential layout

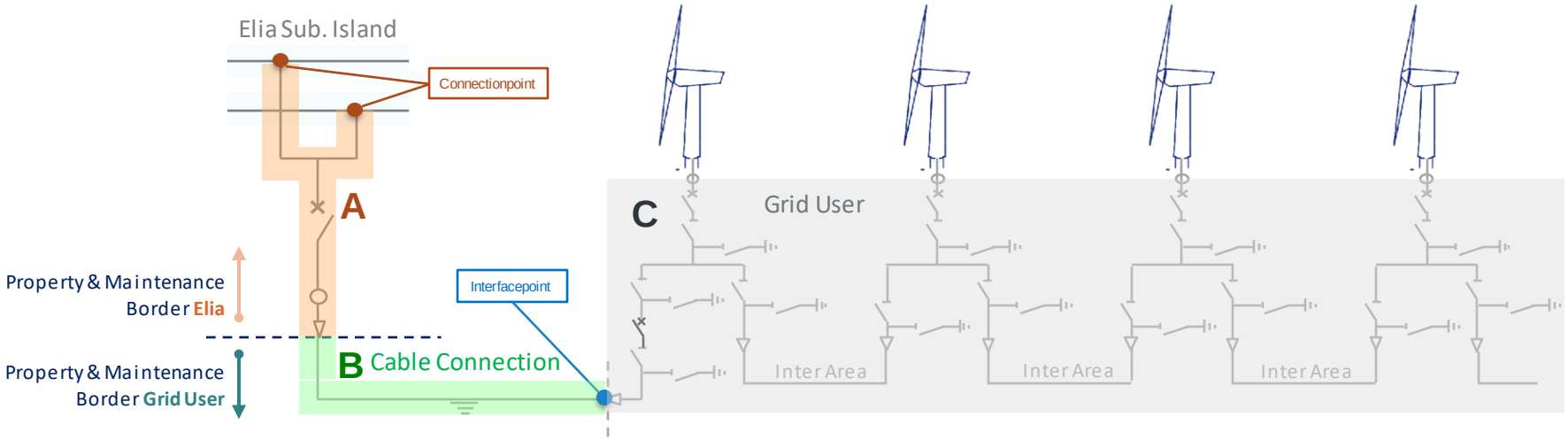
MOG 2 – SLD IAC

Grid design

- 10 blocks of 350MW
  - 1 transformer
  - 1 GIS cabine 66kV
- Array cables:
  - 66kV
  - 90 MW/string
- 1 spare bay per 350MW
- 1 export cable 220kV AC / HVDC
  - 1 shunt reactor per AC export cable



Interfaces



Connectionpoint

The **Connection Point** is the point where the Grid User is connected to the grid. It is usually located at the connection terminals of the busbar where the Grid User is connected to the grid (via its first connection field)

Interfacepoint

The **Interface Point** : the physical location and the voltage level of the point where a Grid User's installations are connected to the connection installations. This point is located on the Grid User's side after the first connection field from the grid on the Grid User's side;

Z **Part Z** : All Installation/equipment **belonging to the Grid**

A **Part A :** All **High Voltage (HV) equipment** of the Grid belonging to the customer's connection. These **are fully allocated to the customer**.

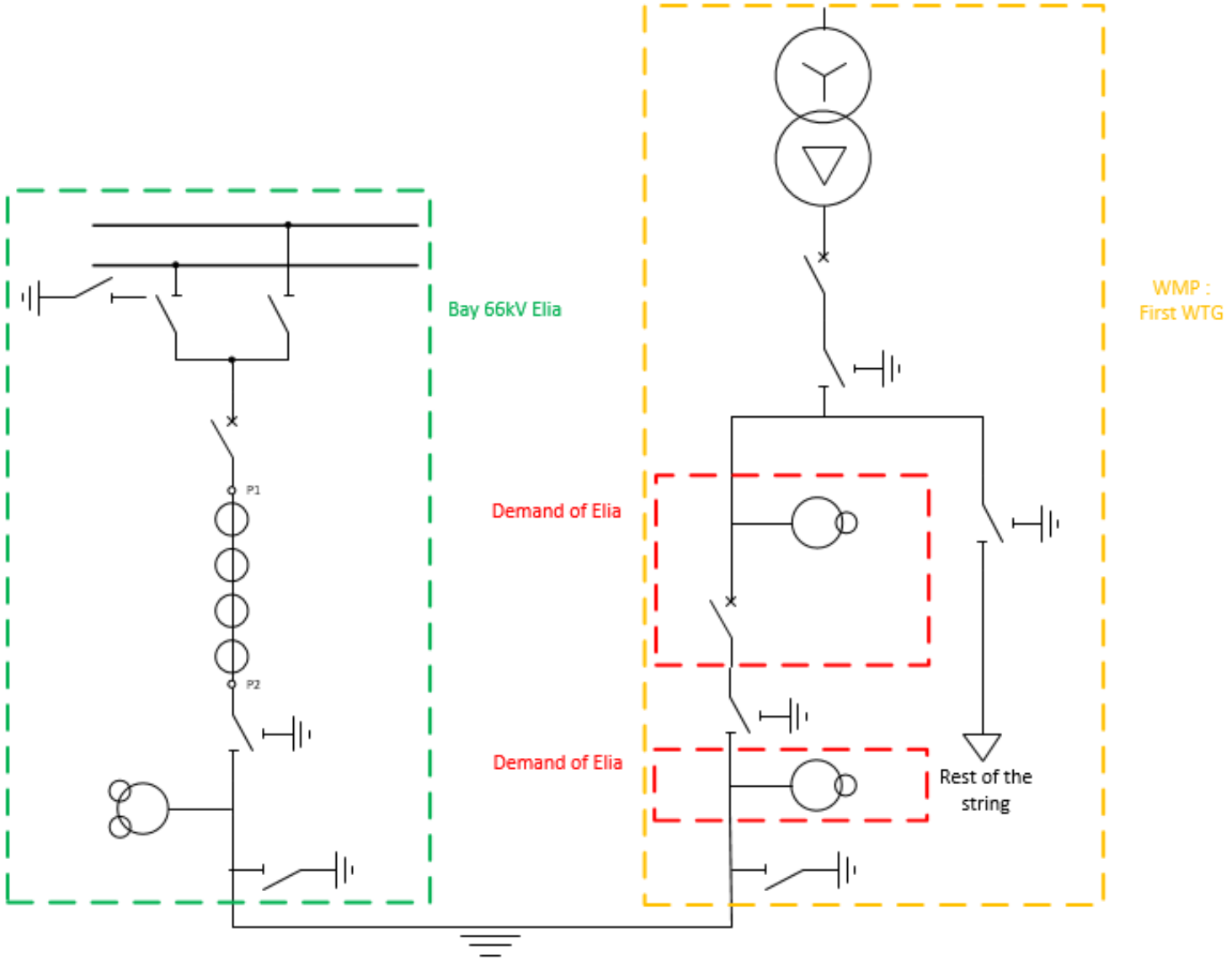
B **Part B : The connection** between the connection field and the Grid User's installations

C **Part C** : **HV equipment** from the **Grid User**

SLD for discussion (not exhaustive)

Single Line Diagram

- SLD 66kV Elia Bay
  - 90 MW/string
- Restrictions at first WTG
  - Integrate Circuit Breaker
  - Synchro-check (VT on phase 7)
  - Synchro-coupling not allowed
- Closed loop (looping strings)
  - Only for aux. services?
  - Overload protection
- Switching error protection WTG?
  - Cable earthing switch
  - Cable disconnector
  - Circuit breaker
  - VT



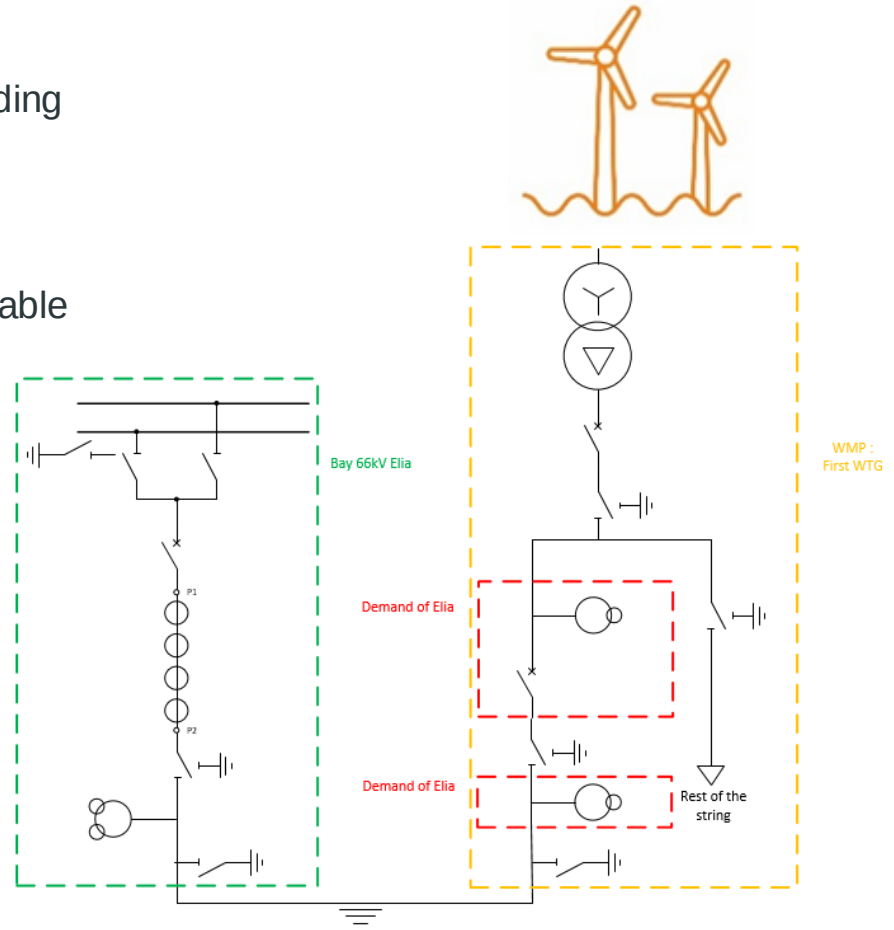
Single Line Diagram

- Turbine transformer
  - Vector group?

    66kV side of turbine transformer: isolated neutral point or delta winding

  - 66kV Elia grid impedance earthed

    No injection of zero-sequence current in case of one phase 66kV cable fault allowed



MOG 2 – GIS 66kV

Operations

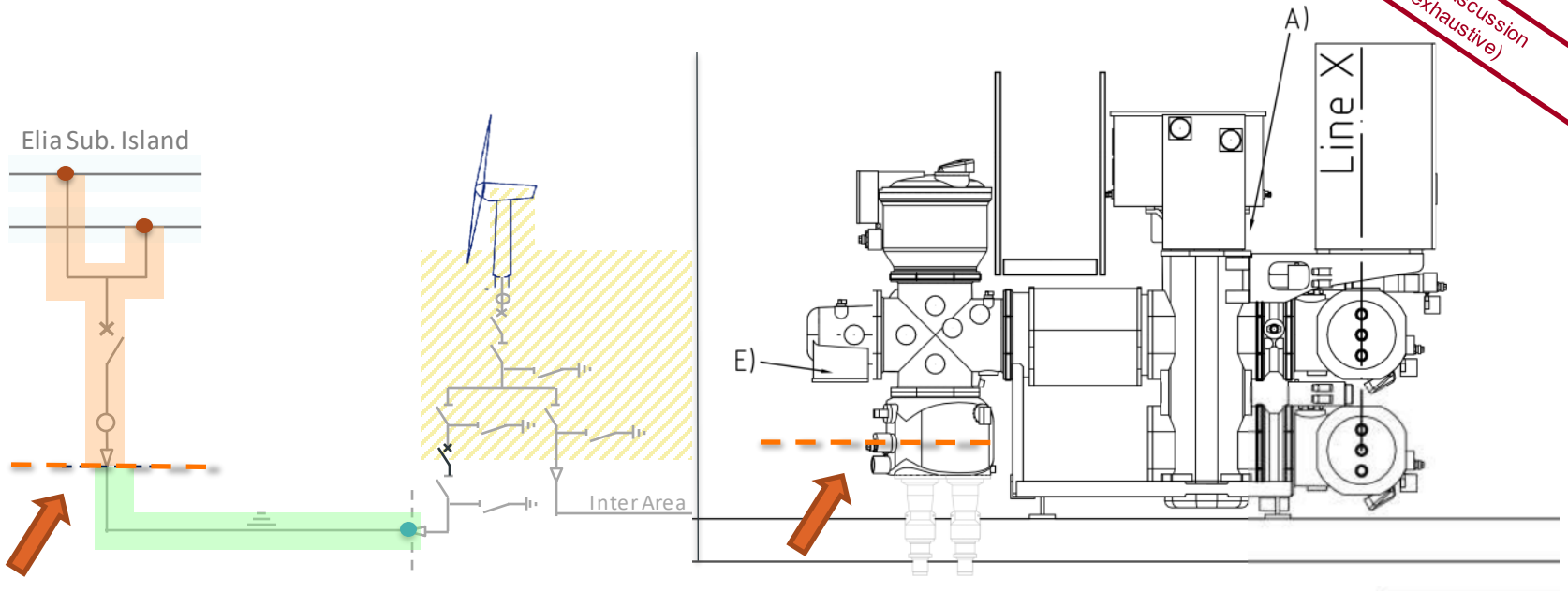
Elia Operates first connection field

Grid User fully and independently operates the entire string as of the first wind turbine

In order to be fully independent a circuit breaker has been placed in the first wind turbine

The connection between the connection field and the Grid User's installations

Property and Maintenance Border



SLD for discussion (not exhaustive)

- Cable + terminal systems
  - Dry-type termination
  - Interface GIS conform acc. IEC 62271-209 cl 7 in customer's scope of supply
- Short-circuit withstand capability
  - 66kV equipment Ik = 31,5kA/3s
  - Cable screen Ik = 8kA/3s

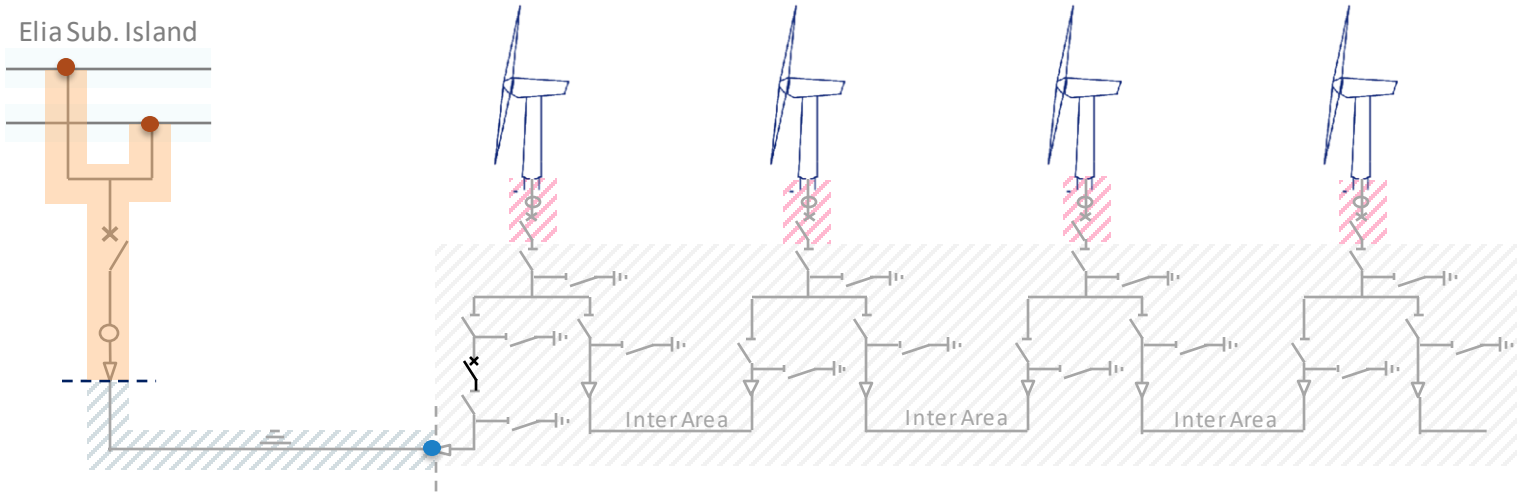
MOG 2 – Interface & Protection Concept

Protections

Elia protects and defines parameters for the first connection between the first connection field and the first Wind Turbine

Elia and the **Grid User** jointly define the parameters of the part of the string behind the first cable connection at the first turbine

Grid User protects each wind turbine by installing own local protection that trips the circuit breaker (settings will also be shared and aligned with Elia)



- 66 kV feeders are protected with P1 and P2
  - Two distance protections
- Protection settings and coordination : shared responsibility between customer and Elia
  - Forward zones (direction cable): to be agreed between customer and Elia
  - Backward zone (direction busbar): to be decided by Elia

Protection 66kV feeders

- Bay controller with build-in measurement convertor
- To improve measurement detail Elia proposes to communicate via :
  - RTU/DCS protocol IEC 104 to windfarm
  - Measuring convertor (in protection cubicle) to windfarm

Device	Sineax DM5S	SIEMENS 7KG85	GE I5MT
Response time	85…165ms	200ms	
Interface	Modbus/RTU (via RS485) 4 analoge outputs +/-20mA	Modbus/RTU Modbus/TCP IEC61850 IEC60870-5-103	Modbus/RTU Modbus/TCP 4 analoge outputs +/-20mA

  - Hard wired (e.g. metering)

Specific protection WTG (String) ?

- …
- …

Windfarm Interface and communication

- Elia will provide « dark » fibers in the cables towards shore
  - Optical fiber split
  - Fibers / OWF: # 24 (12 pair)
- Elia will provide auxiliaries power supply
  - 2x 110VDC / power requirements?
  - 1x 230Vac / power requirements?
- List of exchanged signals (e.g. currents and voltages)
  - ELIA <==> OWF
  - ELIA <==> STRING

Annex - Interface of signals OWF <==> ELIA

OWF ==> ELIA	From	To
Wind speed (m/s)	OWF	Elia
Wind direction	OWF	Elia
Current voltage control mode (V control droop, Q constant, PF mode)	OWF	Elia
Current active power control mode (Maximum available power, limited by ELIA, limited b	OWF	Elia
Current LFSM mode (LFSM-U on, LFSM U off, LFSMO on LFSMO off)	OWF	Elia
Current MW setpoint (in PPC)	OWF	Elia
Current MVAR setpoint (in PPC)	OWF	Elia
Max/min Voltage throughout the string	OWF	Elia
Spare	OWF	Elia
Spare	OWF	Elia
Spare	OWF	Elia
Spare	OWF	Elia
Spare	OWF	Elia
ELIA ==> OWF		
Voltage measurement 220kV Elia	Elia	OWF
Voltage control mode: V control drop; Q constant; PF mode	Elia	OWF
Spare - Emergency control 1	Elia	OWF
Spare - Emergency control 2	Elia	OWF
Spare - Emergency control 3	Elia	OWF
Spare - Emergency control 4	Elia	OWF
Spare - Emergency control 5	Elia	OWF

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Spare - Emergency control 2	Elia	OWF
Spare - Emergency control 3	Elia	OWF
Spare - Emergency control 4	Elia	OWF
Spare - Emergency control 5	Elia	OWF

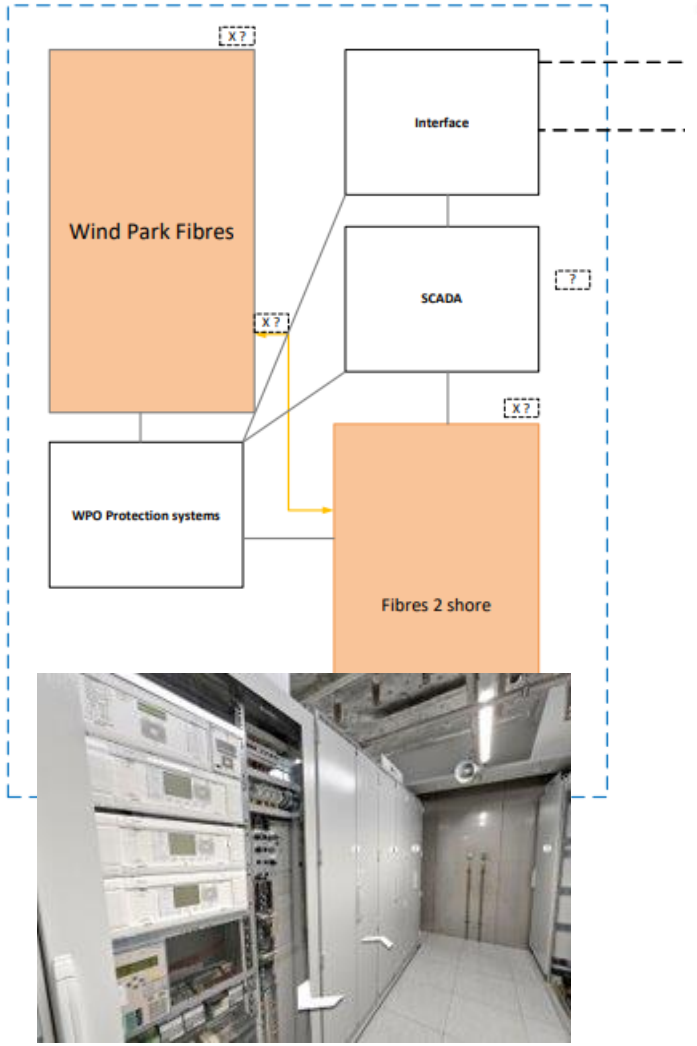
Annex - Interface of signals STRING <==> ELIA

OWF ==> ELIA	From	To	Type	Local/ ICCP
Position line disconnector IN	OWF	Elia	Position	
Position line disconnector OUT	OWF	Elia	Position	
Position line earthing IN	OWF	Elia	Position	
Position line earthing UIT	OWF	Elia	Position	
OUT due to OWF error	OWF	Elia	Alarm	
Number of Wind mills in service	OWF	Elia		
Real time available active power (MW) on the string	OWF	Elia	Measurement	
Spare	OWF	Elia		
Spare	OWF	Elia		
Spare	OWF	Elia		
Spare	OWF	Elia		
Spare	OWF	Elia		
Spare	OWF	Elia		
Spare	OWF	Elia		
ELIA ==> OWF				
Position circuit breaker Elia IN	Elia	OWF	Position	
Position circuit breaker Elia UIT	Elia	OWF	Position	
Position line disconnector Elia IN	Elia	OWF	Position	
Position line disconnector Elia UIT	Elia	OWF	Position	
Position line earthing Elia IN	Elia	OWF	Position	
Position line earthing Elia UIT	Elia	OWF	Position	
Active power measurement Elia (MW)	Elia	OWF	Digital	
Reactive power measurement Elia (MVAR)	Elia	OWF	Digital	
Current measurement 66kV Elia	Elia	OWF	Digital	
Voltage measurement 66kV Elia	Elia	OWF	Digital	
Voltage measurement TFOA 220kV Elia	Elia	OWF	Digital	
Voltage measurement TFOB 220kV Elia	Elia	OWF	Digital	
Voltage measurement TFOC 220kV Elia	Elia	OWF	Digital	
Connection TFO: A, B or C	Elia	OWF	Position	
Active -> (A+)	Elia	OWF	Impuls	
Active -> (A-)	Elia	OWF	Impuls	
Ri+	Elia	OWF	Impuls	
Ri-	Elia	OWF	Impuls	
Rc+	Elia	OWF	Impuls	
Rc-	Elia	OWF	Impuls	
1/4h	Elia	OWF	Impuls	
Host Offline	Elia	OWF	Alarm	
Spare	Elia	OWF		
Spare	Elia	OWF		
Spare	Elia	OWF		
Spare	Elia	OWF		
Spare	Elia	OWF		
Spare	Elia	OWF		
Spare	Elia	OWF		

Windfarm Interface and communication

- **Offshore: 1 room per windfarm operator**
  - Interface cubicle OWF – TSO: 1 or 2 cubicles?
  - Windpark control cubicles: 2?
  - Telecom cubicles: 1?
  - DTS?
  - Metering?
  - Desk + cupboard for schematics? Other?

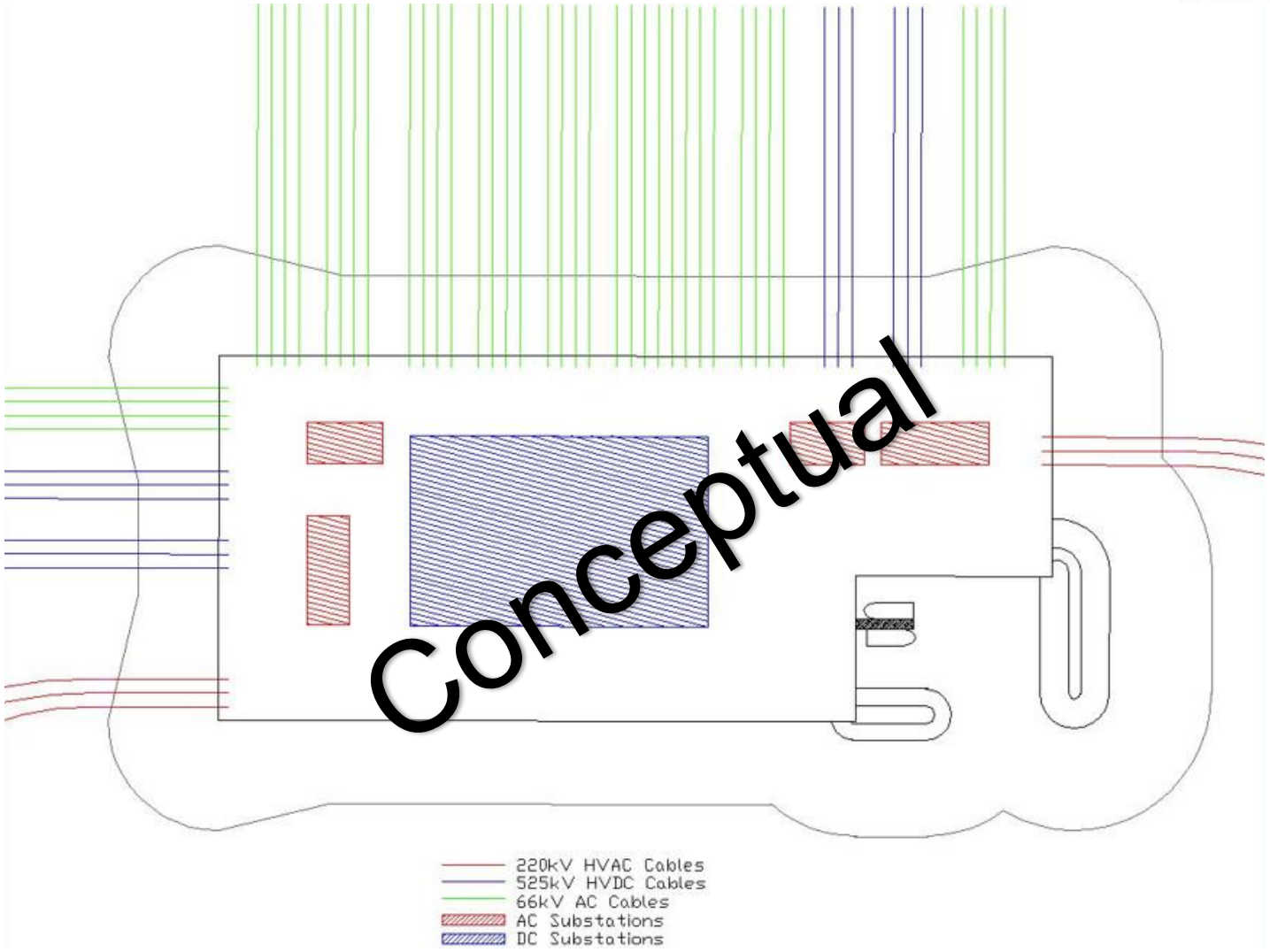
- **Onshore: Elia substation**
  - OTDR cubicles: 4U / OWF?



MOG 2 – Cable Routing around Island

Cable Routing around Island

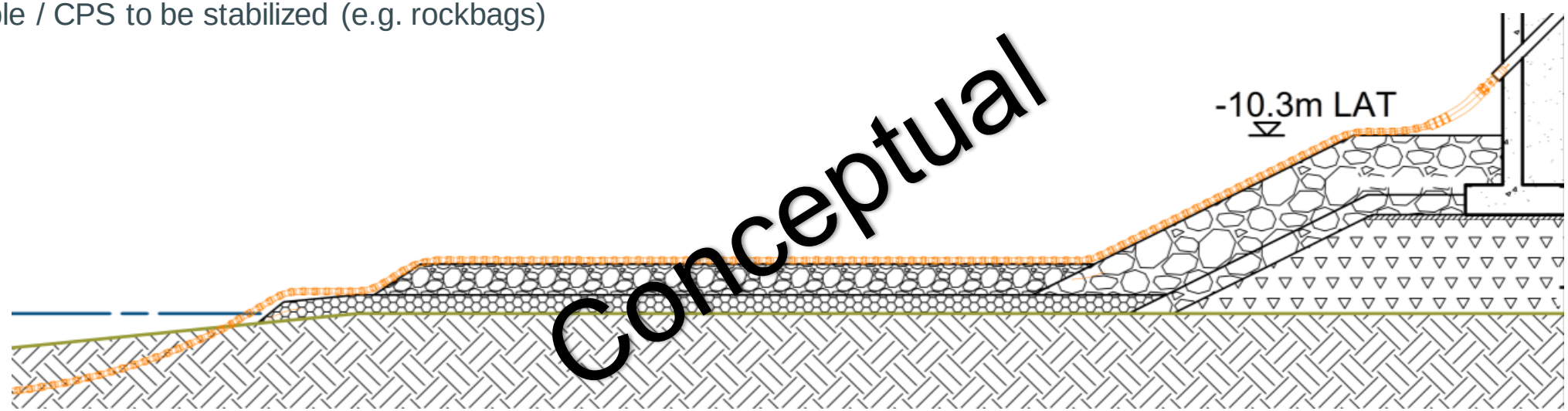
- All submarine cables to be grouped, as much as possible, per OWF concession, package, …
- Defining a corridor per concession between island and applicable concession, for multiple cables
- No offshore crossings within a to be defined distance from the Island. Offshore crossings cannot be avoided for interconnectors
- J-tubes spacing every 6 to 8m (pending detailed design island)
- Spare J-tubes scheduled to be foreseen (number & location to be defined)



MOG 2 – Cable Pull-in

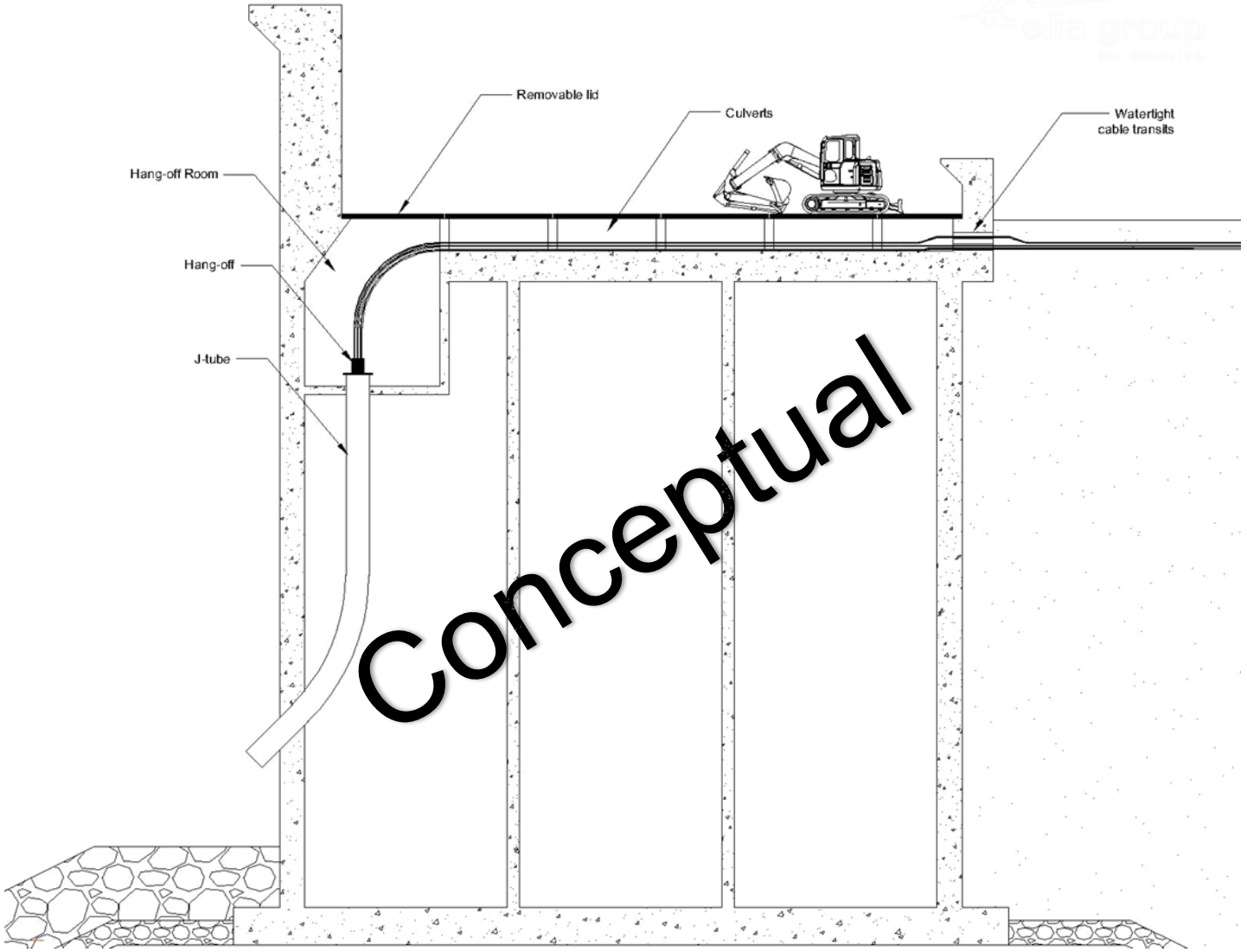
Cable approach

- J-tubes through caisson
- Uniform J-tube design (to accommodate all type of cables)
- J-tubes spacing every 6 to 8m (pending detailed design island)
- Cable to be placed in CPS on top of scour protection
- Cable / CPS to be stabilized (e.g. rockbags)



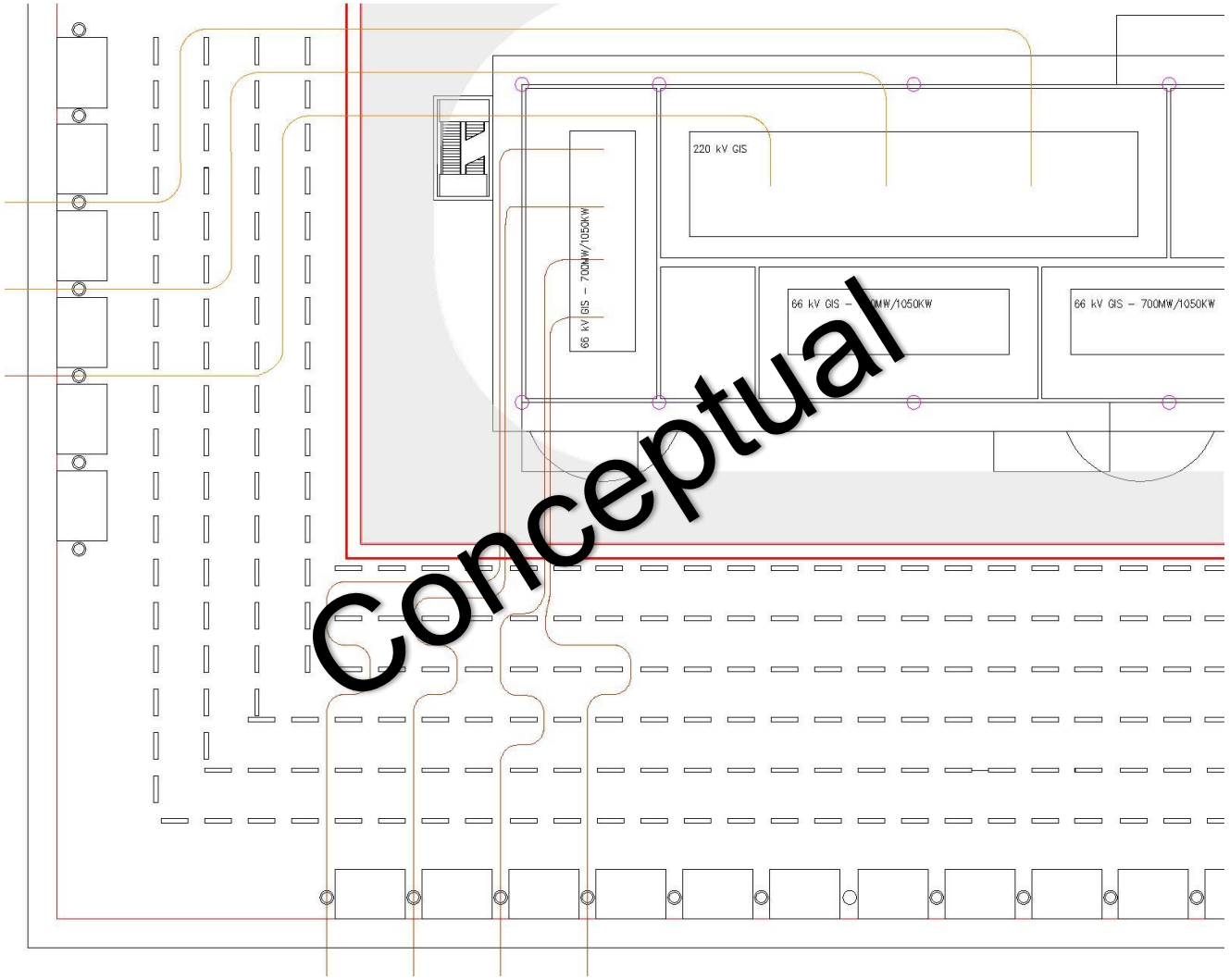
Cable Pull-in concept

- Lid above hang-off to be opened, pull-in system / structure to be placed above to accommodate pull-in
- Cable to be routing in concrete culverts over the caisson
- Cables routed through water tight cable transits that can be closed off.
- Cables to be further routed on the island towards the AC Substation



Routing on the Island

- Lid above hang-off to be opened, pull-in system / structure to be placed above to accommodate pull-in
- Cable to be routing in concrete culverts till inner part island.
- Cables to be routed on the island from the hang-off towards the GIS inside AC Substation



MOG 2 – Feedback OWF

Legend

SLD IAC: Single Line Diagram Inter Array Cables

OWF: Offshore Wind Farms

WTG: Wind Turbine Generator

CB: Circuit Breaker

VT: Voltage transformer

RTU / DCS: Remote Terminal Unit / Digital Control System

TSO: Transmission System Operator

DTS: Distributed Temperature Sensing

LFSM: Limited frequency sensitive mode

PPC: Power Plant Controller

OTDR: Optical Time Domain Reflectometry

CPS: Cable Protection System

Many thanks for your attention!

ELIA ASSET
Boulevard de l'Empereur 20
1000 Brussels

+32 2 546 70 11
info@ elia.be

www.elia.be
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