Co-funded by
the European Union

Jicable '23
Since 1982

Belgium’s Offshore Energy Hub" by

Valérie Daloze, Head of program Management Elia Belgium

13/06/2023|

Elia Group

REGULATED ACTIVITIES | **NON-REGULATED ACTIVITIES**

Grid management

System operations

Market facilitation

Trusteeship

50hertz

- Northern/Eastern Germany TSO operator
- On- and offshore transmission systems
- 80% owned by Elia Group (20% KfW)
- Monopolistic position in Northeast Germany

elia

- National TSO
- On- and offshore transmission systems
- 99.99% owned by Elia Group
- Monopolistic position in Belgium

nemolink

- 50/50 JV between Elia and National Grid (UK)
- Grid interconnection between BE and UK
- 50% owned by Elia Group

elia group

egi Elia Grid International

- International energy market consultancy and engineering services

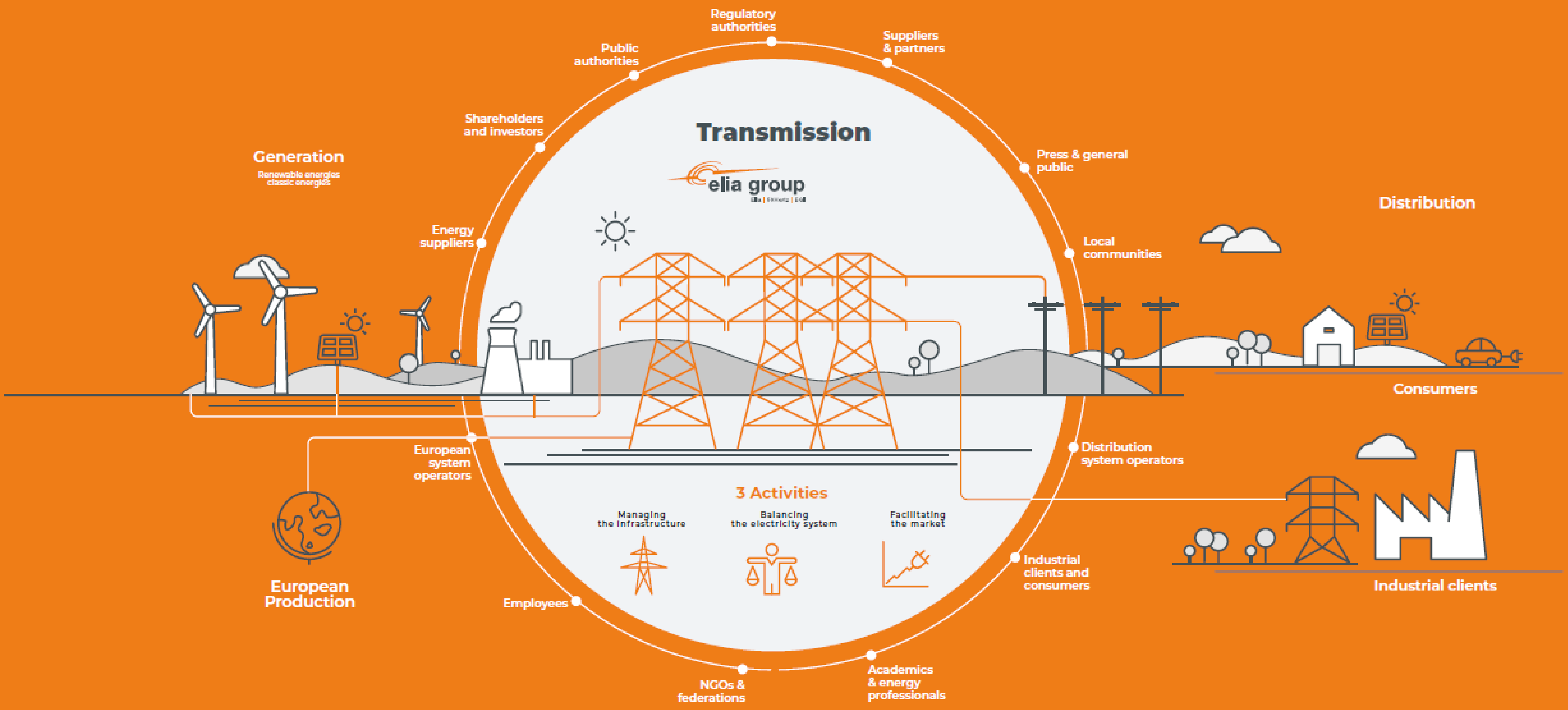
realto

- European market platform
- Exchange and valorization of data and digital services
- 100% owned by Elia Group

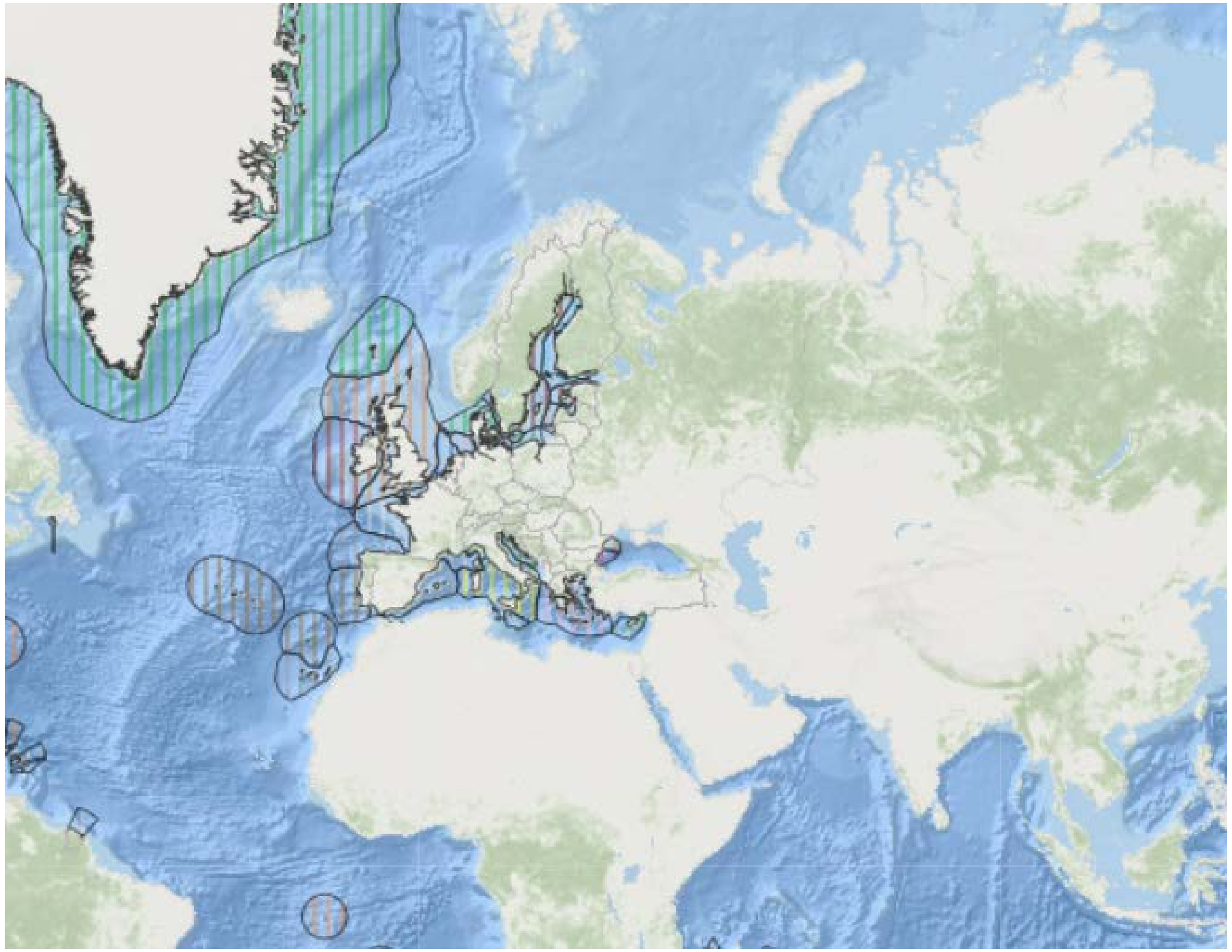
WindGrid | Elia Group

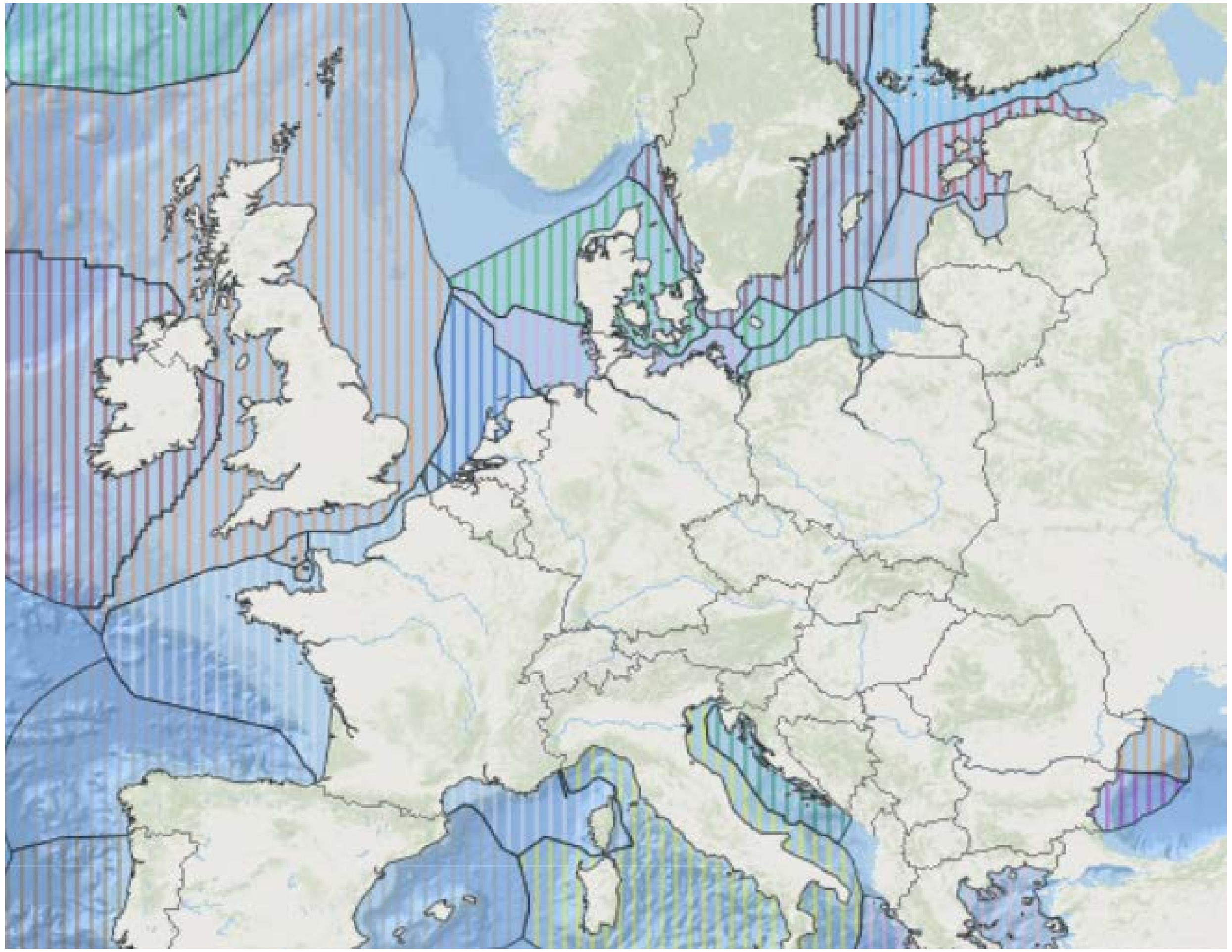
- 100% subsidiary of Elia Group
- Focusing on international offshore developments

We connect distribution and generation

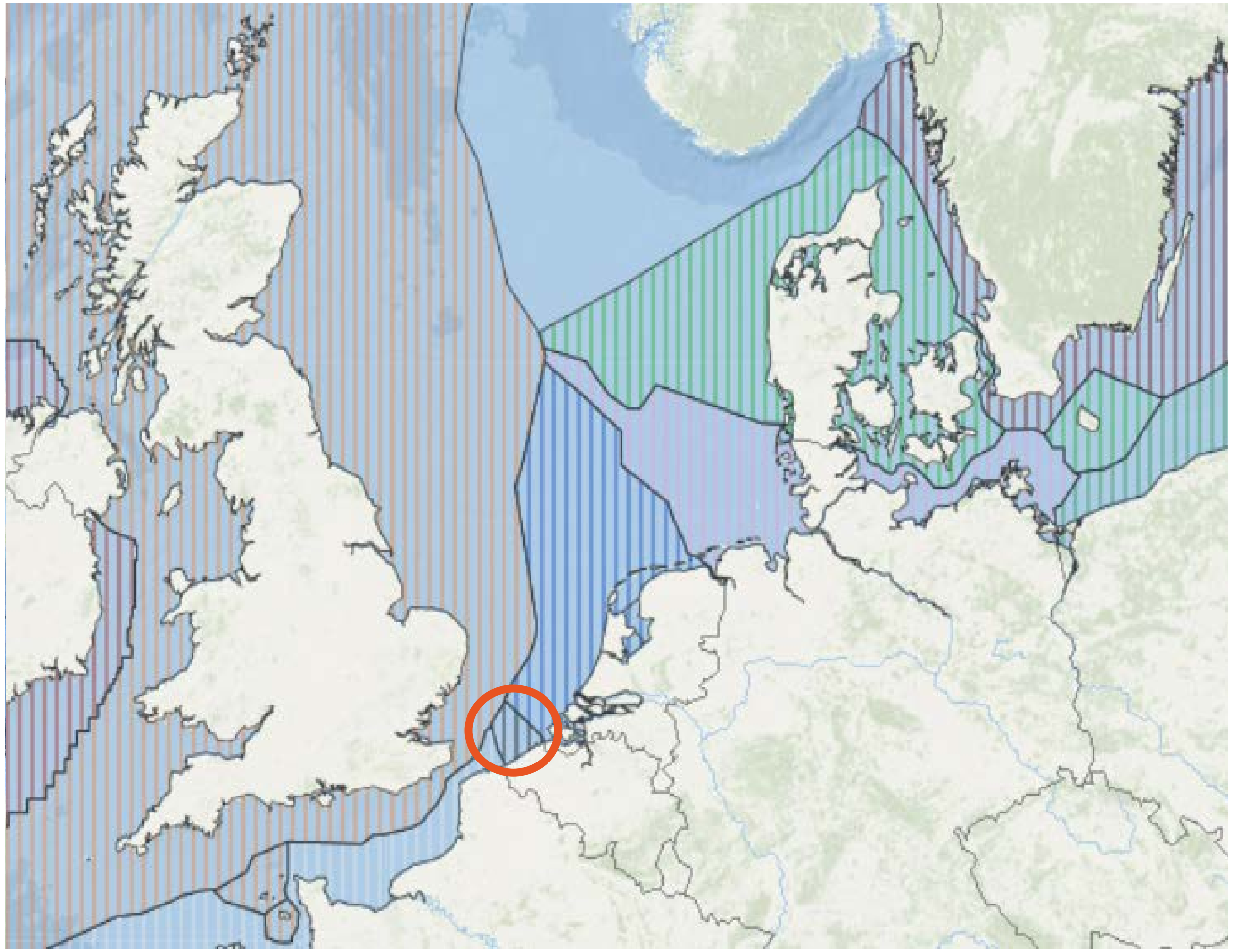


Offshore wind in the Belgian North Sea





Belgian North Sea



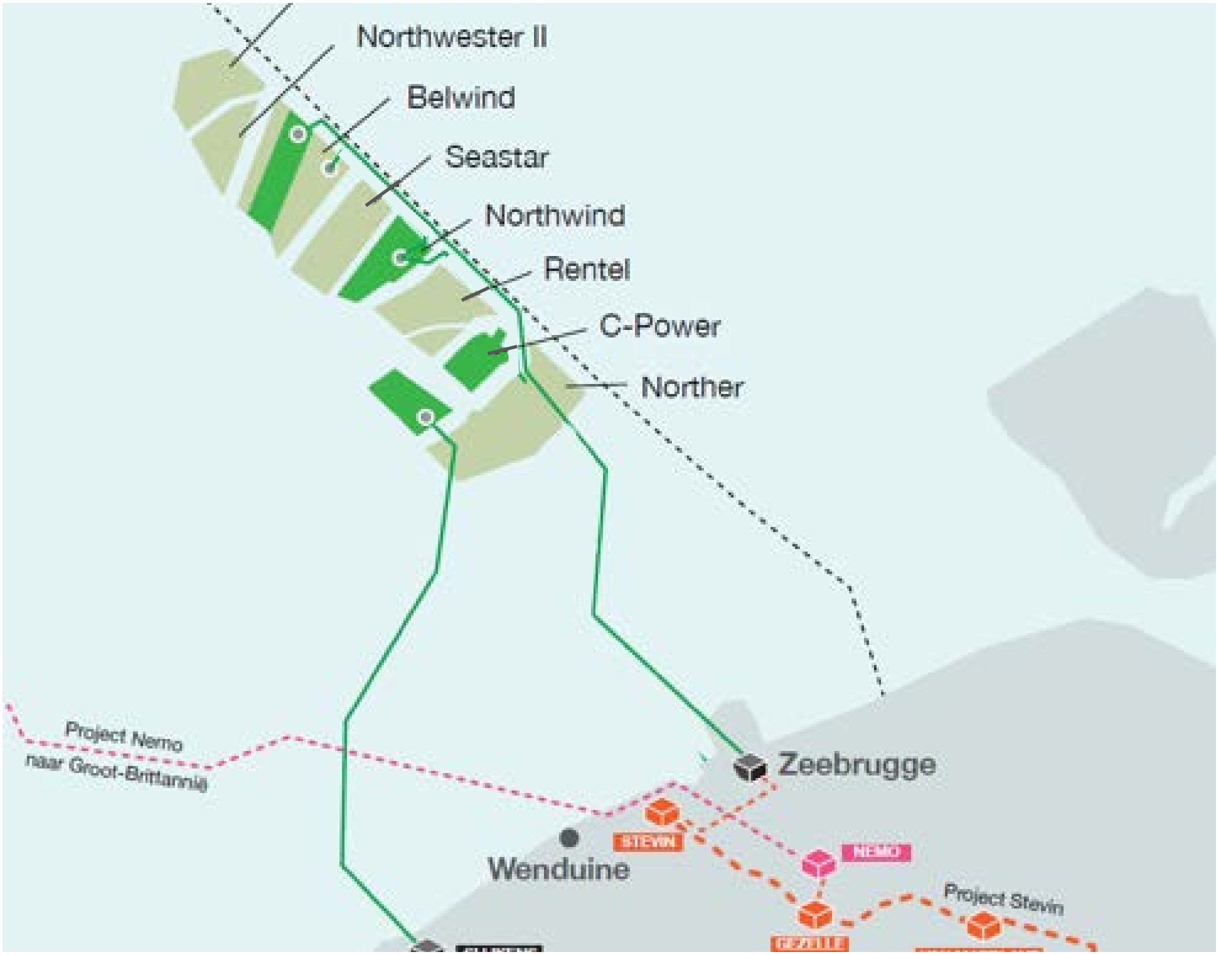
- The furthest point : 83km from coast
- Depth between 20m and 45m
- 65km coastal line
- 0,5% of the total surface of the North Sea
- 3400km^2

Absolute must of coordination and optimisation

Marine Spacial Plan 2014-2020

From “spaghetti” scenario …

- 2010 : C-power and Belwind : direct connection 150kV to the coast
- Far from optimal :
  - Environmentally
  - Expensive
  - Technical
- Elia, with developers published a “<u>*Offshore Vision*</u>” in June 2011, to develop step by step a meshed offshore grid.

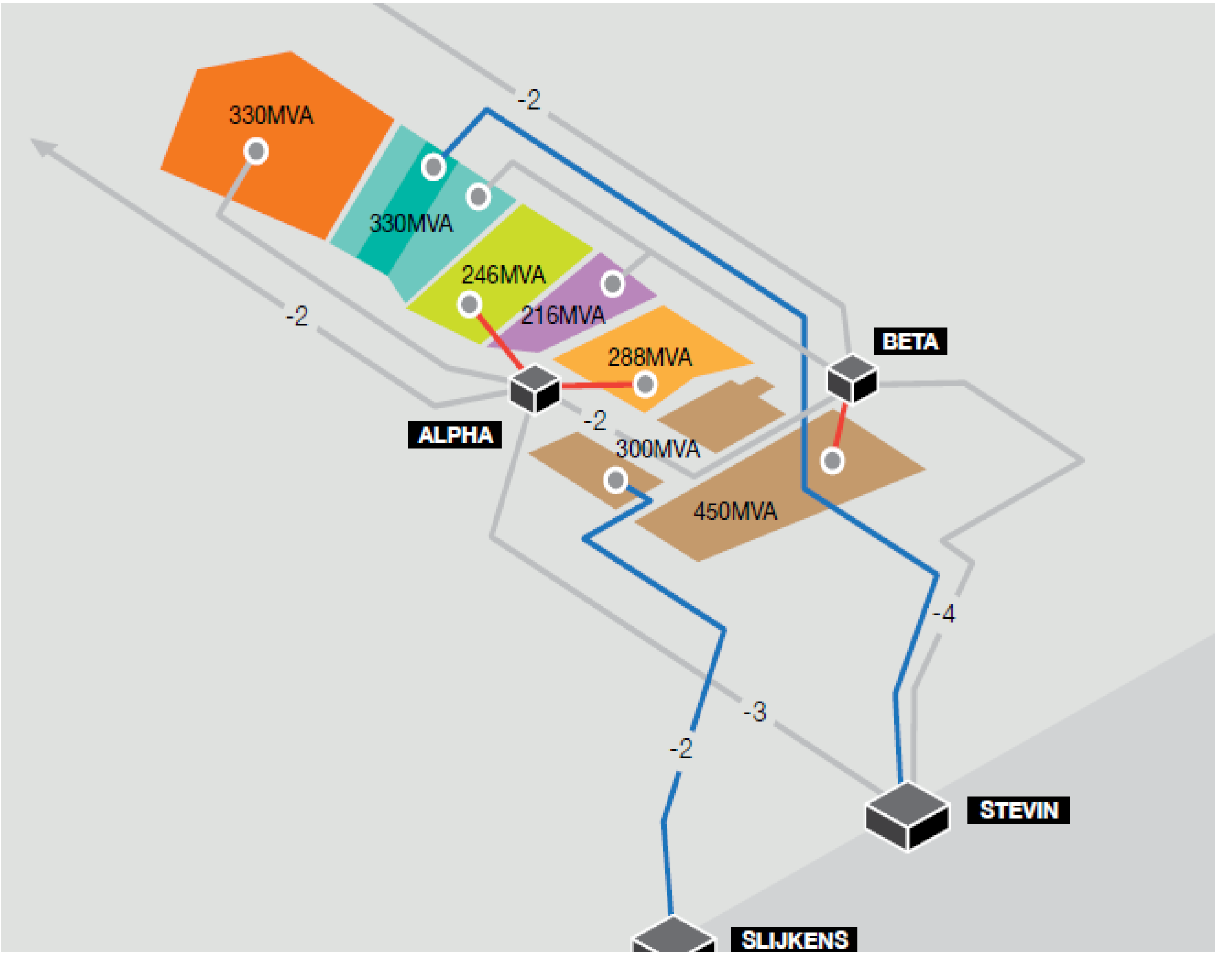


To the first meshed offshore gird

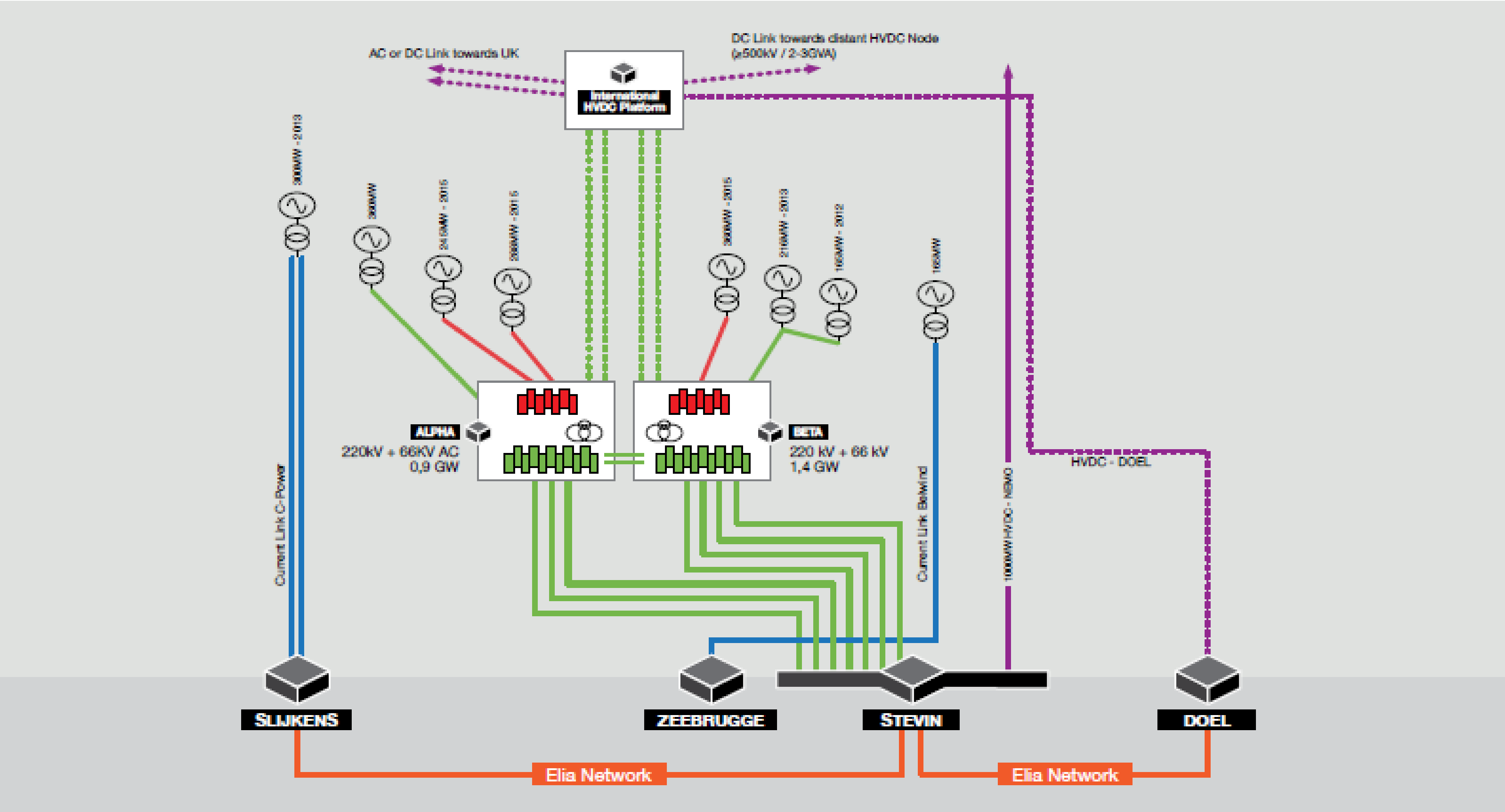
Providing benefits as onshore net :

- Reliability
- Optimisation of investment
- Fewer cable connections

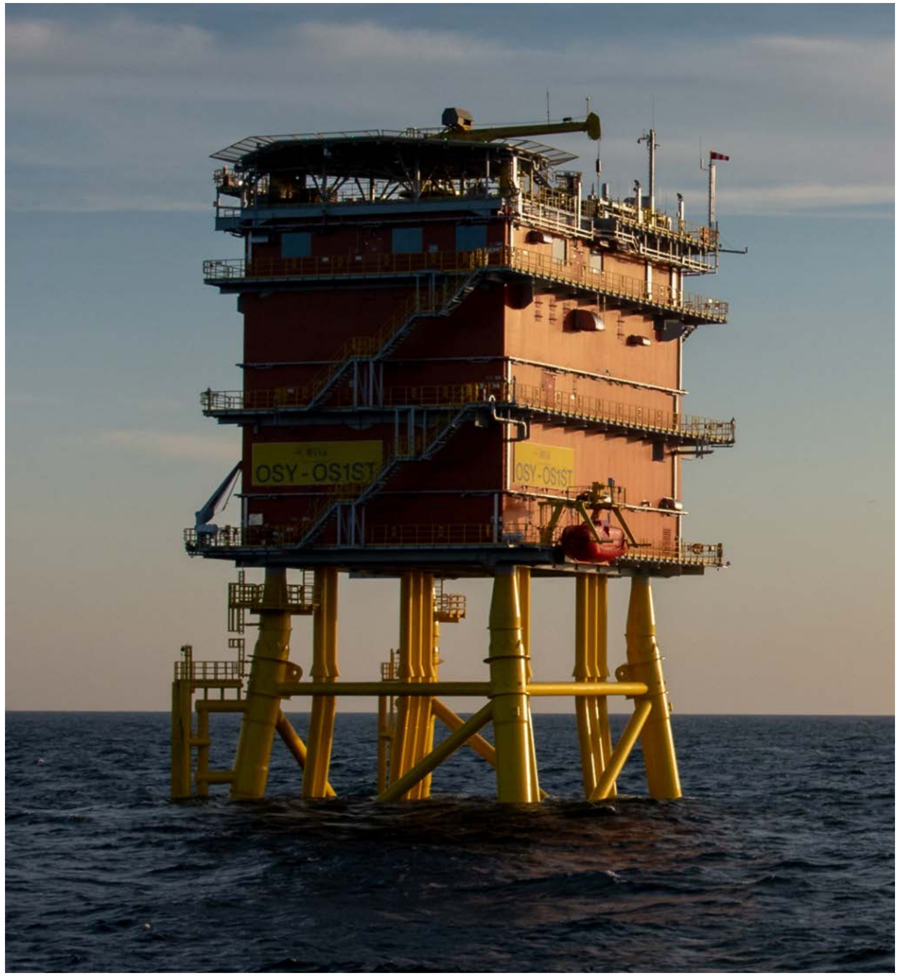
Stage by stage development



Ready for connection to a future international platform



Offshore wind in the Belgian North Sea : First offshore wave



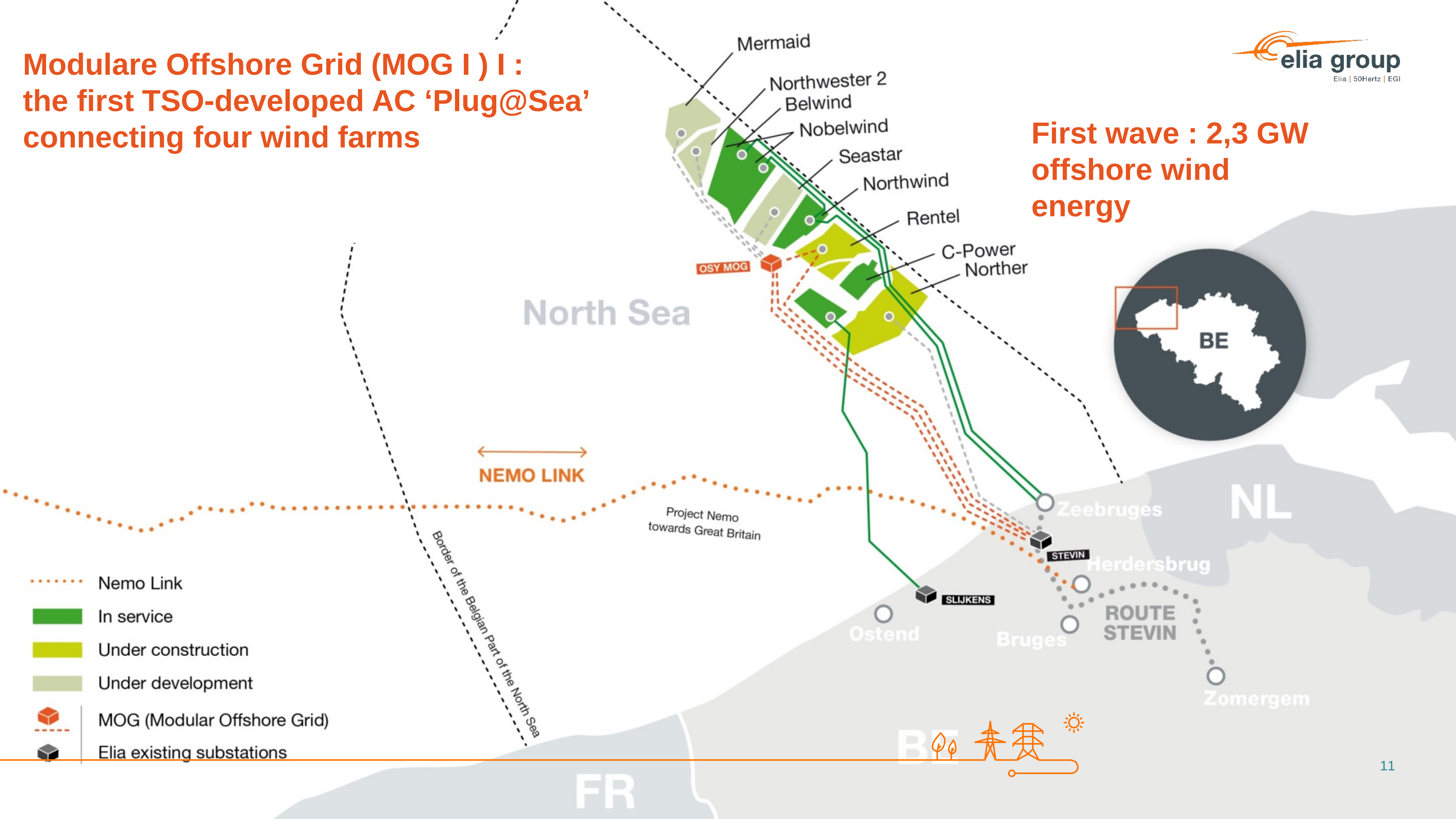
- December 2011 : Elia is appointed as Transmission System Operator in the Belgian Part of the North Sea
- 2012: Development and validation of meshed grid solution
- 2013: Engineering and tendering of Belgian Offshore Grid
- 2014 : A change in legislation : Norther officially applied for a direct connection to Stevin => re-engineering necessary
- 2014 : regulatory framework for the offshore context was still not in place.
- 2015 : starting point of the concept of the Modular Offshore Grid (MOG) as an integral part of Elia's transmission system.
- The initial MOG consists of the OSY platform, three export cables and a short cable to the Rentel offshore substation and was successfully commissioned in September 2019.

Modular Offshore Grid (MOG I) switchyard platform 40 km off the coast successfully commissioned in September 2019.

Modulare Offshore Grid (MOG I) I : the first TSO-developed AC 'Plug@Sea' connecting four wind farms

elia group
Elia | 50Hertz | EGI

First wave : 2,3 GW offshore wind energy



Offshore wind in the Belgian North Sea : Second offshore wave

State of discussions / milestones reached in 2018

Energy Strategy & Marine Spatial Planning

- The ambition to realize 4GW offshore wind by 2030 has been confirmed (Energy Strategy, April 2018)
- A surface of 281km² has been reserved to construct ± 2GW offshore wind (MSP 2020 – 2026, December 2018).
- Elia's interest to **position grid infrastructure** on the map and **secure corridors** for future cable routes (i.e. MOG II and Nautilus).

Tendering (taskforce)

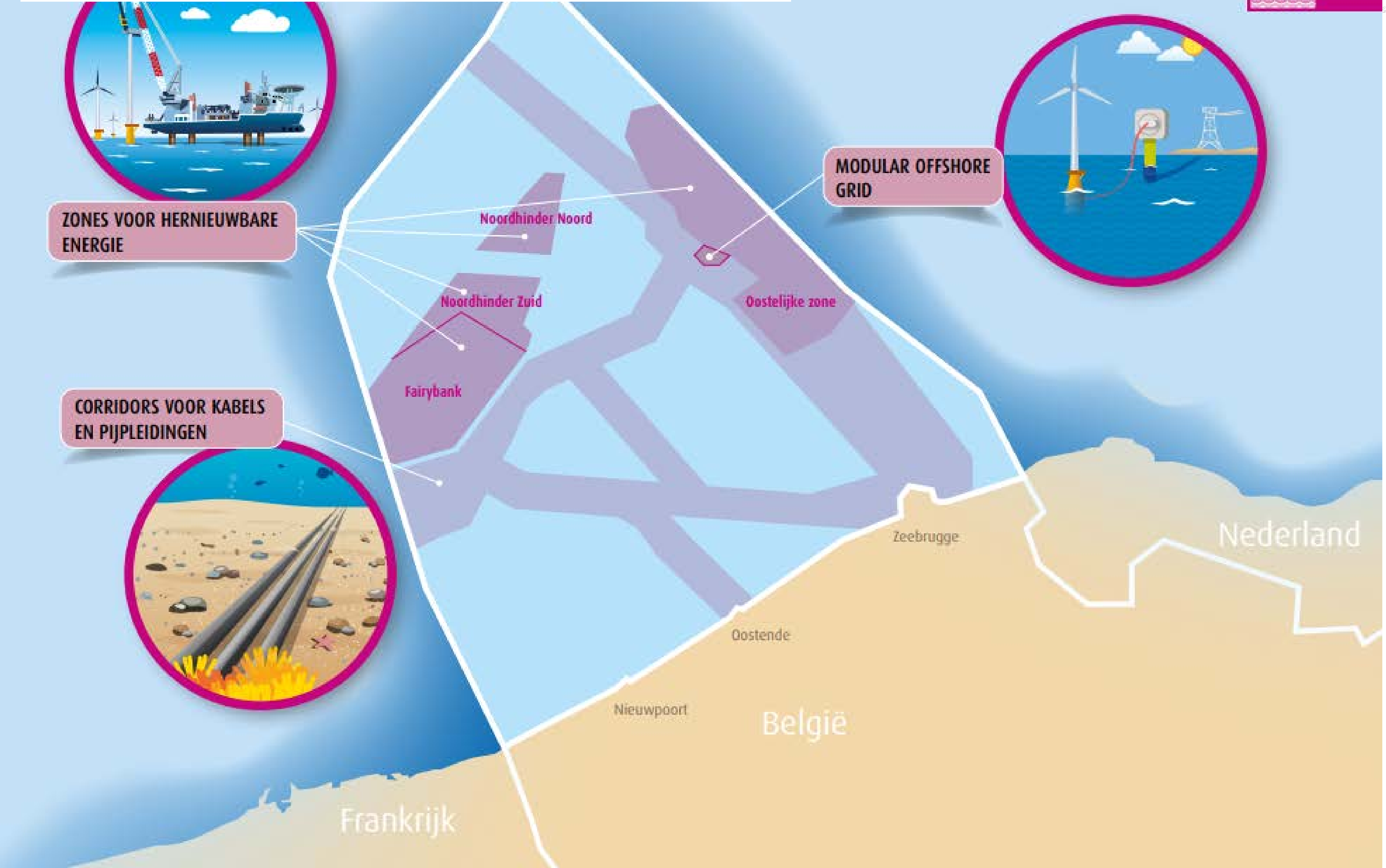
- Ambition of the government to have a concept note on a tendering system (August 2018) and the necessary e-law amendment (December 2018).
- Elia's interest to support the government in achieving this and embed its **mission as offshore grid operator** in upcoming law amendments.

Offshore grid design

- Elia insists on the importance of an optimal design (both for grid and wind farms together) to achieve climate objectives at the lowest cost for society.
- Elia's interest to take the lead on this part **influencing the size and location of concessions, installed power, the timing**,…

Marine Spacial Plan 2014 - 2020

Marine Spacial Plan 2020 - 2026



From interest to law

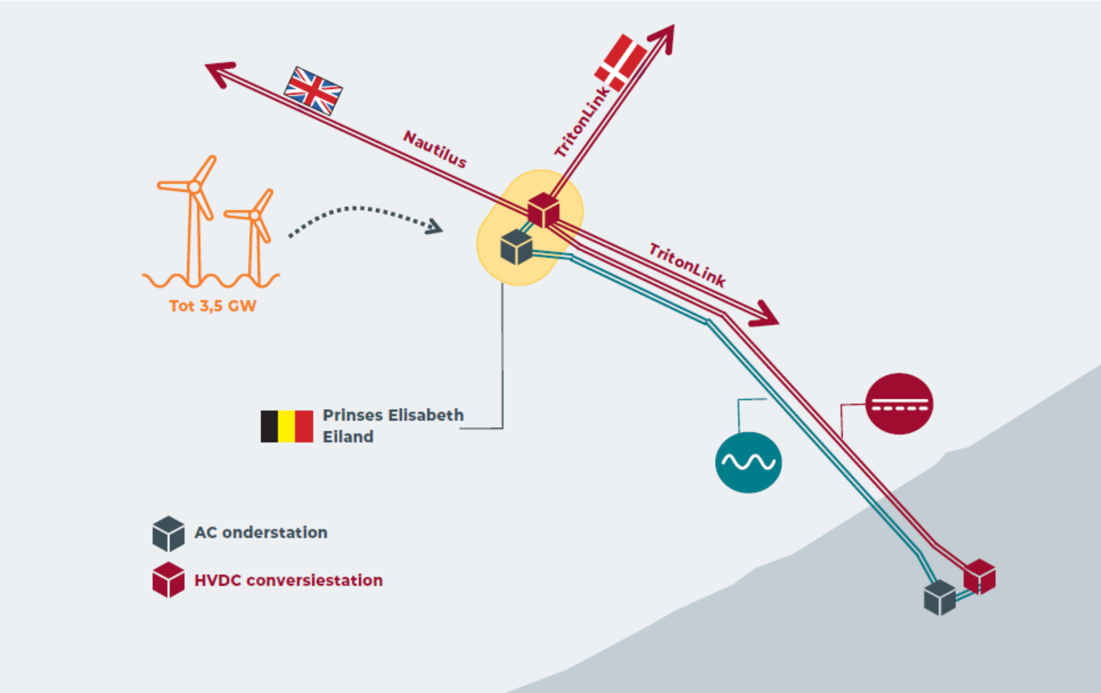
- In 2019, the government saw it fit to expand the role of the transmission system operator to develop all infrastructure related to electricity transmission (i.e. including transformation) for all future expansions of the Modular Offshore Grid. This resulted in an additional modification of the Electricity Act on 12th May 2019, embedding the above principle in the law.
- In particular, article 6/5 §1 explicitly states that future offshore generation is mandatorily connected to the MOG and that Elia defines the connection point and technical connection requirements.
- Additionally, Elia must (according to article 6/3 §4) perform all necessary studies for the extension of the MOG, whilst the competent ministers are charged with the studies concerning the generation installations (art. 6/3 §5).
- Article 6/4 §2 then stipulates that Elia must propose a design for the extension of the Modular Offshore Grid (the “Grid Design”) for advice by the CREG and for approval by the Minister of Energy and the Minister of the North Sea

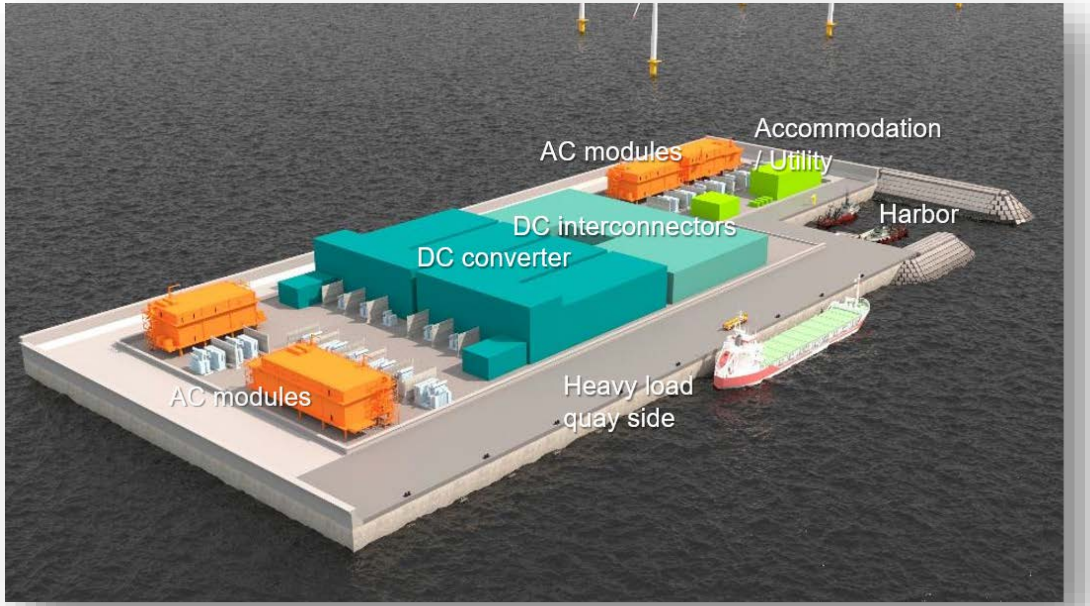
Offshore wind in the Belgian North Sea : Second offshore wave

- Studies showed that the new zone for offshore renewables can generate 3,5GW.
- 3,5GW on an island is more efficient and future proof than platforms.
- Elia proposed a concept for an offshore energy hub on an artificial island that would not only provide the connection point for up to 3.5 GW of offshore renewable generation, but also serve as a connection point for interconnectors.
- The impact of this artificial island on the marine environment should be as low as possible, with a footprint on the seabed of maximum 25ha.
- In order to do so, the surface of the island should be used for electricity transmission purposes only, except for small-scale activities supporting the energy transition or offshore sector, such as R&D activities. Activities for the protection of the Belgian territory (by the Belgian Navy) are also to be investigated.
- Elia's proposition was approved by the Federal Council of Ministers end of 2021.

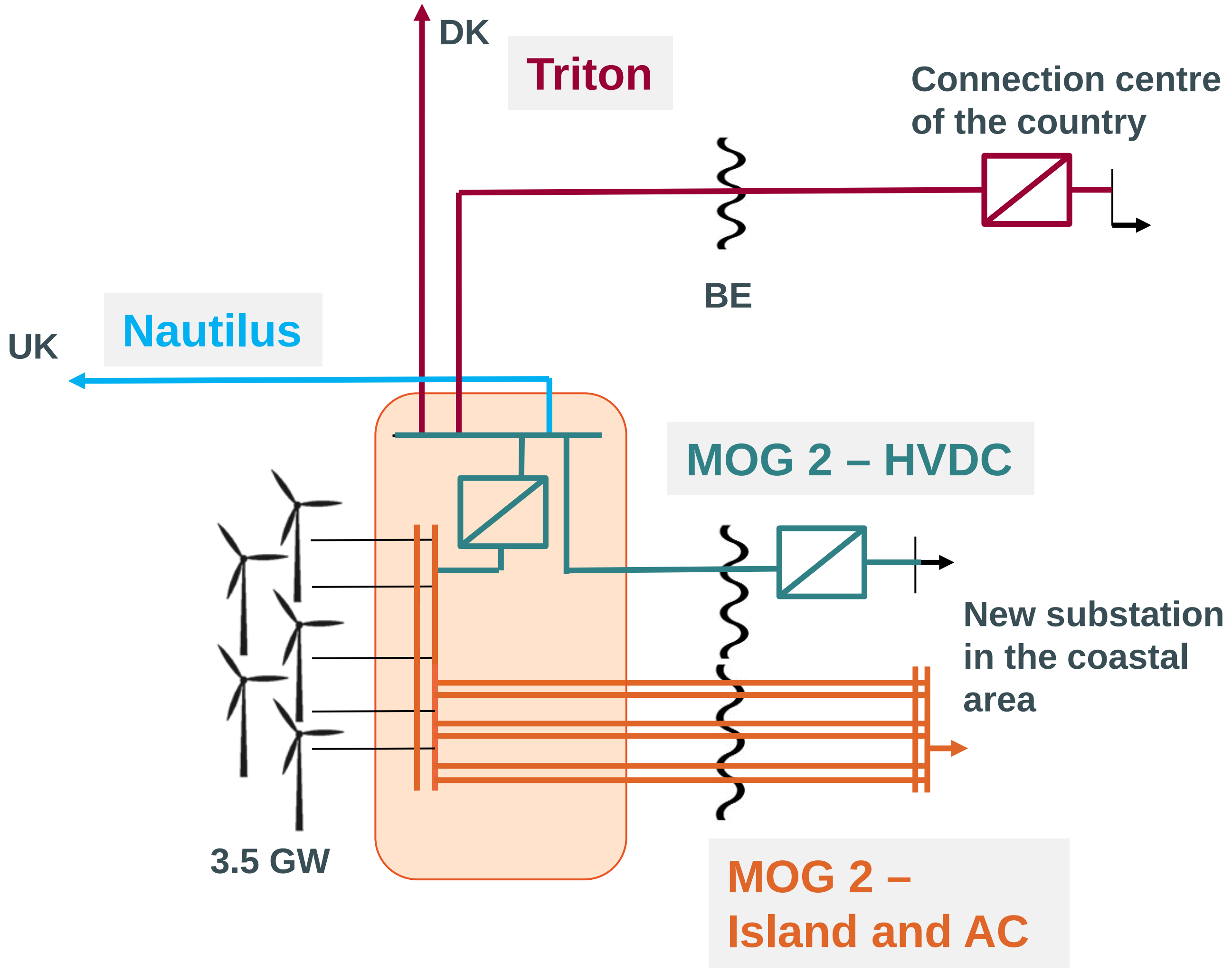
Result

The Princess Elisabeth Island will house the transmission infrastructure to connect up to 3.5GW of offshore wind from the Princess Elisabeth wind zone and to provide a connection point for interconnectors (such as Nautilus and Triton Link). Therefore, a mix of AC (alternating current) and HVDC (high voltage direct current) is envisaged to achieve these goals.





Overview of the offshore/HVDC projects under development by Elia



MOG 2 – Island and AC

- Artificial island & general infrastructure
- 66 kV & 220 kV substations on the island
- 6 x 220 kV export cables

MOG 2 – HVDC

- 525 kV bipole connection between artificial island and the Belgian coast
- DC busbar for future interconnections
- Multi-vendor ready

Nautilus

- Jointly developed with NGV
- Single vendor solution combined with MOG2
- Potentially connection of UK offshore wind

Triton

- Jointly developed with Energinet
- Potentially multi-vendor extension

Facts and figures

281 km^2 of new wind zone

45 km offshore

5 ha useful area

< 25 ha impact on seabed

330 km of offshore AC cable

60 km of offshore HVDC cable

60 km of onshore AC cable

10 km of onshore HVDC cable

Start of works 2024

End of works 2026

Commissioning of wind farms

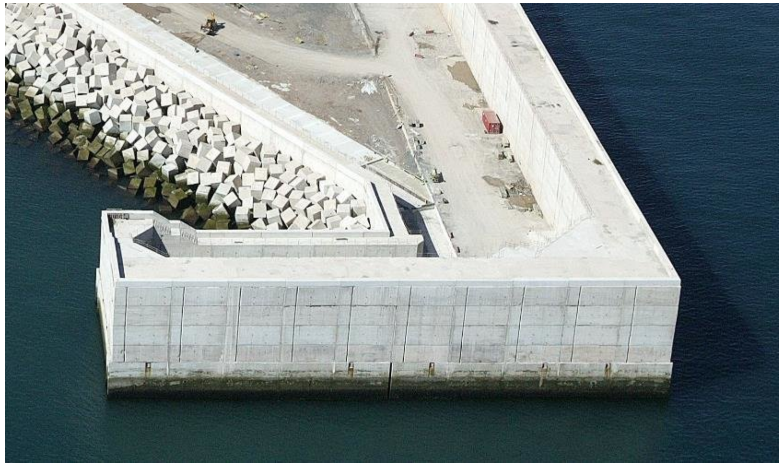
2028-2030

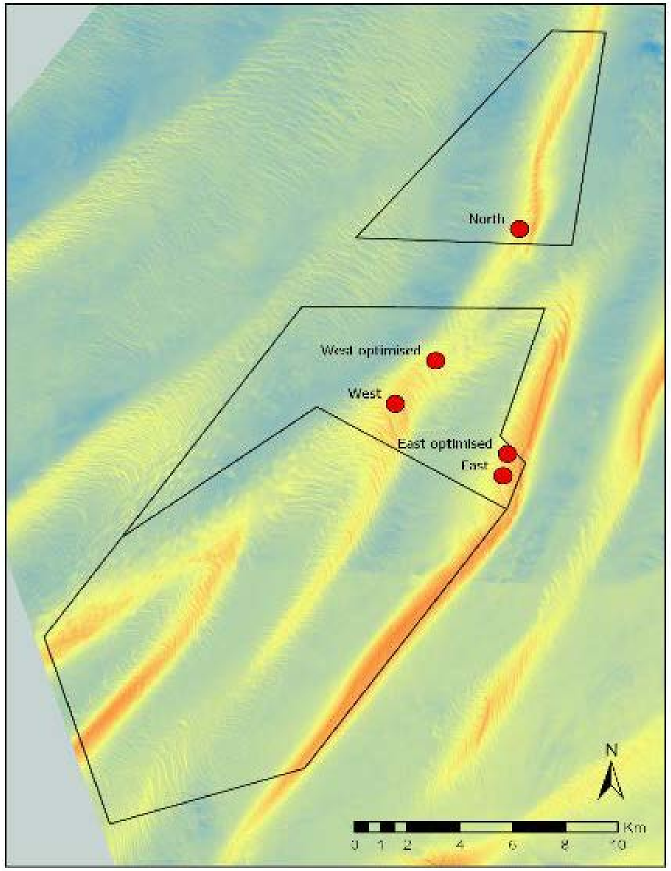
Co-funded by the EU

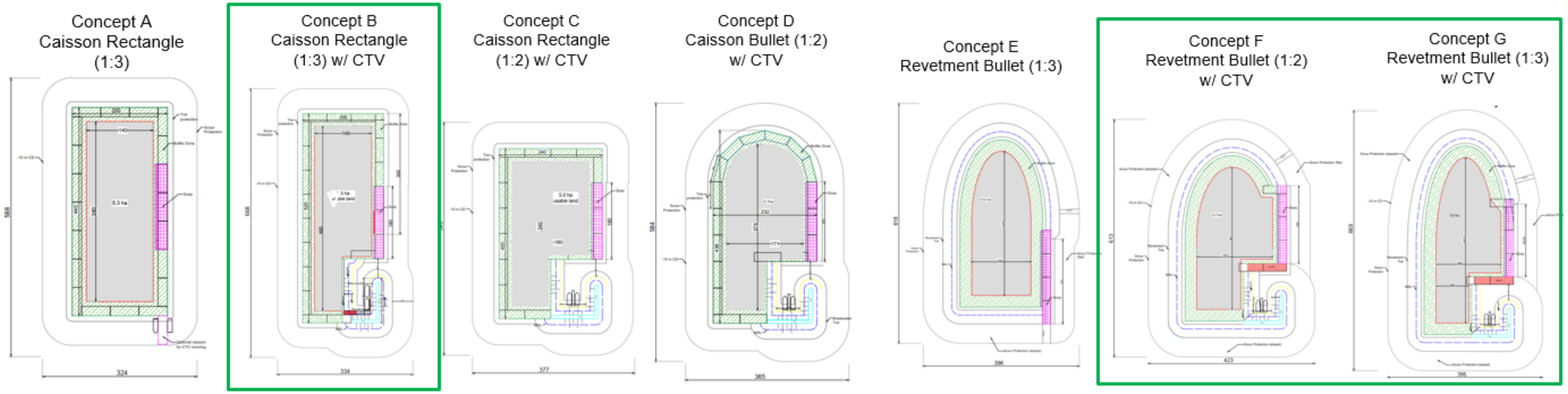
Island conceptual questions

Main attention points and decisions

- Location
- Shape
- Limiting environmental impact
- Access and Egress
- Type of breakwater

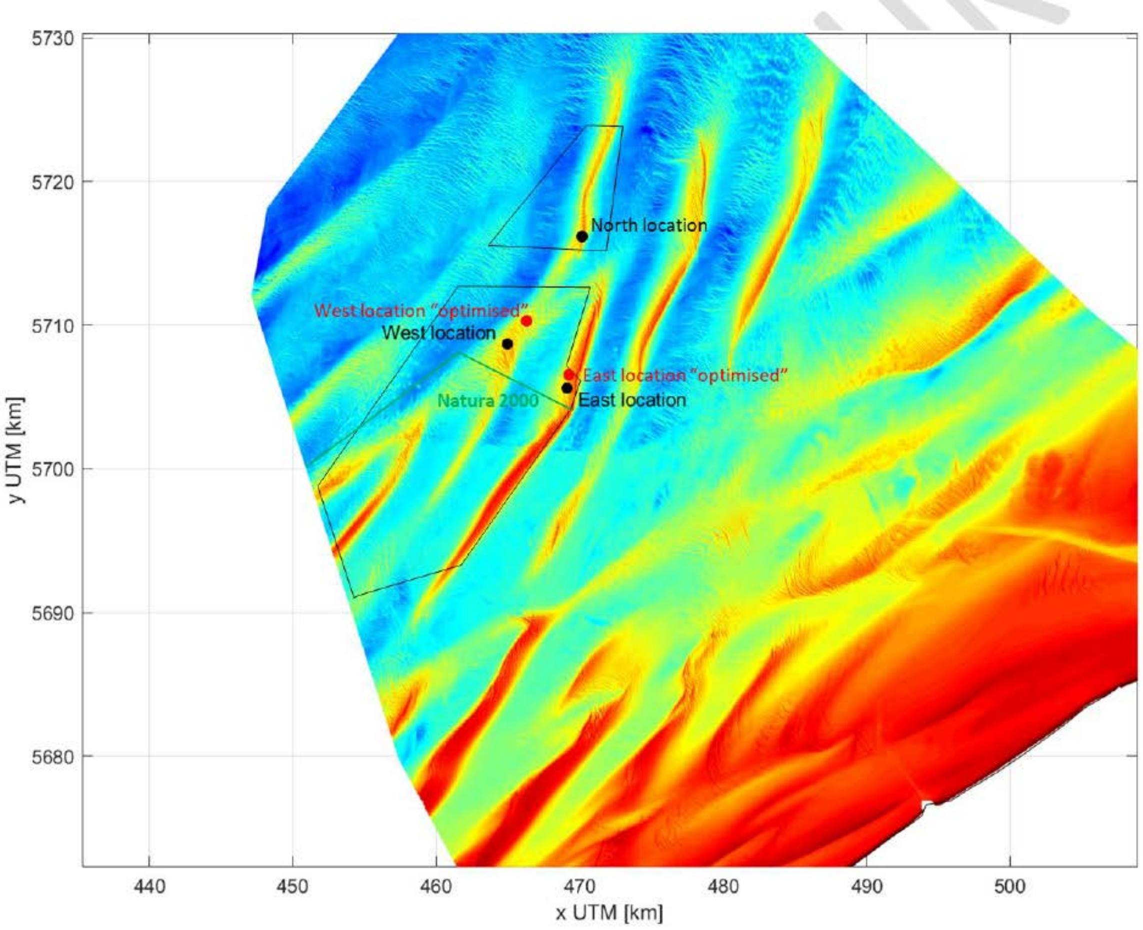




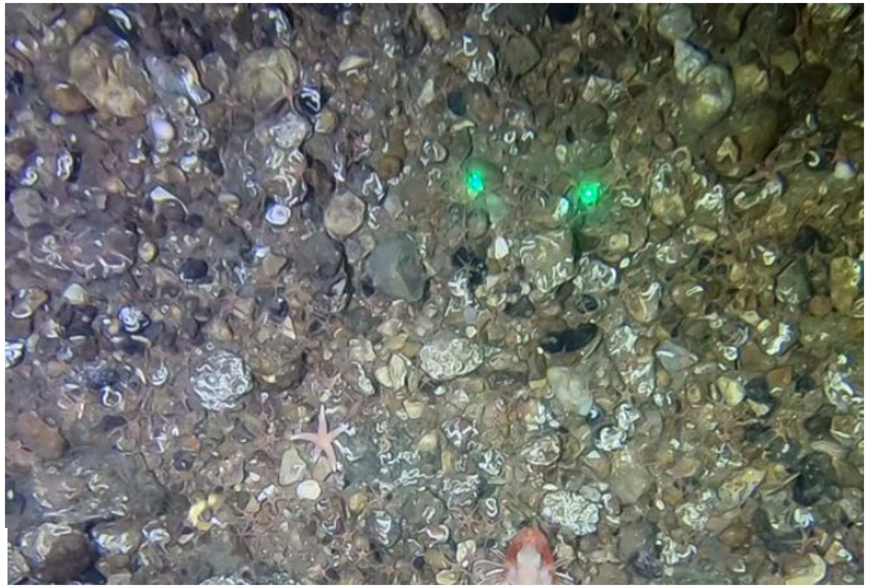


Island location

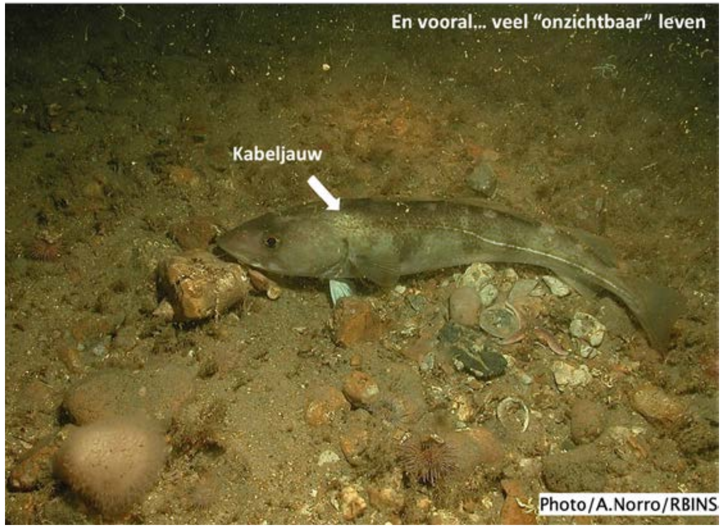
1. Limite impact on neighboring gravel beds
2. Volume of sand needed for the island
3. Cable lenghts (inter-array and export)
4. Impact on shipping traffic
5. Operational impact (cable corssings, interfaces between TSO and producer, acces possibilities, ….)
6. Impact on powerdensity of the Prinses Elisabeth zone (fex. Limitations due to helicopter flight paths).
7. Impact op de costs



Gravelbeds



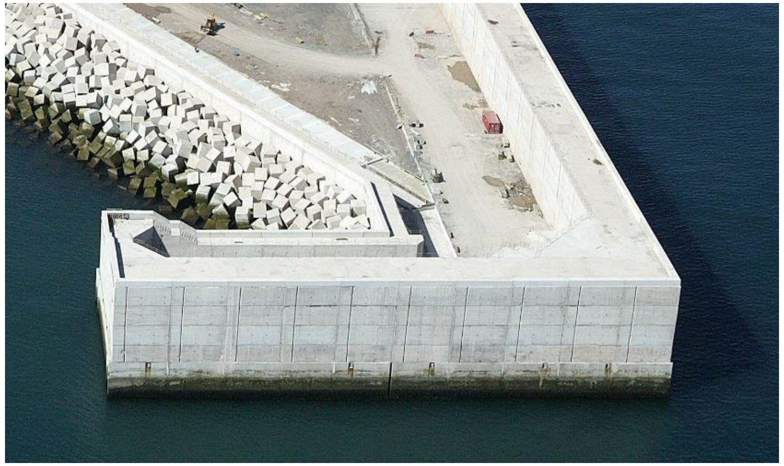
Example of a relatively dense gravel bed displaying stones colonised by tubeworms and mature colonies of the soft coral dead man's fingers (Alcyonium digitatum). Image acquired using an underwater video frame. (Image: RBINS)

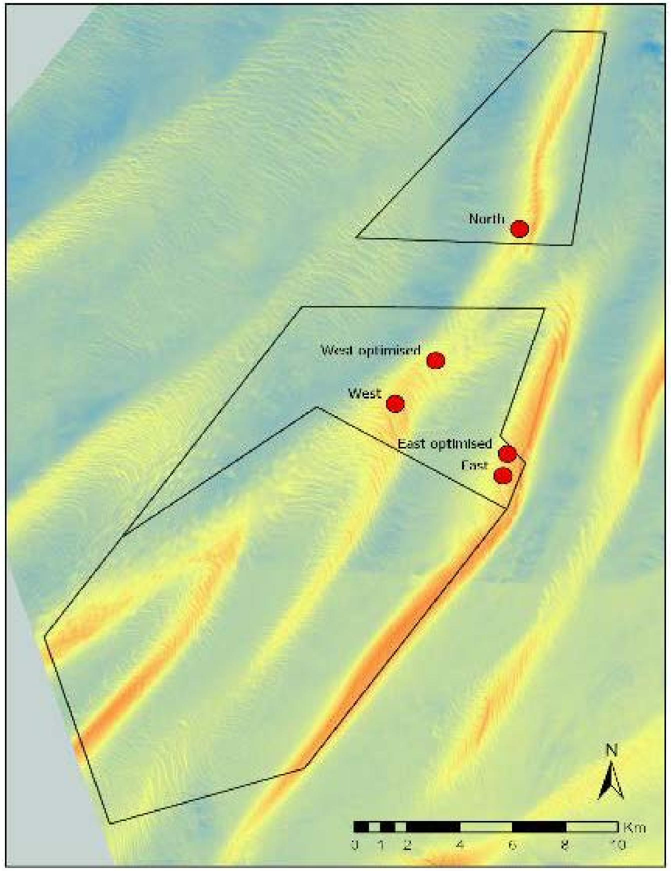


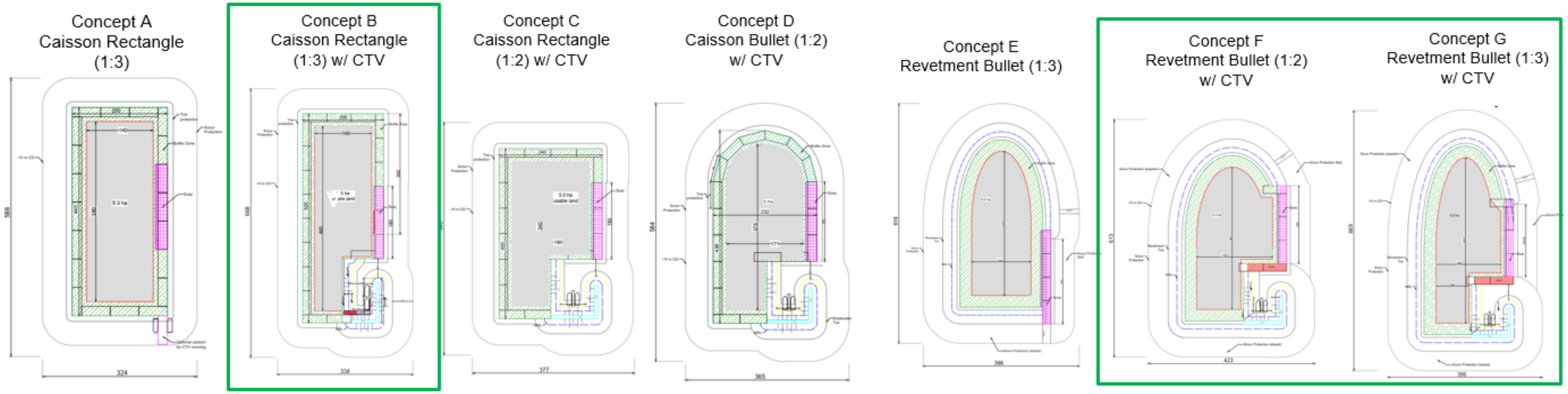
Island conceptual questions

Main attention points and decisions

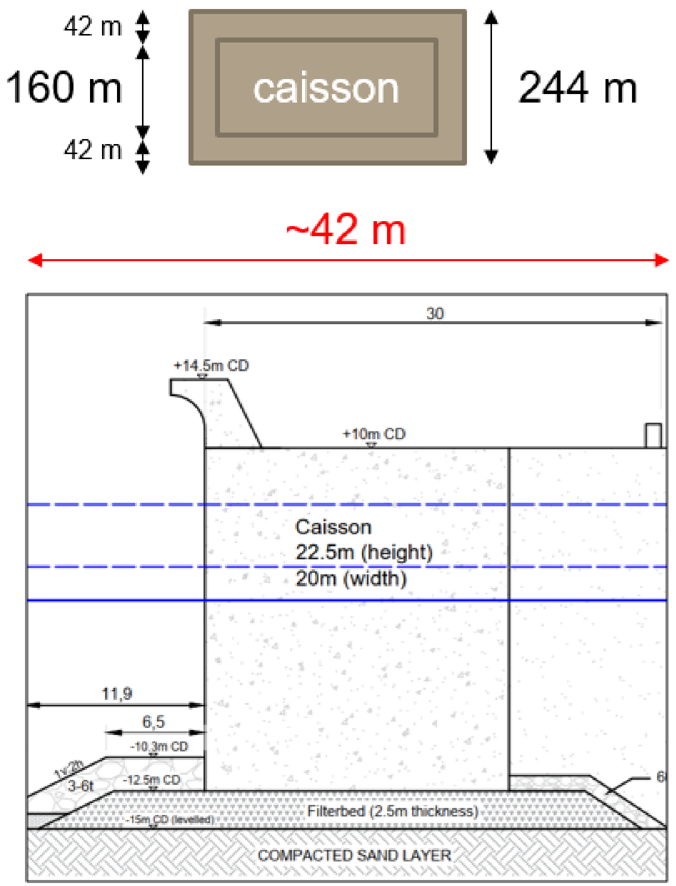
- Location
- Shape
- Limiting environmental impact
- Access and Egress
- Type of breakwater

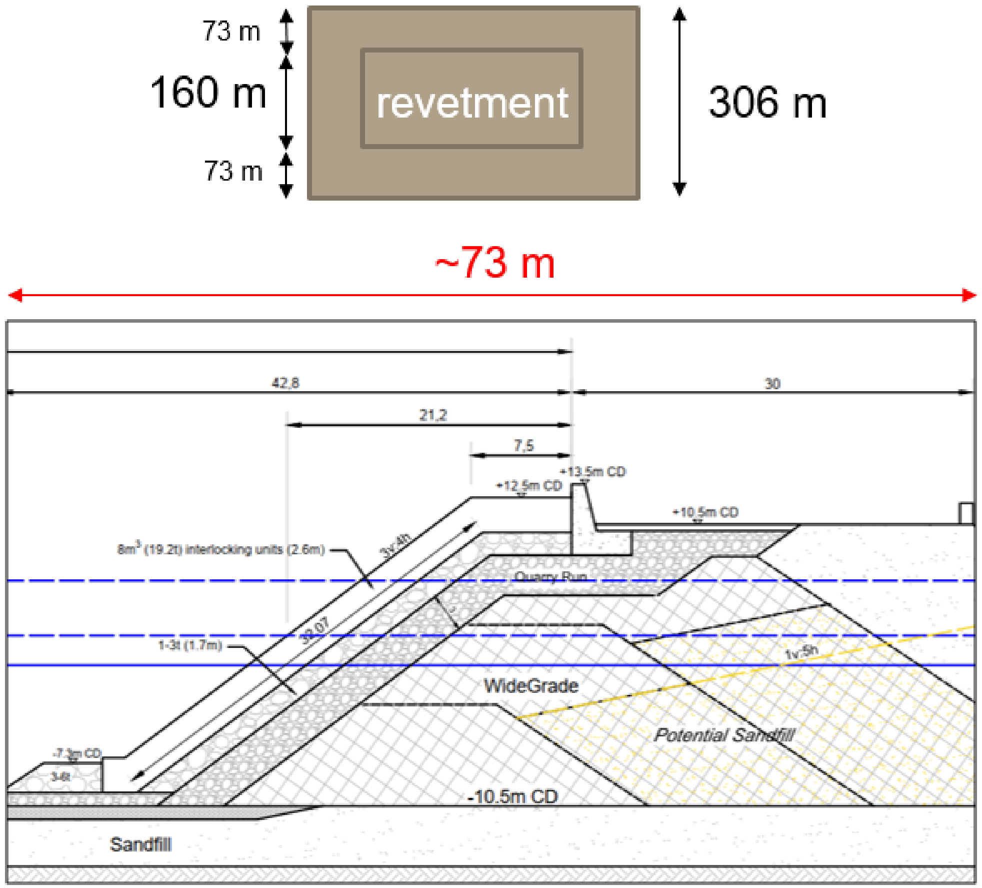






Island shape study: caisson vs revetment

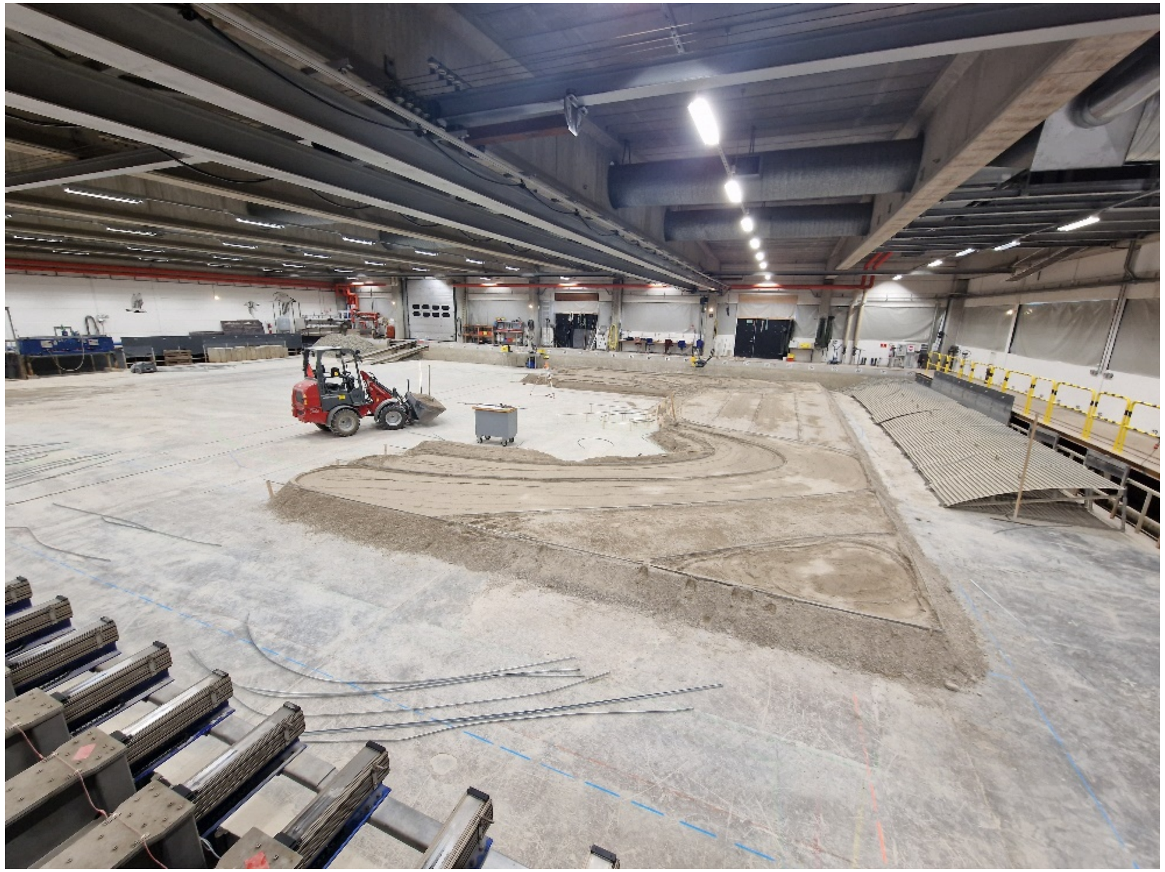




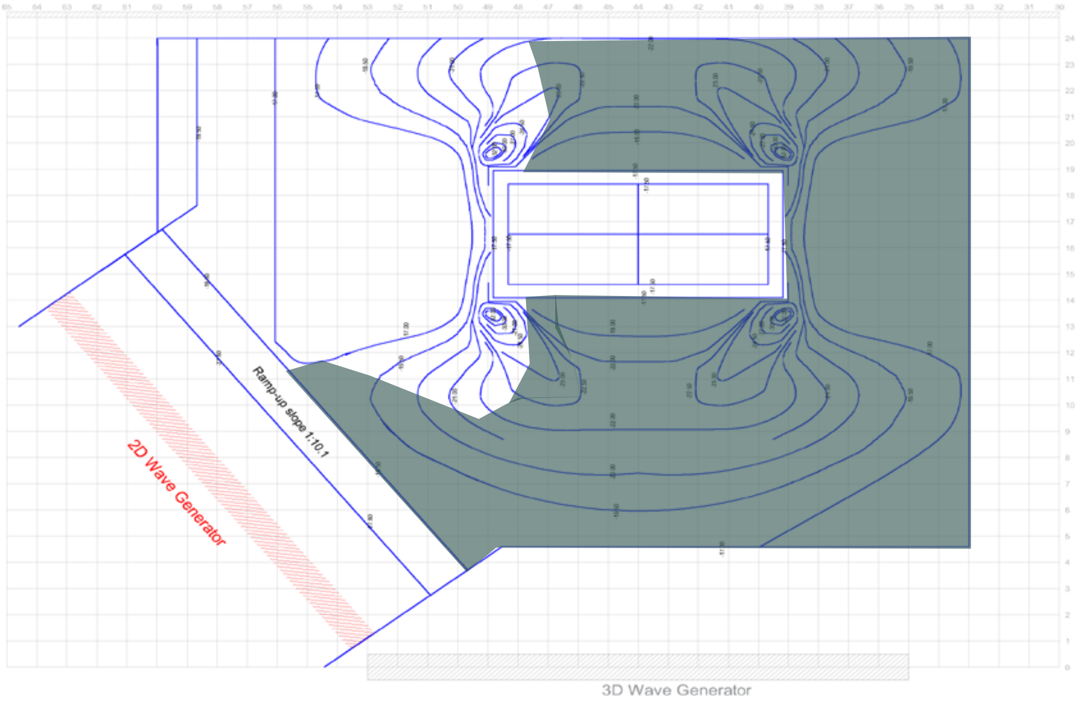
Island physical tests

- Island concepts tested in a 2D lab
- Concept can be adapted in line with lab results

Construction of bathymetry



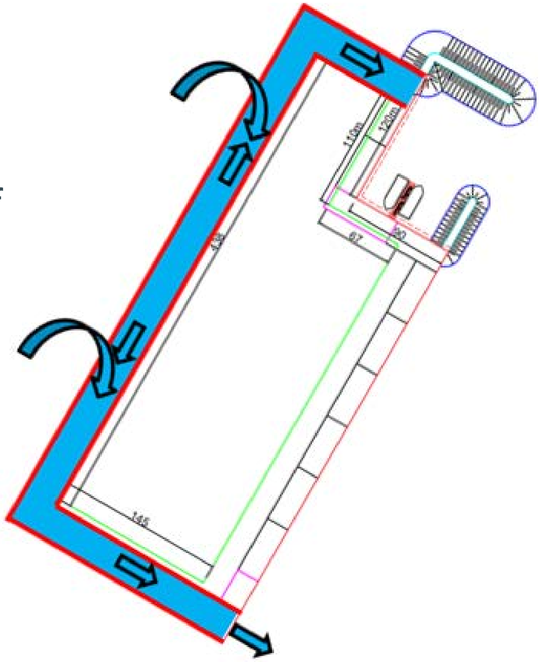
Status on bathymetry

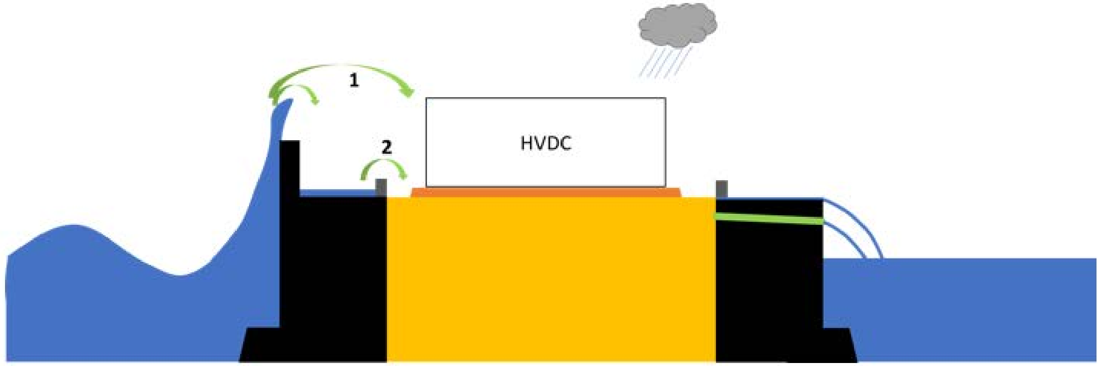


Compacted Gravel

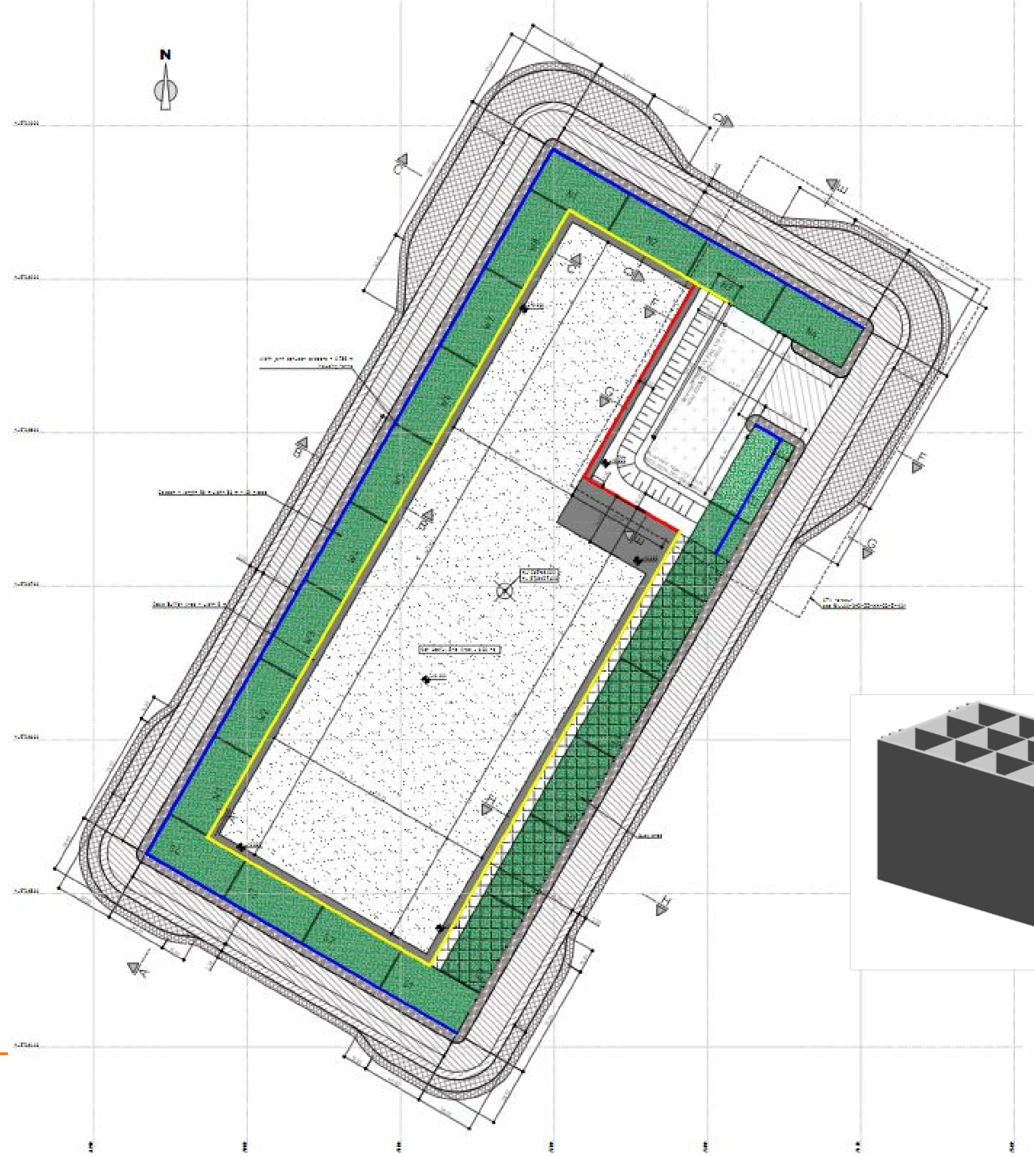
Island Layout – Quay area

- 3 sides 'exposed' (N, S, W) with high primary Wave Wall to limit overtopping;
- Buffer zone behind Wave Walls to catch and drain overtopping water towards the Eastern (sheltered) side of the Island. This buffer zone can be used for logistics as well.
- Secondary wave wall of ~2m to prevent / minimize flooding of the 'net useful area' where the Grid Infrastructure is located.
- Sheltered Eastern side does not require an outer wave wall. Due to its sheltered location the Quay and entrance to the CTV harbour are located here
- Allowable impact for various safety levels:
  - During low RP's (1~10yr RP) overtopping should not affect island operations
  - During ~100yr RP the 'useful area' shall preferably not flood, or only marginally,
  - During a 1,000yr RP event the flooding of the useful area shall be 'acceptable' (<1m directly behind wall and 0.2m average in island)

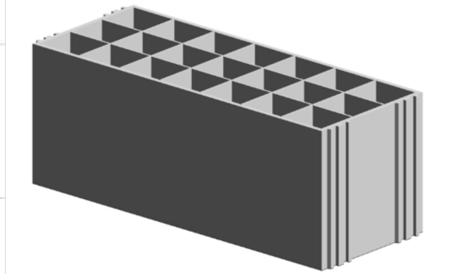




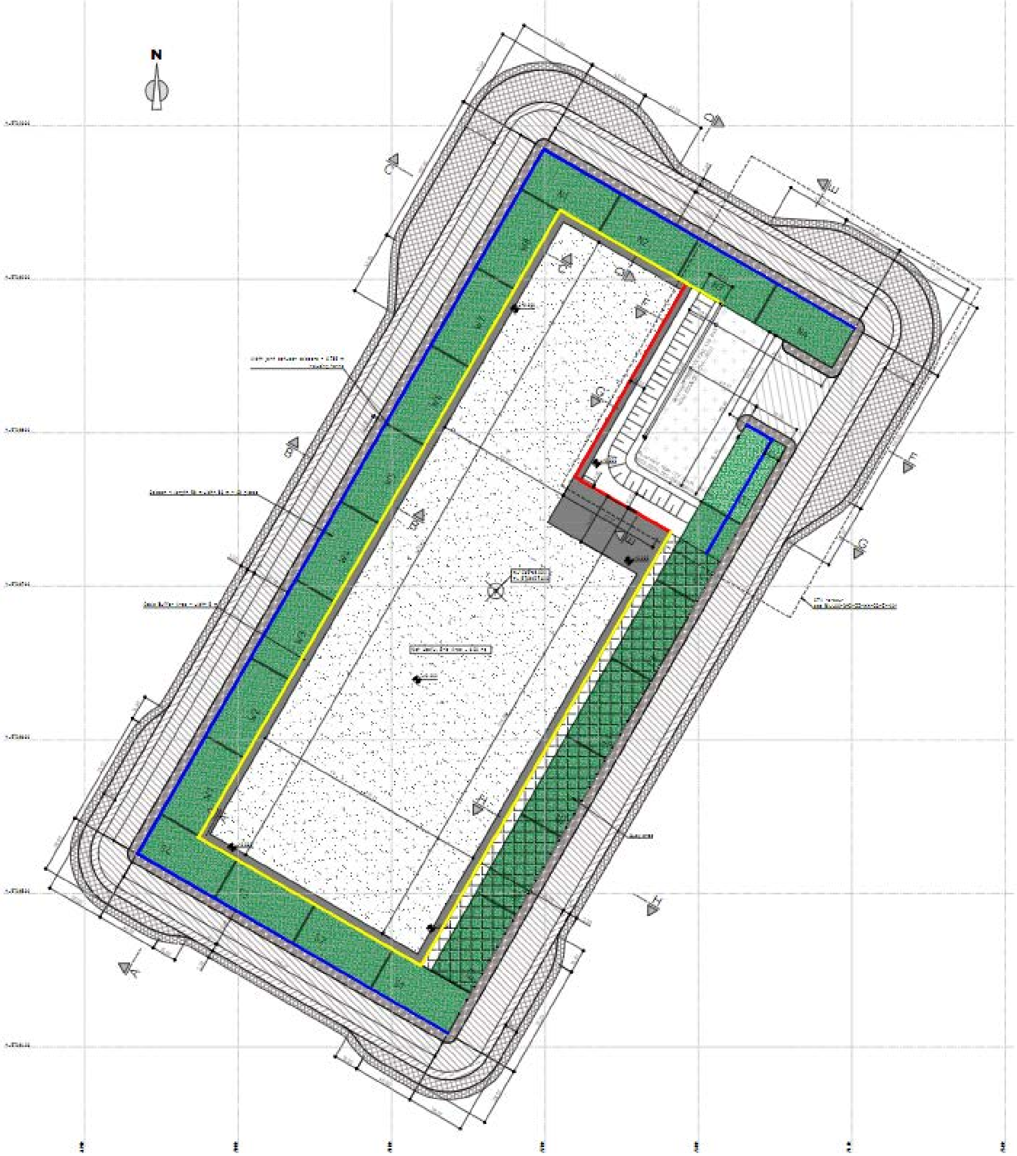
General layout



- Dimensions at water level
  - Width ~230 m
  - Length ~520 m
- Dimensions including rock protection
  - Width ~350 m
  - Length ~620 m
- Net Useful Grid Area
  - 6.00 ha
- Highest point island perimeter
  - +18,5 m above low water level
- 23 caissons
  - Length 58 m
  - Width 28 m
  - Height including sea wall 32 m
  - Height excluding sea wall 22 m



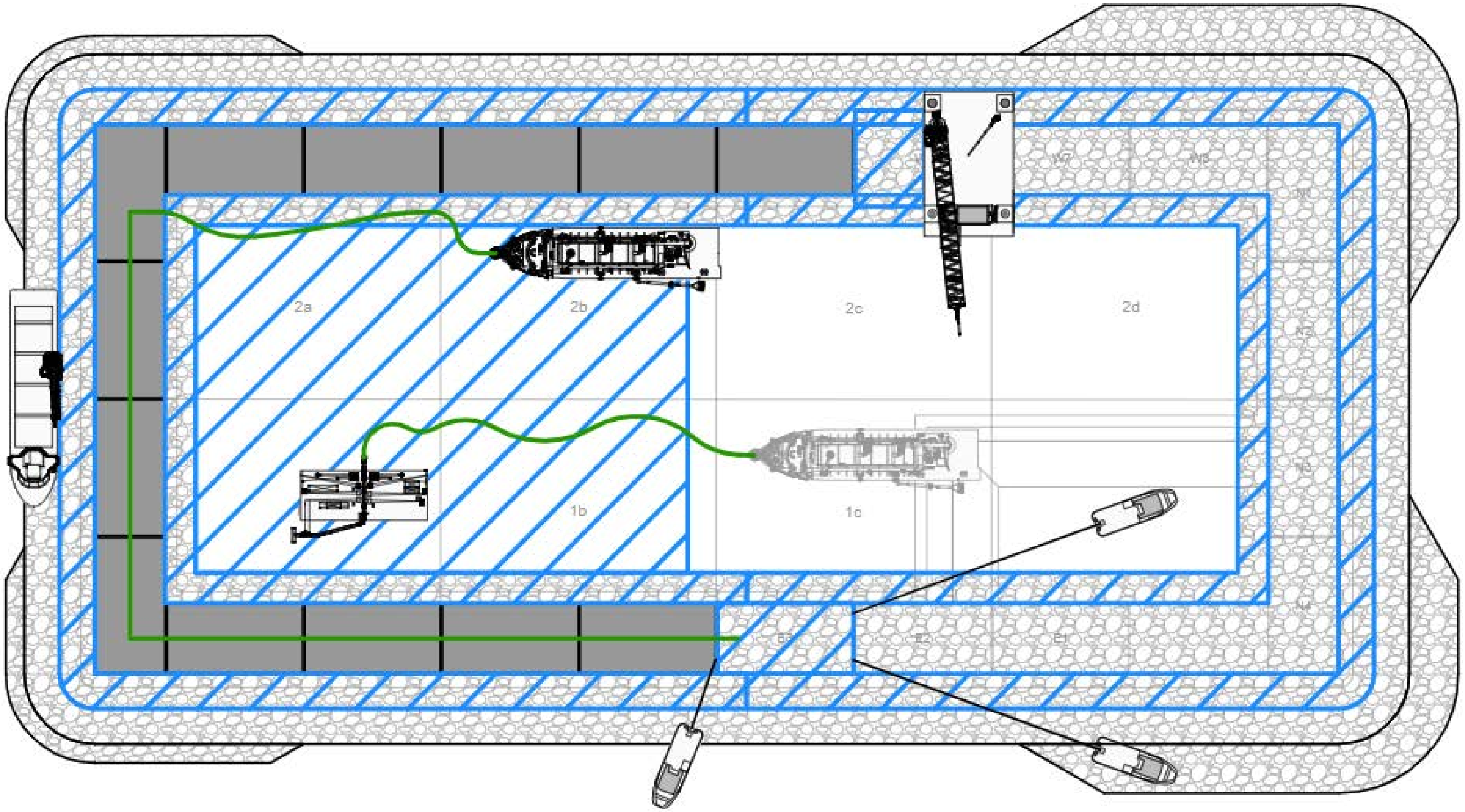
Key quantities



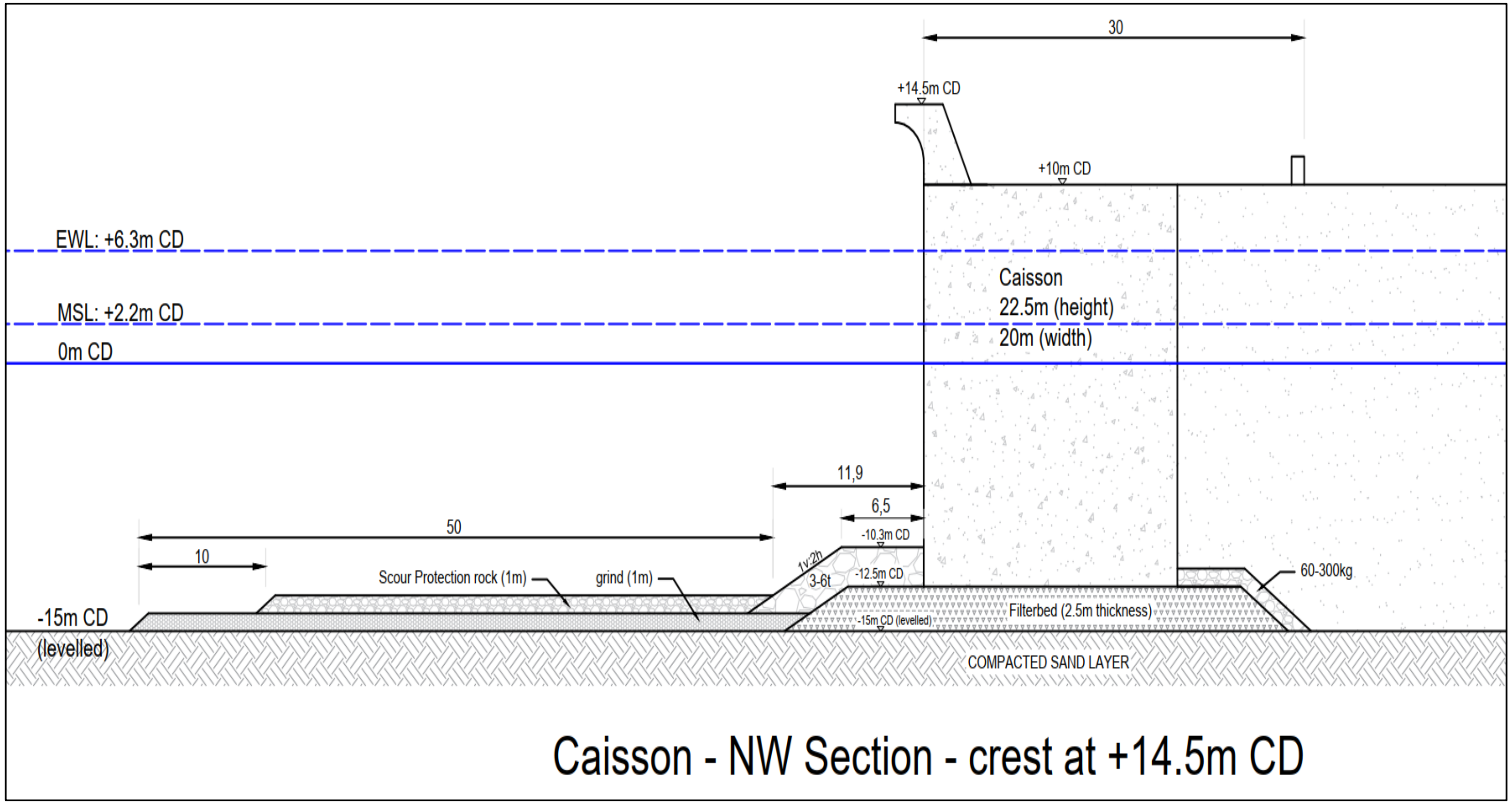
- Sand
  - 2,200,000 m³ for island fill
  - 580,000 m³ for caisson fill
- Concrete
  - 200,000 m³ for caissons and wave walls
- Steel
  - 38,000 t for reinforcement steel caissons and wave walls
- Rocks
  - 940,000 t for supporting and protecting caissons

Construction

- Up to 850 persons working for Contractor at peak
- Up to 15 vessels at site at peak (construction, support, accommodation, crew transfer, …)



Construction



A close collaboration between

- The Royal Belgian Institute of Natural Sciences (RBINS)
- The Federal Public Service Marine Environment
- The Flanders Marine Institute (VLIZ)
- The Flanders Research Institute for Agriculture, Fisheries and Food (ILVO)
- The Research Institute for Nature and Forest (INBO)

- 2 NGO's : WWF and Natuurpunt (representing 4Sea)
- 2 Universities: Gent and Antwerp

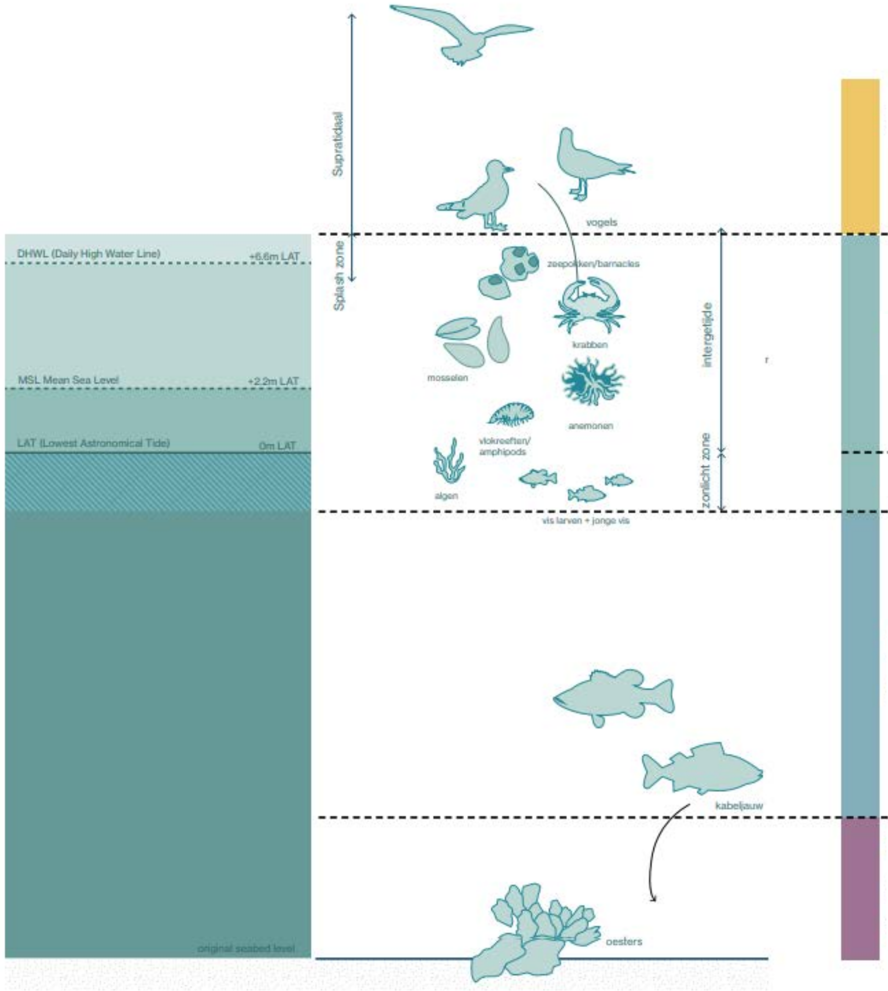
- De Blauwe Cluster
- International Marine and Dredging Consultants (IMDC)

Marijn Rabaut

All NID visuals are the work of ORG

6 workshops held in the period March - October 2022

NID Zones



Supratidal zone

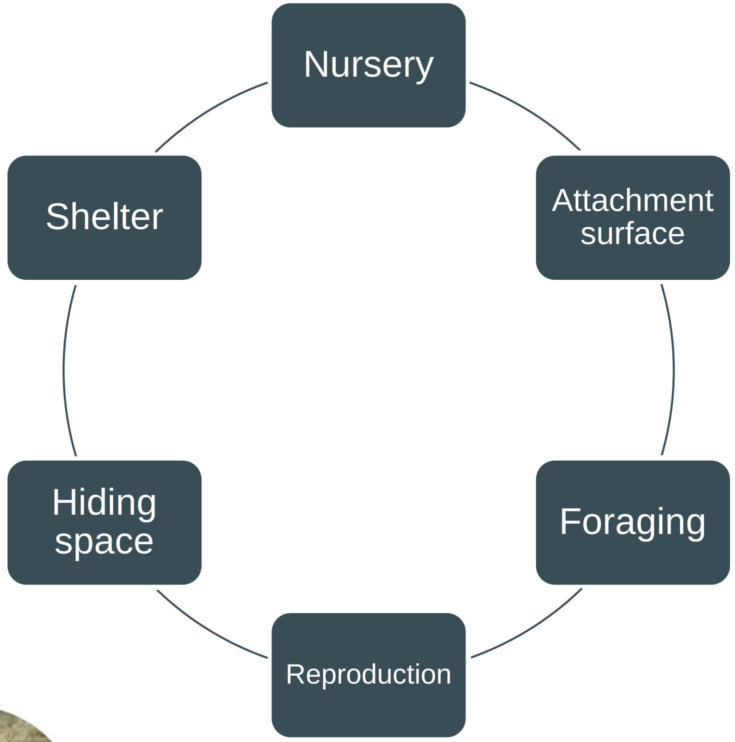
Intertidal zone

Shallow subtidal zone

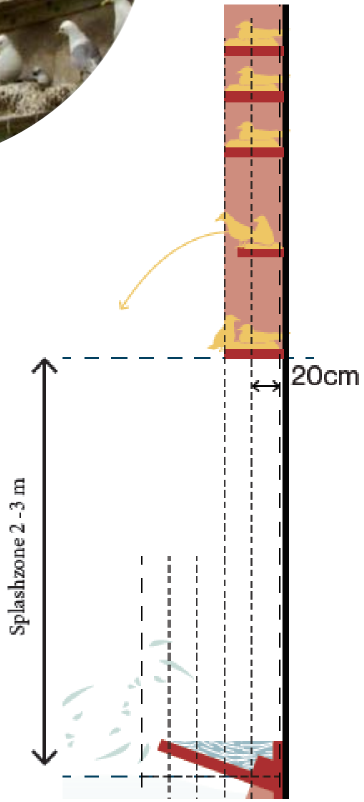
Deep subtidal zone with pelagic species

Seabed with demersal species

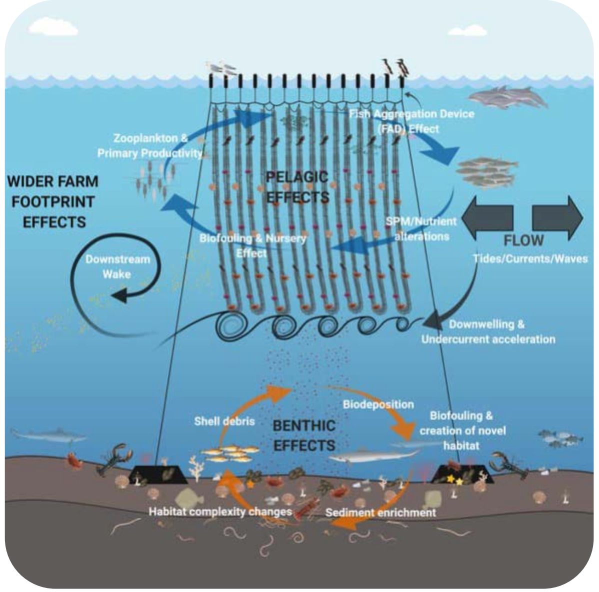
NID Functionalities



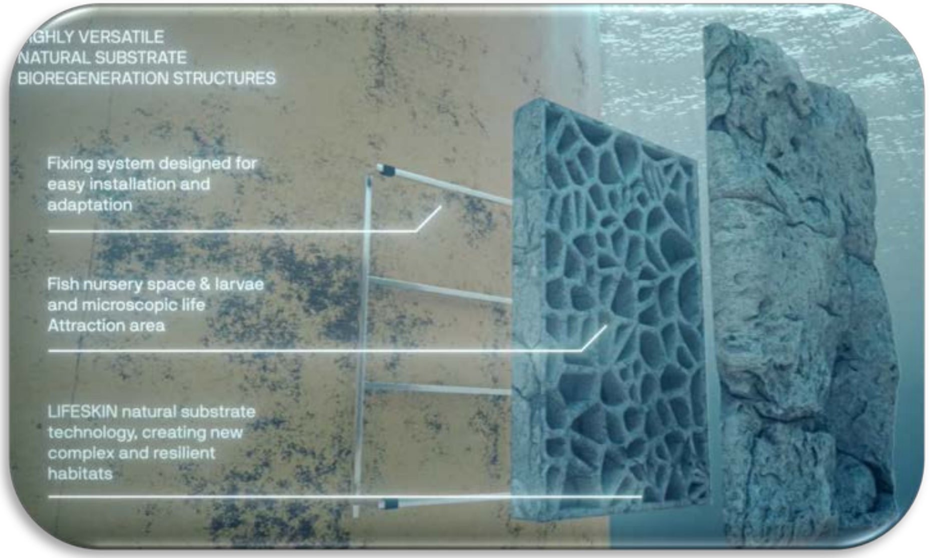
Execute wavewall as a cliff for kittiwake



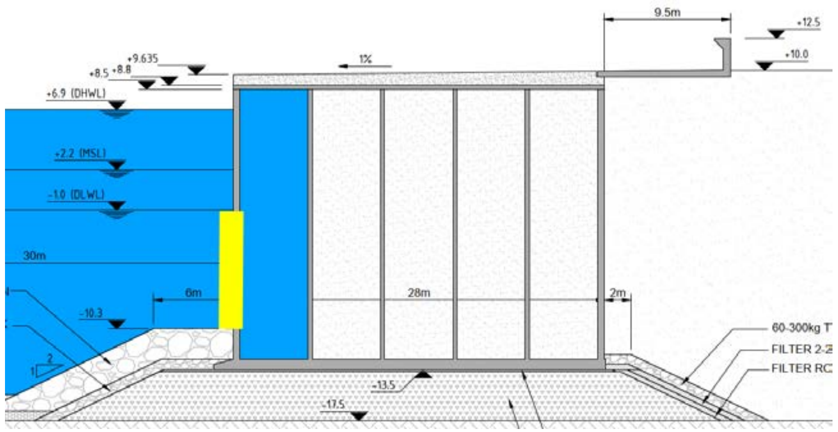
Long lines in intertidal and subtidal zone



Rough pane in subtidal zone



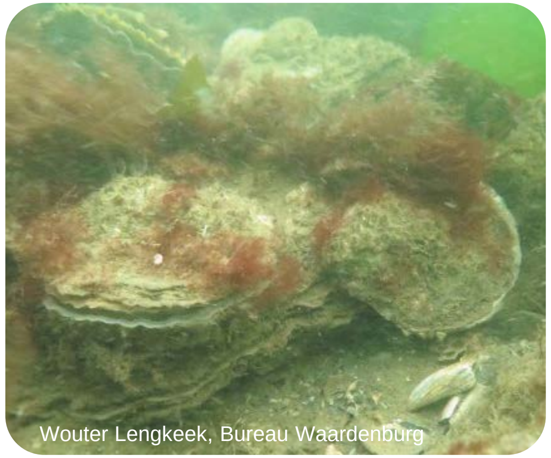
Ocean Ecostructures

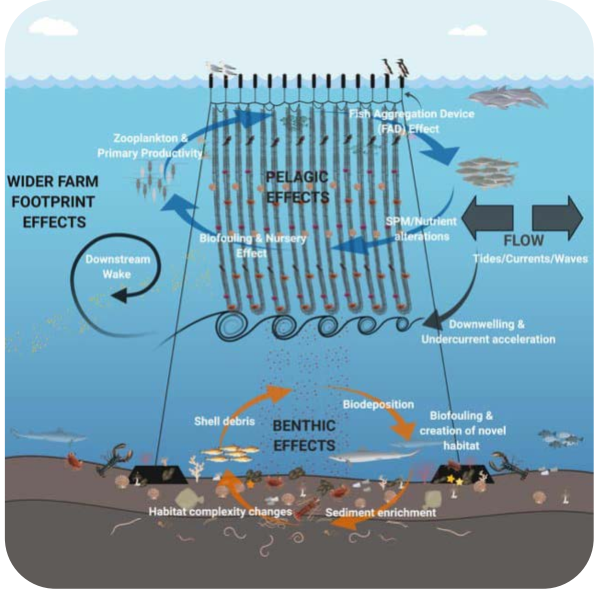


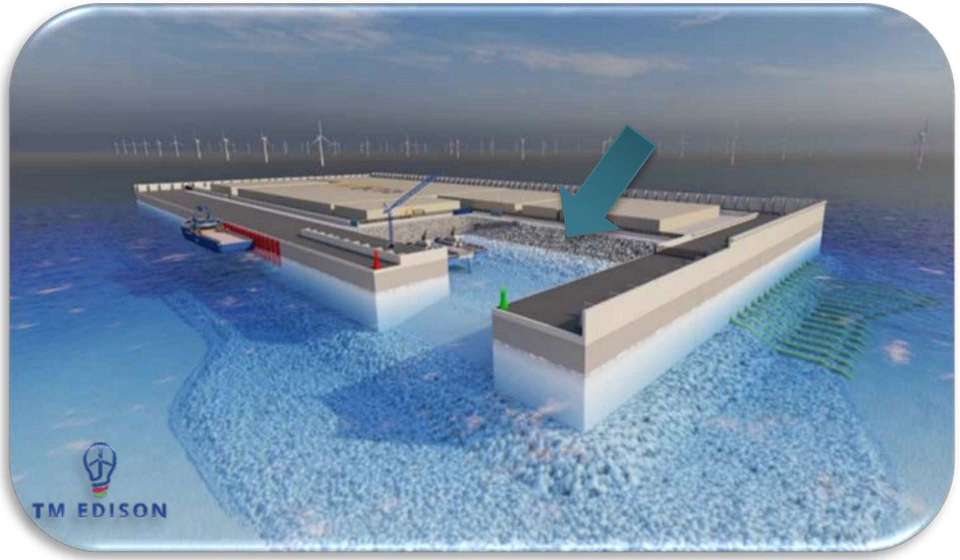
Structures / stones with European oysters

Chaotic stone carpet

Tidal pool in CTV rock revetment







Structures in the erosion protection

thefishsite.c

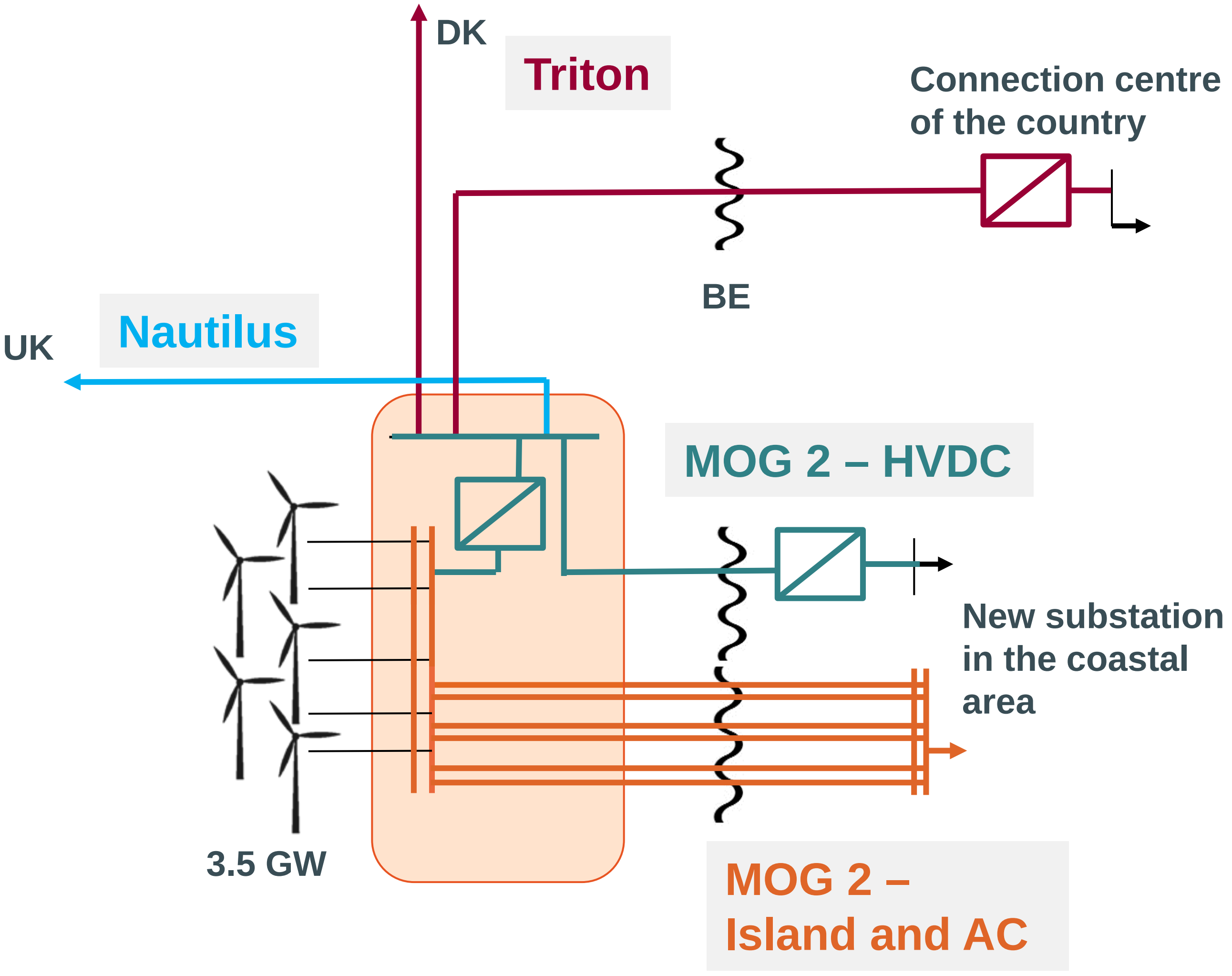
Boulders


Cor Kuyvenhoven - www.animalstoday.nl

Special cable protection

ECONCRETE

Overview of the offshore/HVDC projects under development by Elia



MOG 2 – Island and AC

- Artificial island & general infrastructure
- 66 kV & 220 kV substations on the island
- 6 x 220 kV export cables

MOG 2 – HVDC

- 525 kV bipole connection between artificial island and the Belgian coast
- DC busbar for future interconnections
- Multi-vendor ready

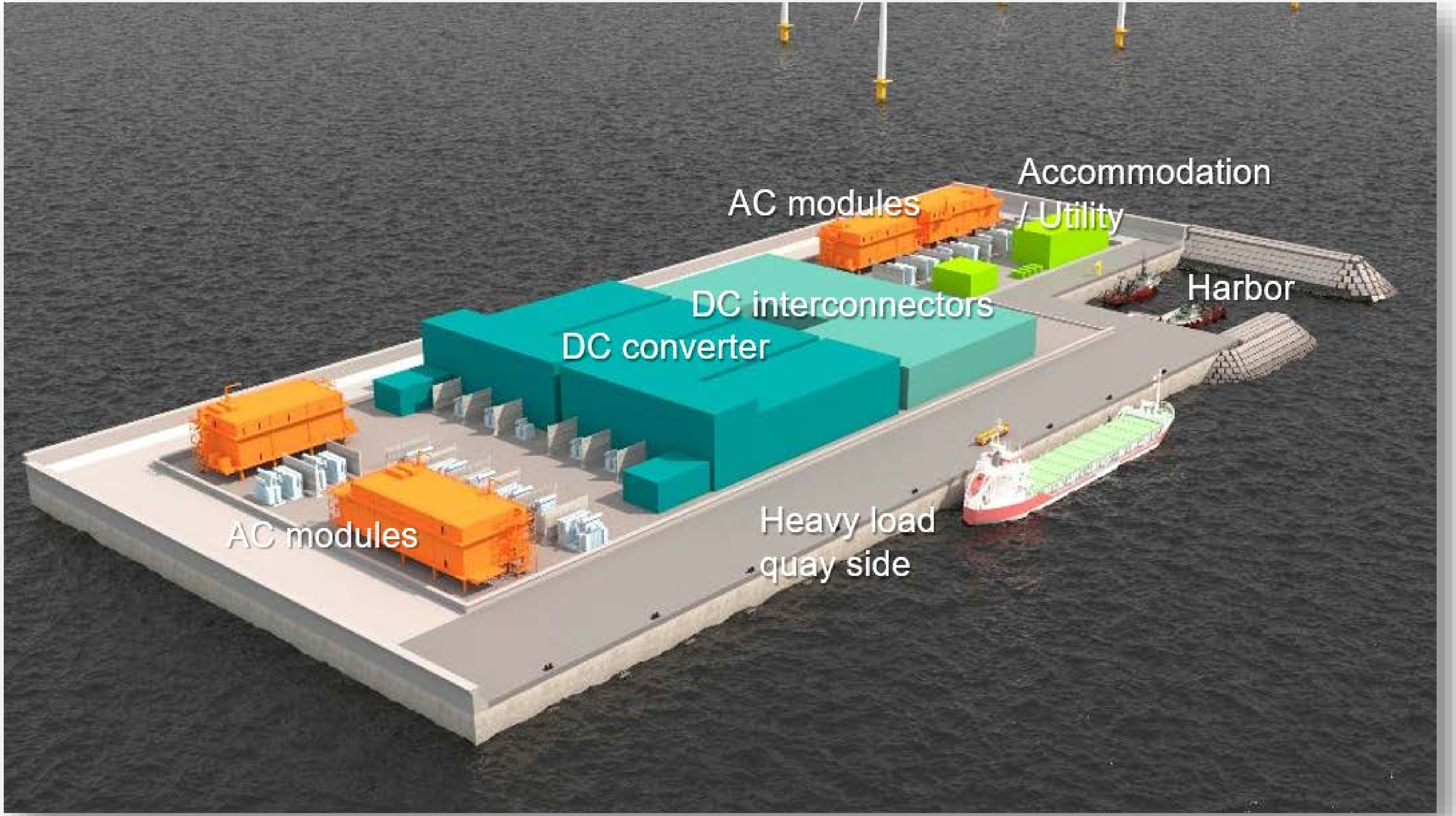
Nautilus

- Jointly developed with NGV
- Single vendor solution combined with MOG2
- Potentially connection of UK offshore wind

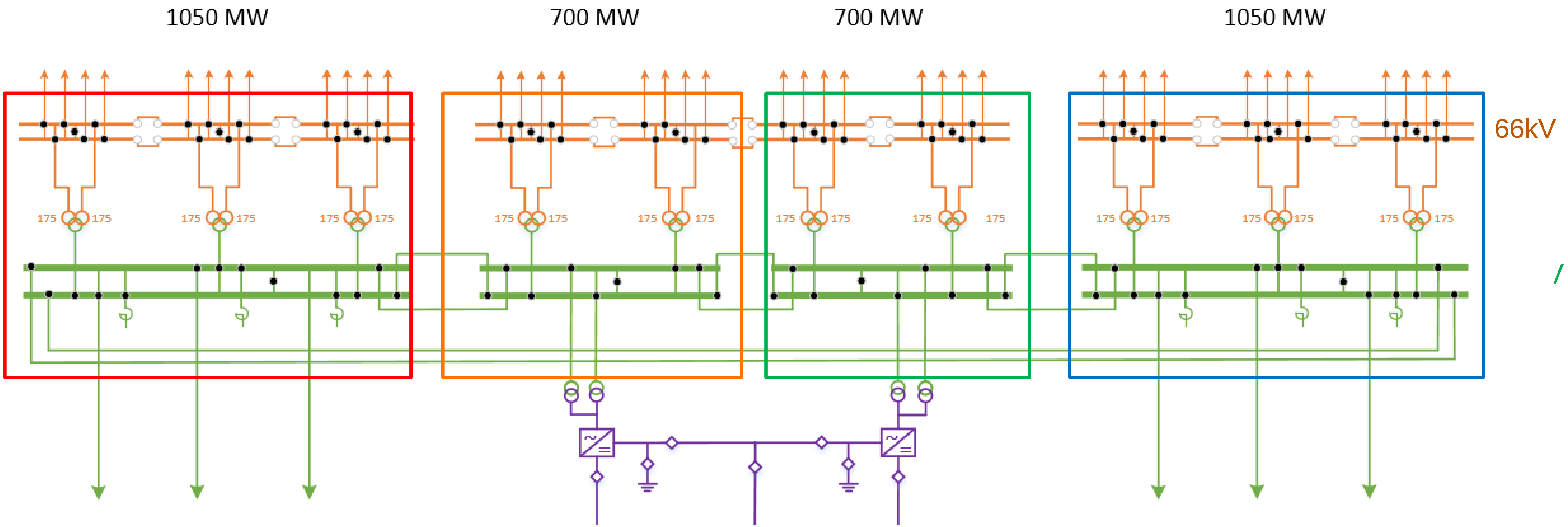
Triton

- Jointly developed with Energinet
- Potentially multi-vendor extension

Electrical Concept

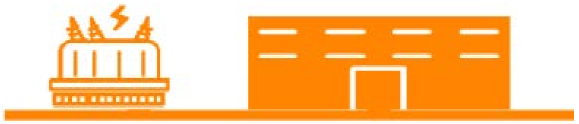


Electrical Concept and AC challenges



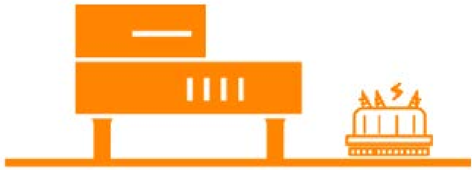
– 4 AC substations: 2 x 1050 MW + 2 700 MW
– 66kV: connection voltage of the wind farms
– 220 kV: export cable voltage and connetion to DC converter

Building Concept: 3 options



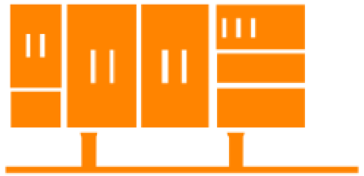
Classic

- Conventional industrial building, erected offshore
- All equipment transported, installed and commissioned offshore



Module

- Steel modules, TFOs outside
- Built onshore, partly commissioned and transported to the Energy Island



Topside

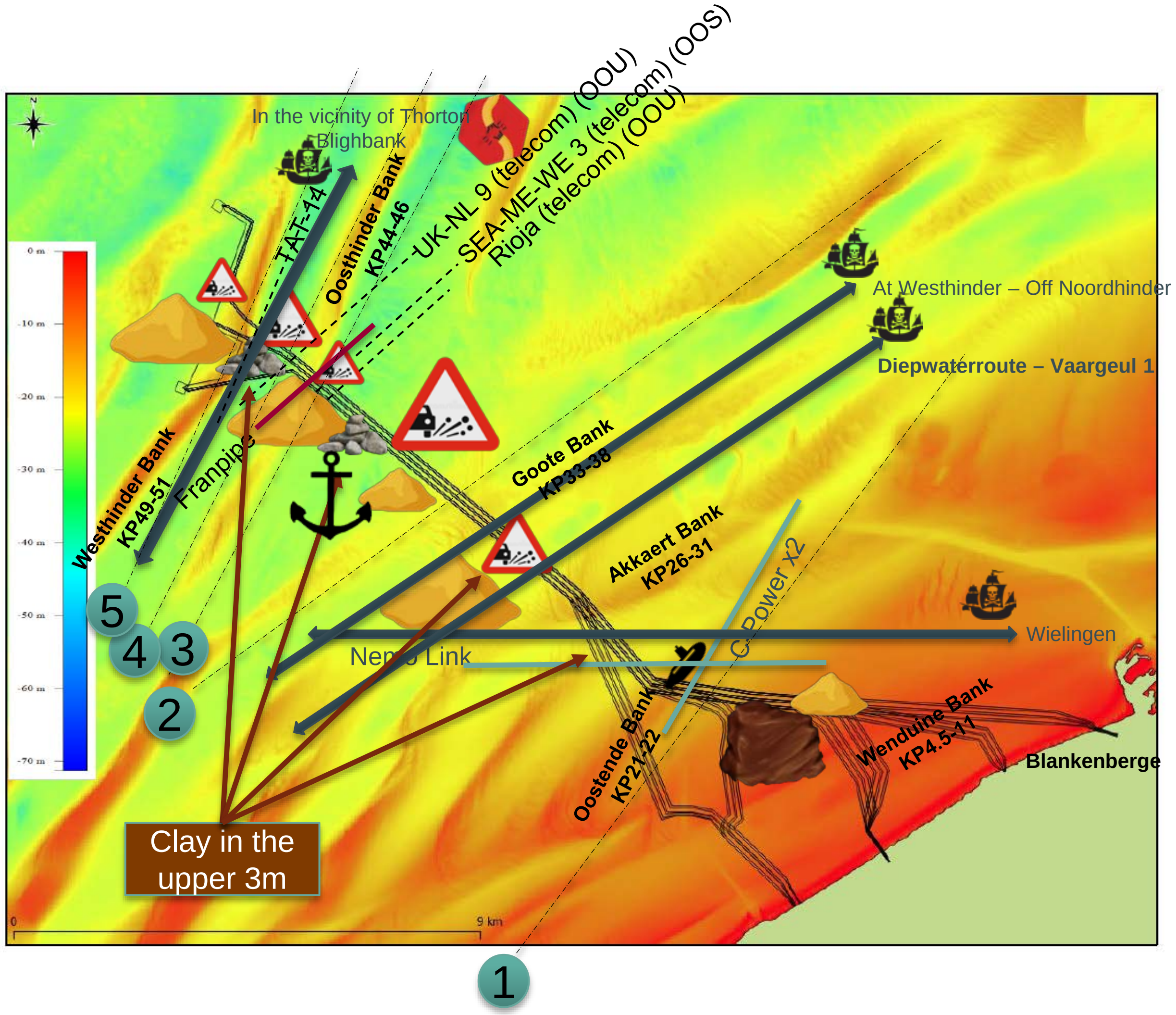
- Large steel module, TFOs inside
- Built onshore, partly commissioned and transported to the Energy Island

MOG2 - HVDC - Key challenges

1. Operation, control and protection concept of the multi-terminal HVDC link (incl. the DC connection of OWF)
2. Integration in the AC network of the MTDC system (weak AC grid, lots of power electronic devices in the direct vicinity, …)
3. Construction of a converter on the island by 2029
4. Delivery of a 525 kV DC GIS
5. Delivery & installation of a 525 kV DC Cable system (onshore & offshore)
6. Expandability of the DC system in a multi-vendor environment (uncharted territory)

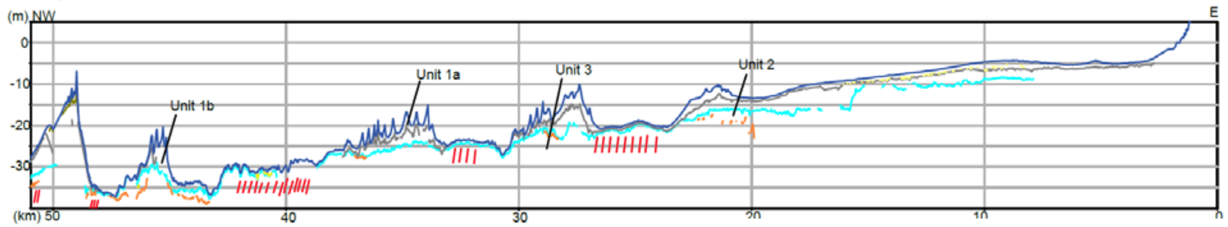
Lots of novelties and even world premieres and tight schedule

Cable Challenges



GENERAL GEOLOGICAL PROFILE OF MOGII PROJECT:

from platform B1 to nearshore



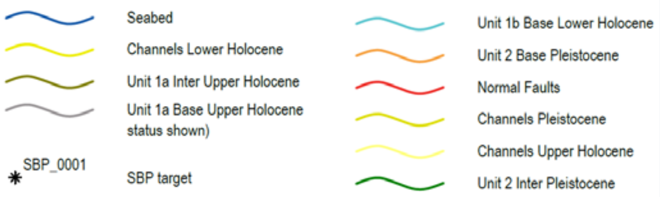
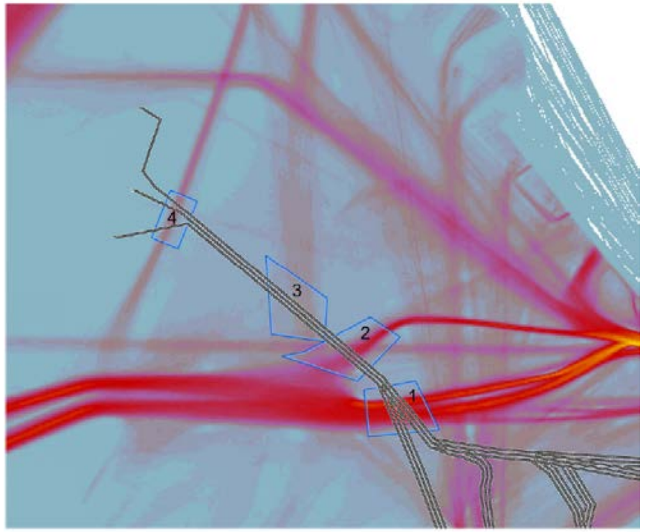


Table 5: Zones of Seabed Sediment Classifications

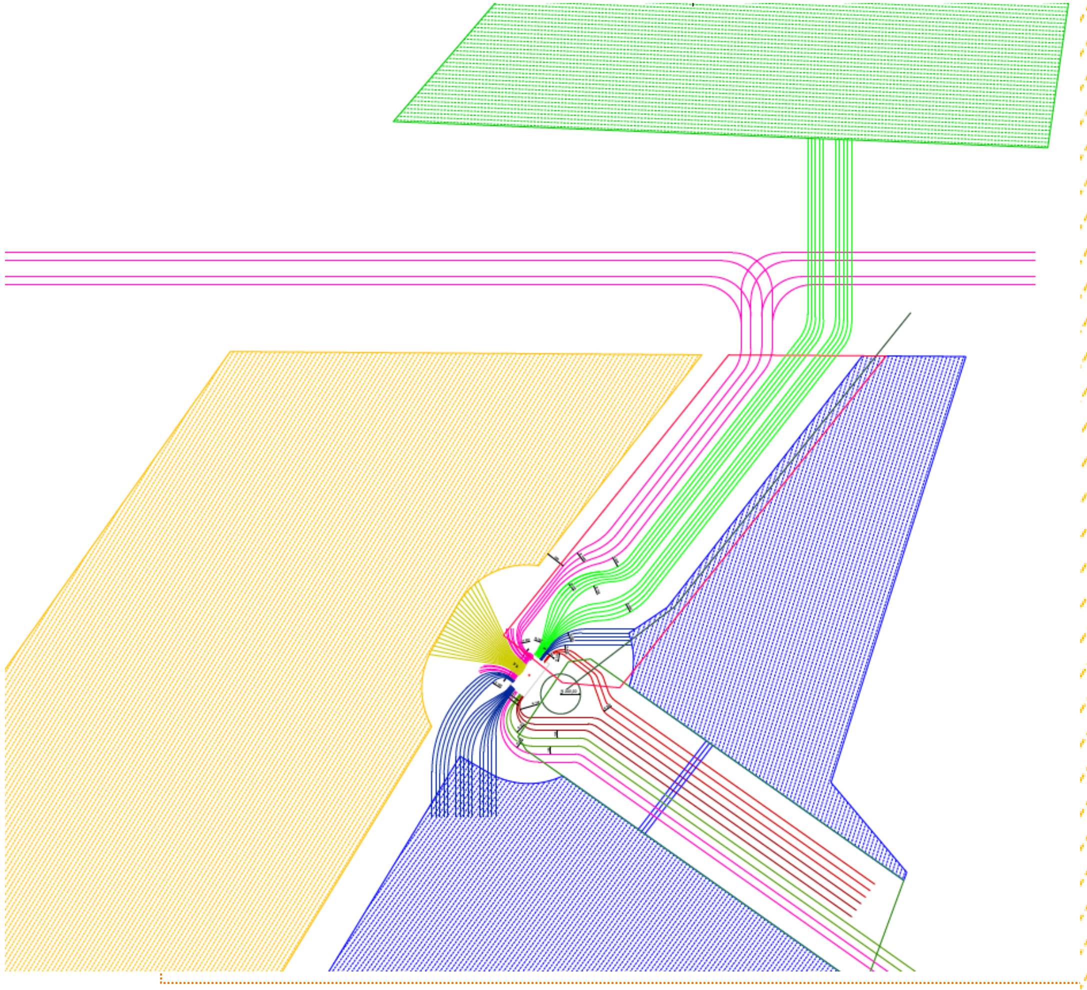
Zone	KP Range (approx.)	Description
1	0.0 – 20.5	Sandy CLAY and CLAY dominated, with occasional SAND
2	20.5 - 38.0	SAND and Gravelly SAND dominated, approximately aligning with areas of the route encountering sand waves.
3	38.0 - 42.5	GRAVEL and Gravelly SAND dominated
4	42.5 - 47.0	SAND and Gravelly SAND dominated, approximately aligning with areas of the route encountering sand waves.
5	47.0 - 48.0	GRAVEL dominated.
6	48.0 - 56.0	SAND and Gravelly SAND dominated, approximately aligning with areas of the route encountering sand waves.

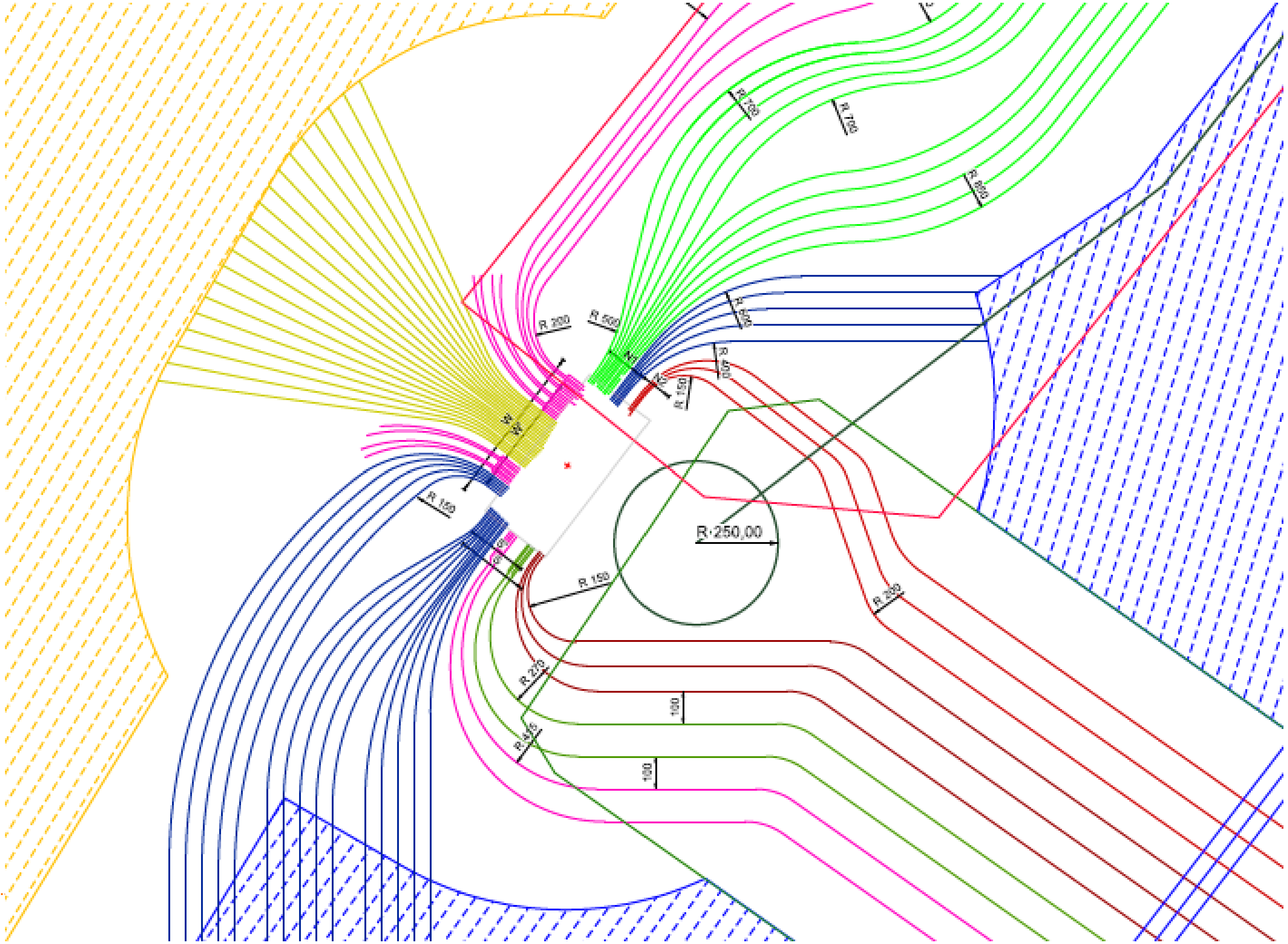
Figure 1: Vessel density map



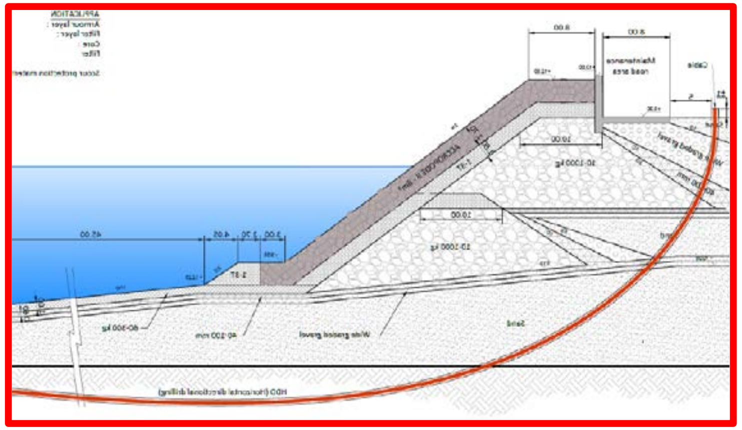
Export Cable corridor crosses 4 North Sea shipping lanes

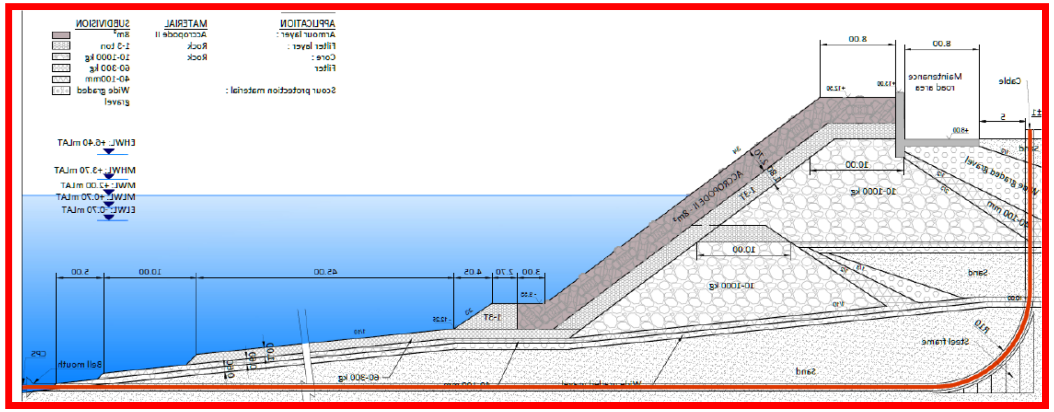
Cable Challenges

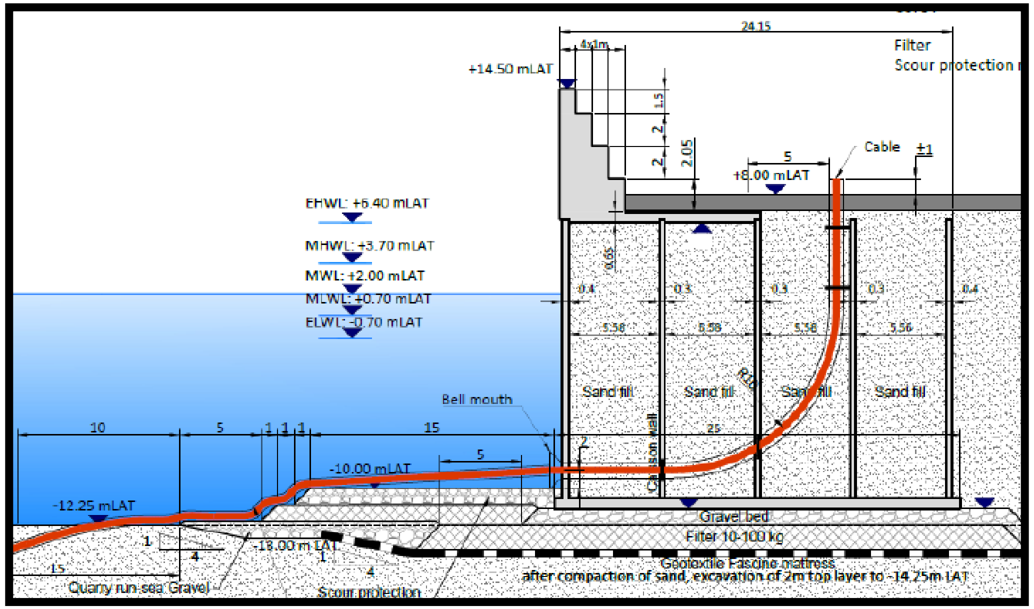


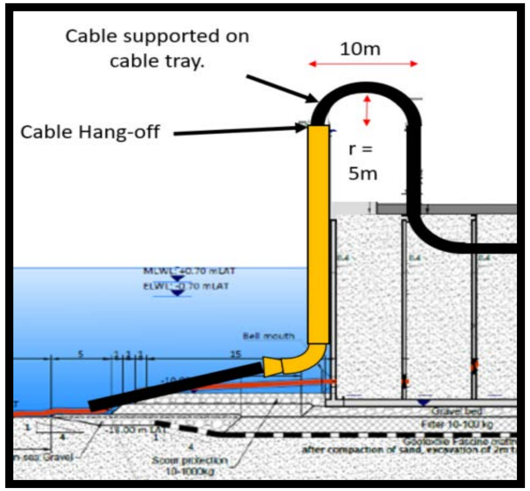


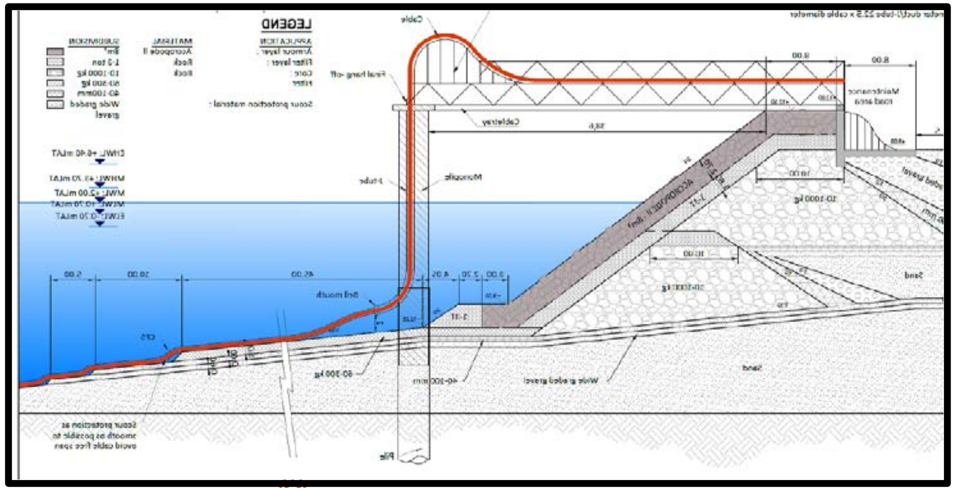
Offshore Cable challenges



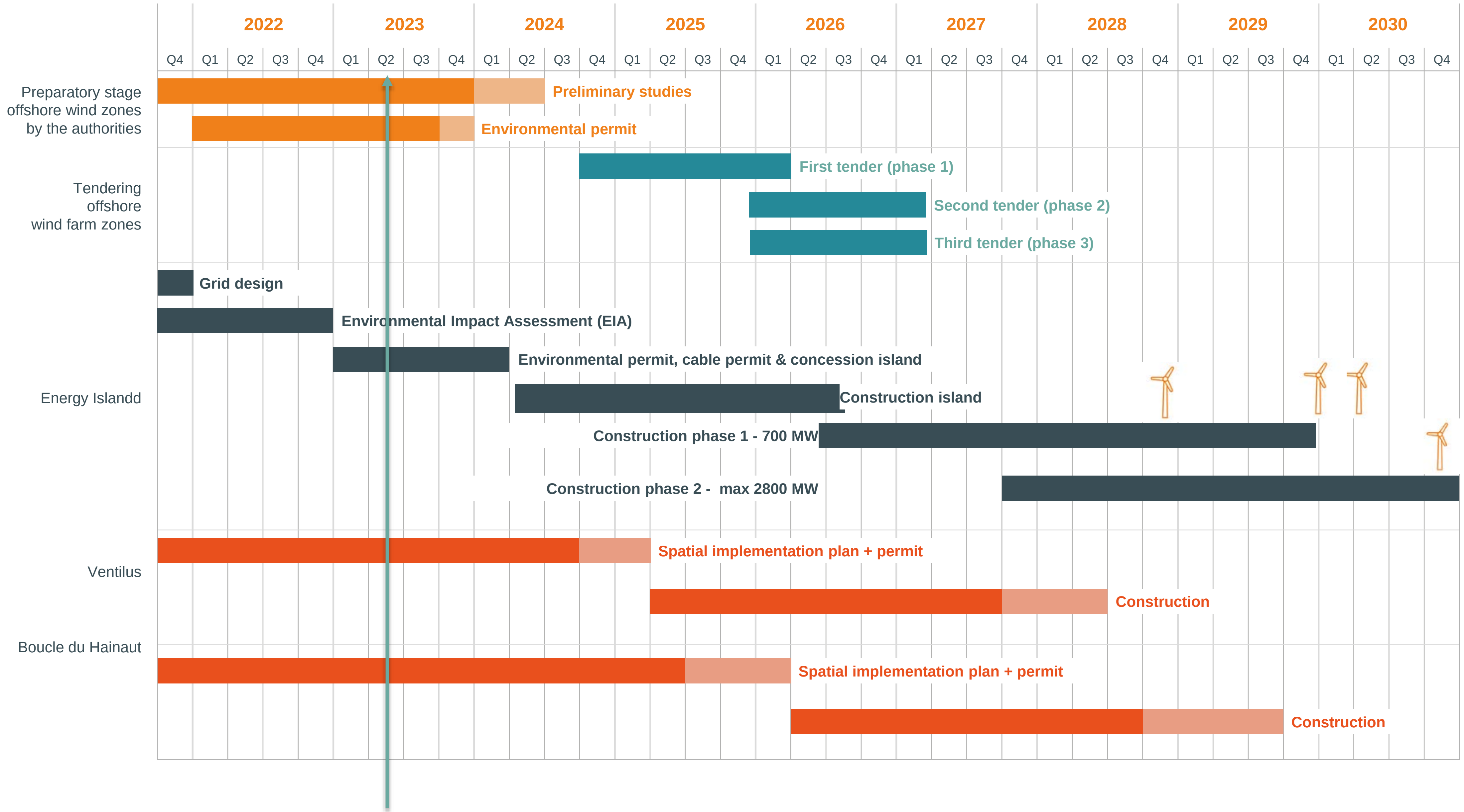








First steps are taken... But some major steps still need to be taken...



Thank You