BETTER SHIPS, BLUE OCEANS

OPEN INNOVATION

Multi-use concept development for floating solar and seaweed around wind turbines

Erik-Jan de Ridder and Floor Spaargaren

What we do

… shipping …

… offshore installations …

‘Making ships cleaner, safer and smarter’

… offshore operations …

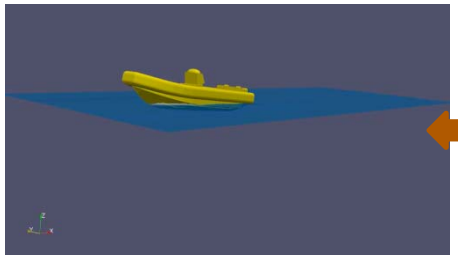
… ports & waterways…

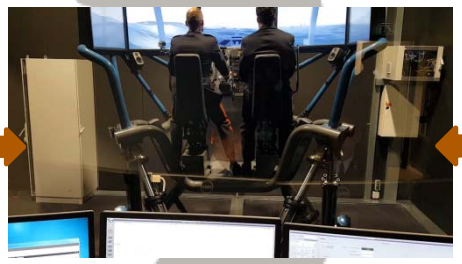
, and sustainable use of our ocean

How we do it

Bridging the gap between design and operation

Concept ⟷ **Design** ⟷ **Operation**





Simulations	Model tests	Simulators	Monitoring
Desk / Computer	Prototype	Virtual reality	Reality

Some facts and figures

Design to Operation	Global player with Dutch roots	>85 86 years young	Wageningen, Houston, Shanghai, Sao Paulo
Innovative and Independent	For industry and government	For civil and defence	JIPs and Networks
400 employees	€ 45 M revenue	37% Dutch, 30% EU and 33% international	Active in 39 countries

Some facts and figures

- **Approx. 250 projects a year**
- **150 ship models a year: 10000th model (8 m.) this year**
- **100 full numerical projects (50% RANS), 10000 core cluster**

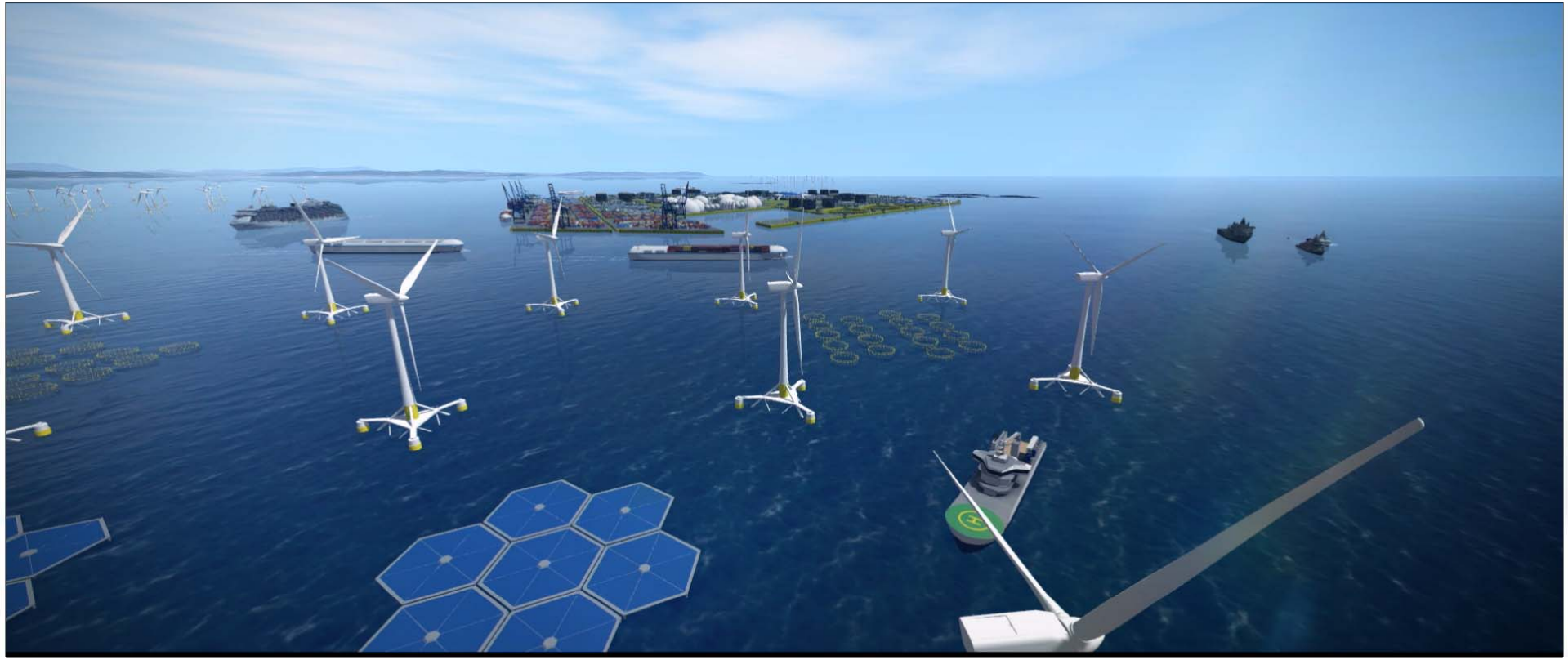
400 employees

€ 45 M revenue

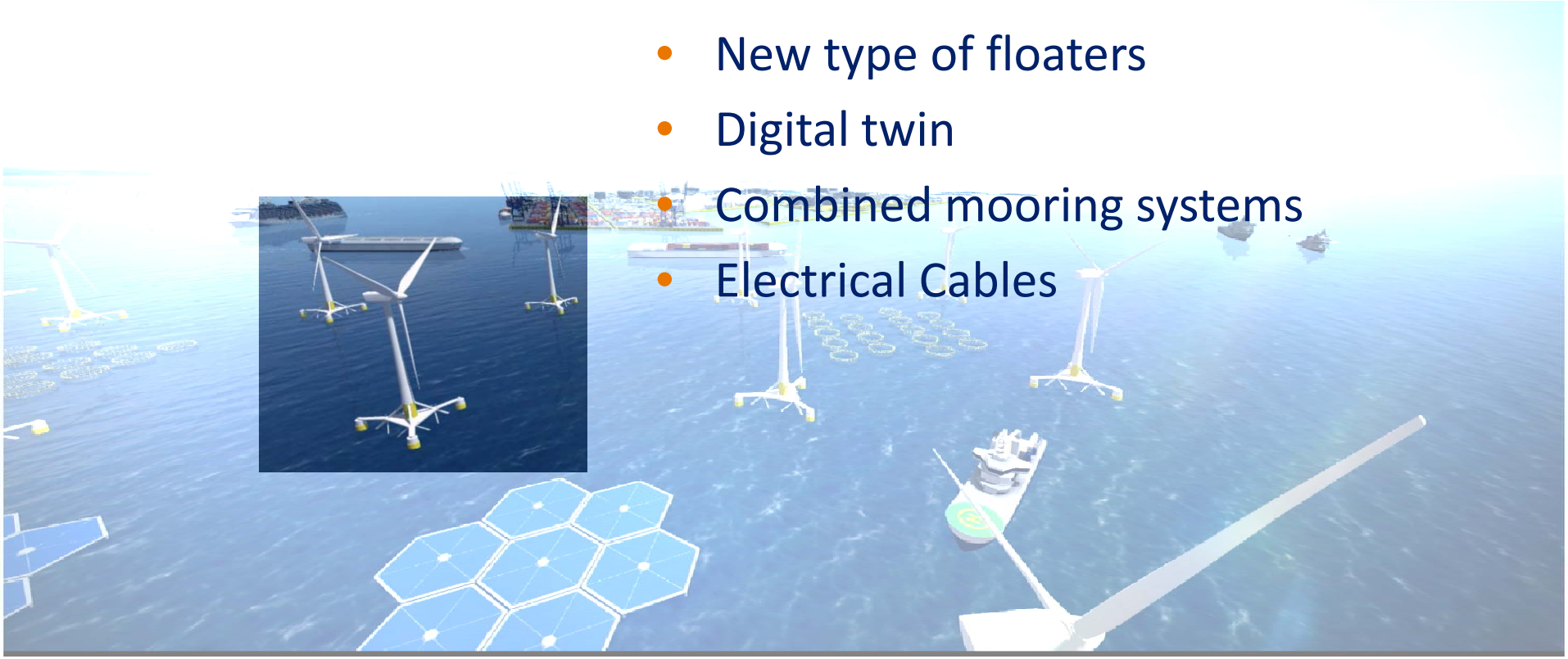
37% Dutch, 30% EU and 33% international

Active in 39 countries

Areas of research (floating) offshore wind



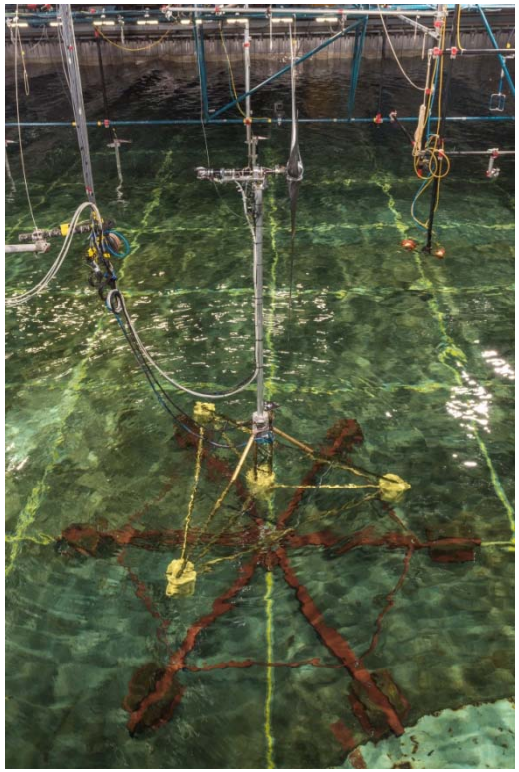
Floating wind turbines



- New type of floaters
- Digital twin
- Combined mooring systems
- Electrical Cables

Floating wind turbines: New type of floaters

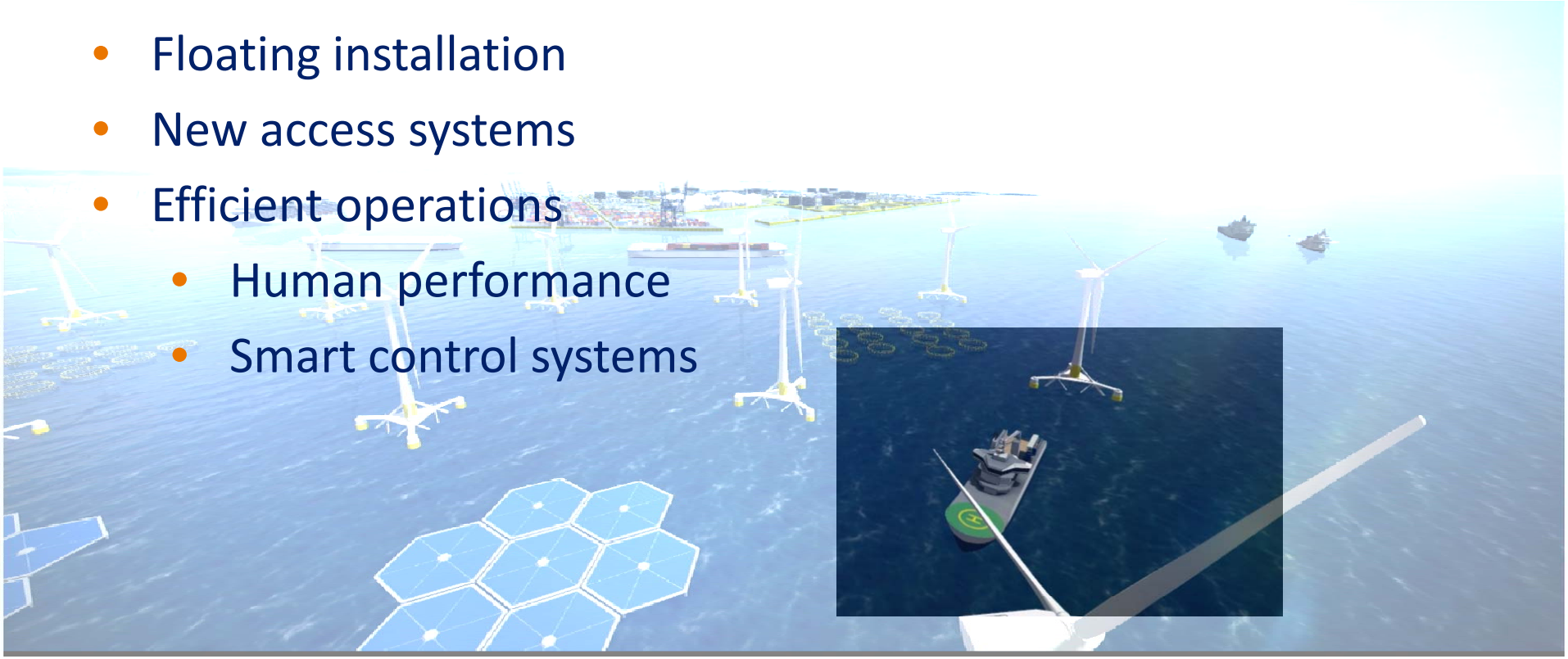
SBM Offshore in cooperation with IFPEN



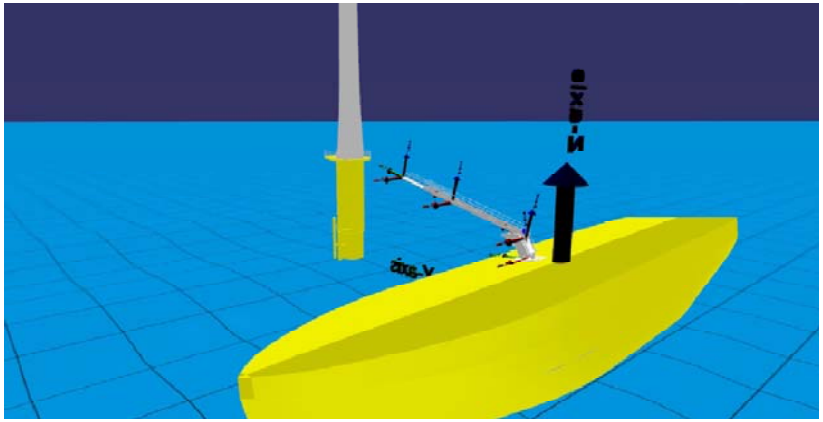
Hexicon floating wind turbine design

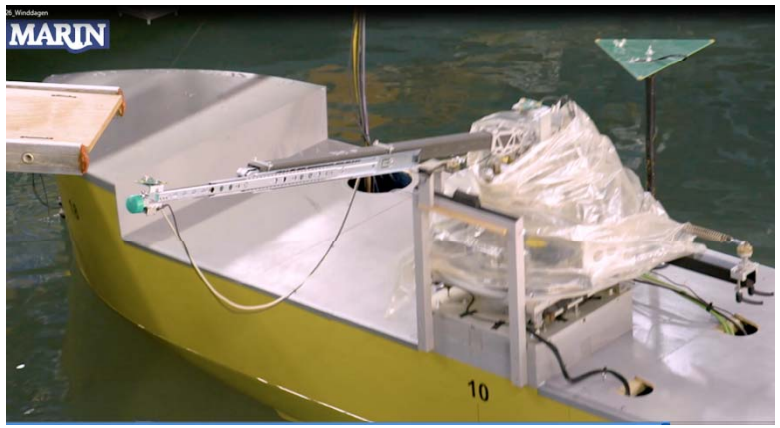
Operation for Offshore wind turbines

- Floating installation
- New access systems
- Efficient operations
  - Human performance
  - Smart control systems

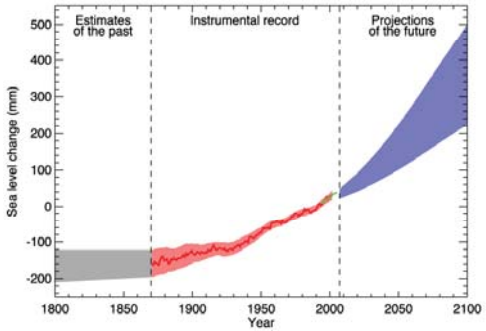


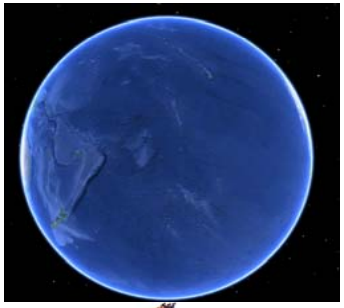
Operation: New access systems and efficient operations





Open innovations to solve Social challenges





Offshore space

Combinations

Solar energy

Seaweed

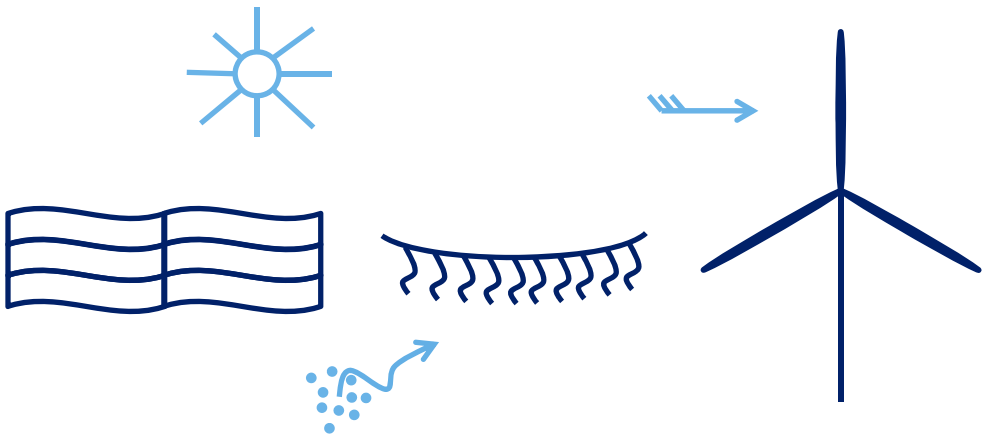
Open innovation

- Concept development
  - Design sprint
- Testing on model scale
- Evaluation and outlook
  - Demonstration seminar

Concept development

Design challenge

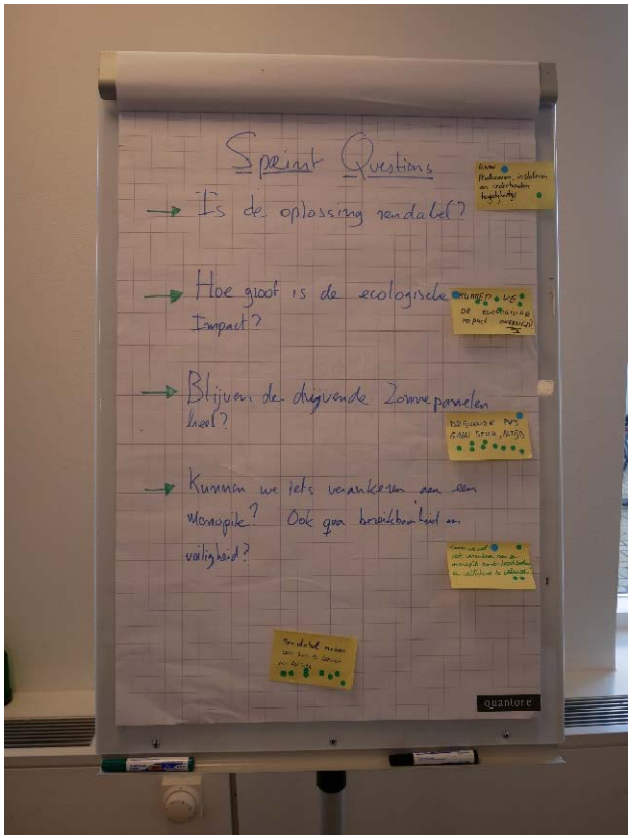
- Wind, solar, seaweed farm to be designed
- Make use of possible synergies



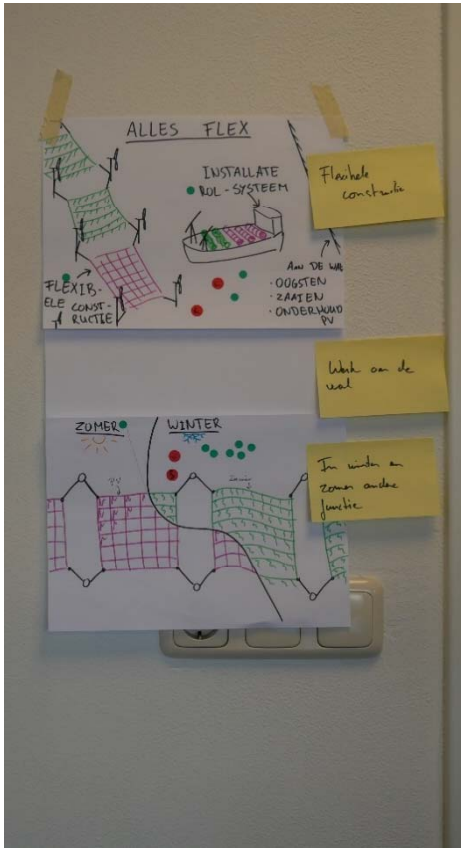
Design sprint with experts

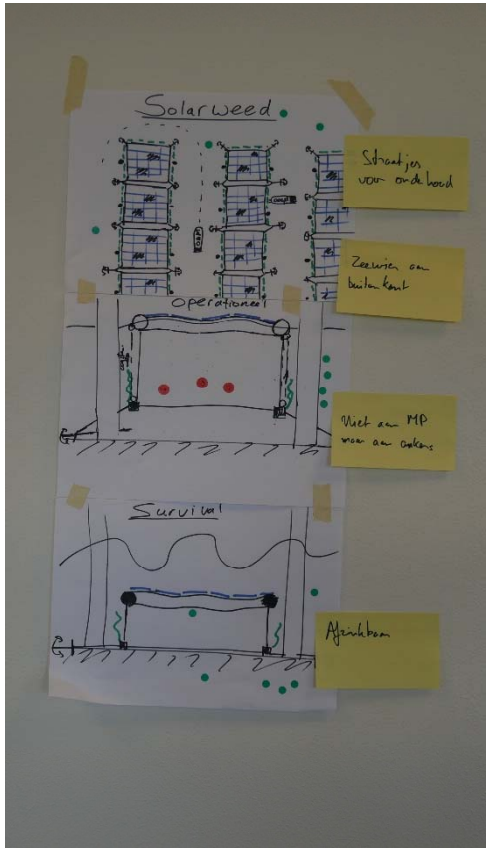
Sprint questions

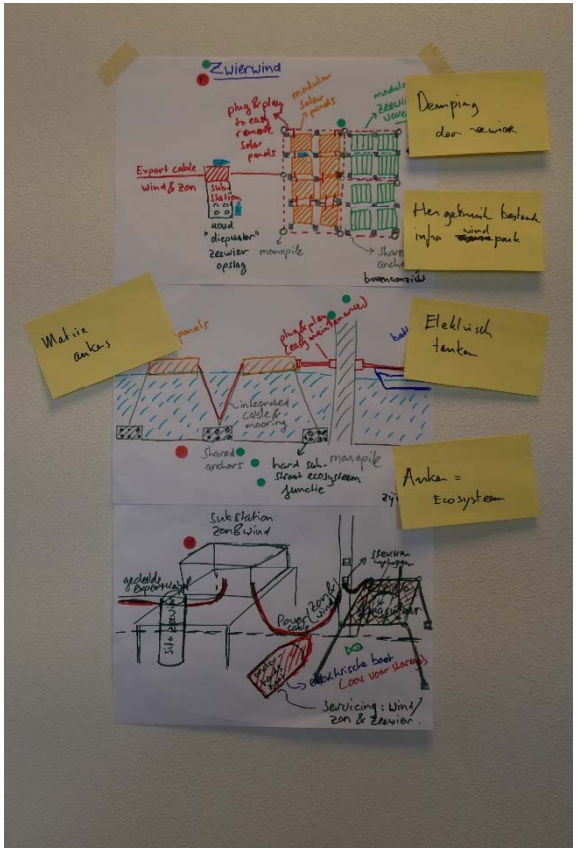
- Maximize the energy and food production on the North sea per m^2
  - Is the solution viable?
  - How large is the ecological impact?
  - Will the structure stay intact?
  - Can we moor things (close to) the support structure of the wind turbine? Also taking into account safety and accessibility.



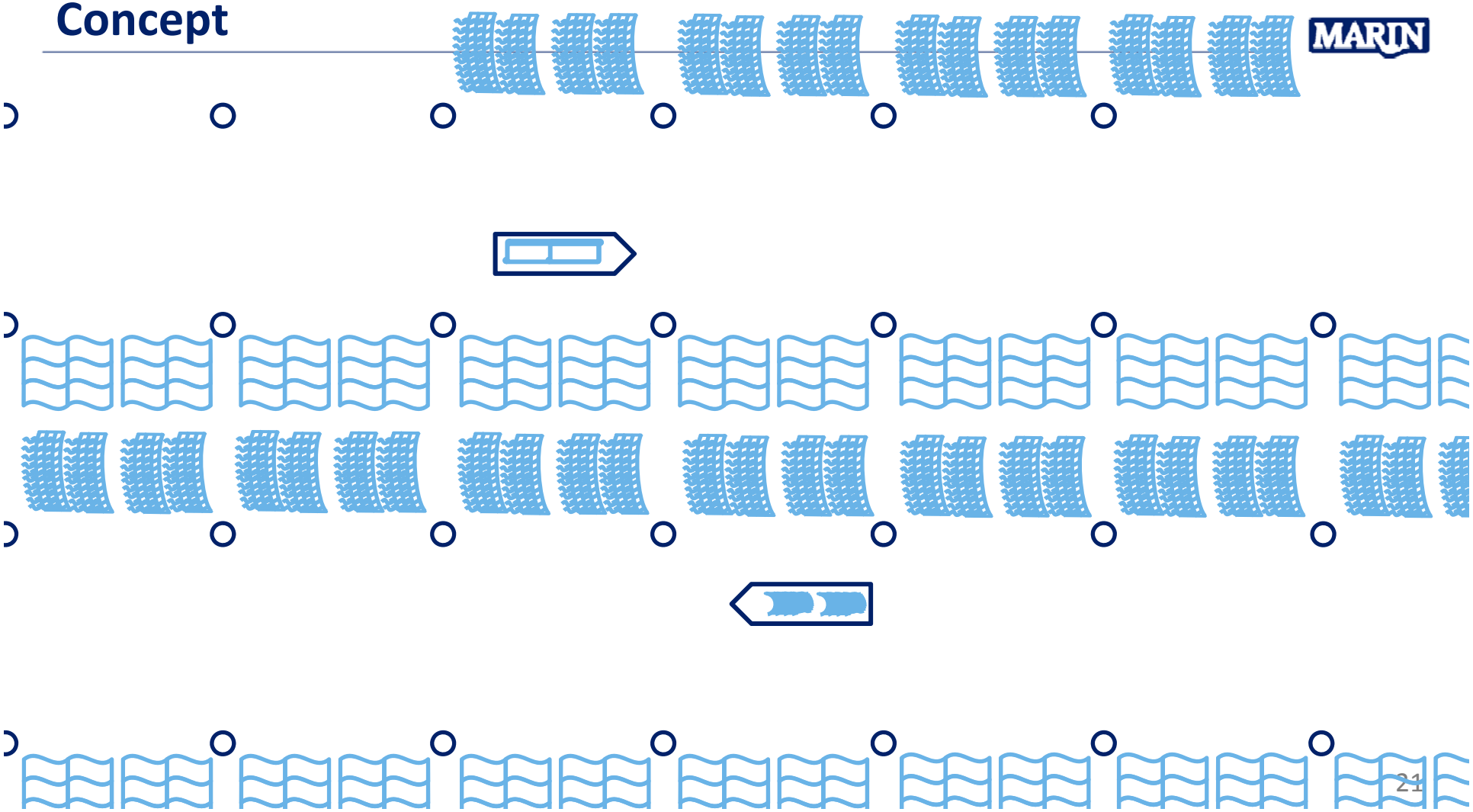
Concept


ALLES FLEX
INSTALLATIE ROL-SYSTEEM
Flexibele constructie
FLEXIBELE CONSTRUCTIE
AAN DE WAL
· OOGSTEN
· ZAAIEN
· ONDERWATER PV
Werk aan de wal
ZOMER
WINTER
In winter en zomer andere functie

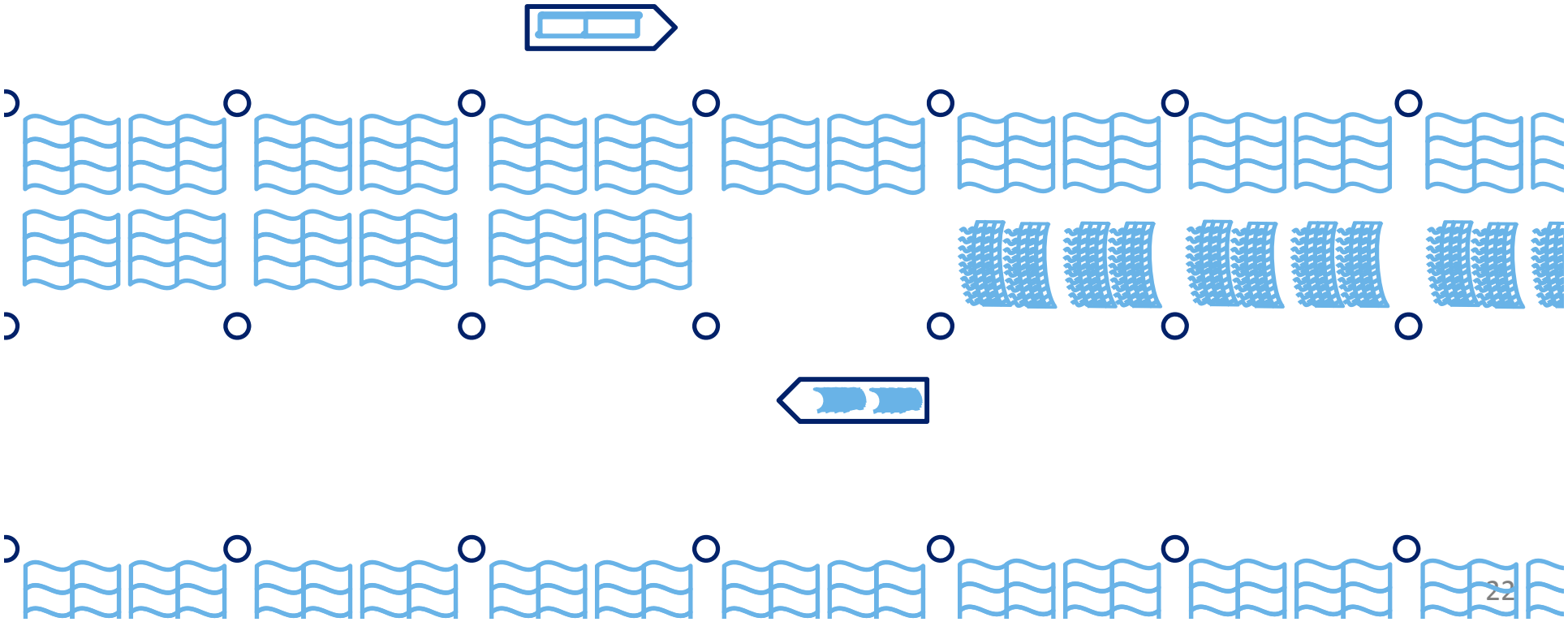

Solarweed
Stroatjes voor onderhoud
Zeewier om binnen kant
operational
Niet aan MP maar aan ankers
Survival
Afrinkbaan


Zwierwind
Demping door zeewier
Export cable wind & zon
Substation
zeewier monopile opslag
Hergebruik bestaand infra wind park
Matrix ankers
Elektrisch tanken
integrated castle mooring
Shared anchors
hard sub. strout ecosystem functie
monopile
Anker = Ecosystem
Substation Zon & Wind
Servicing: Wind/zon & zeewier.

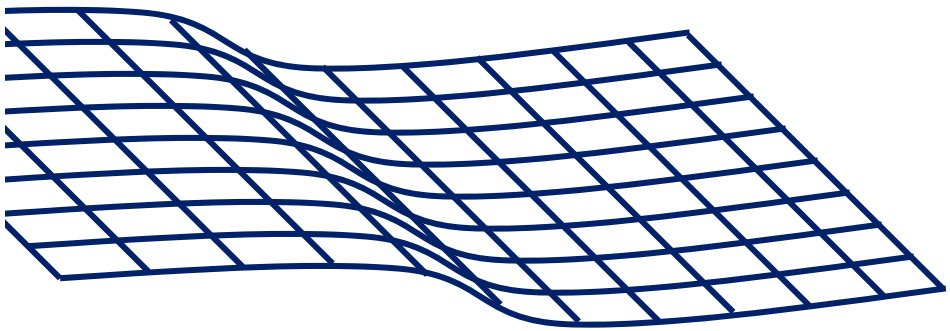
Concept



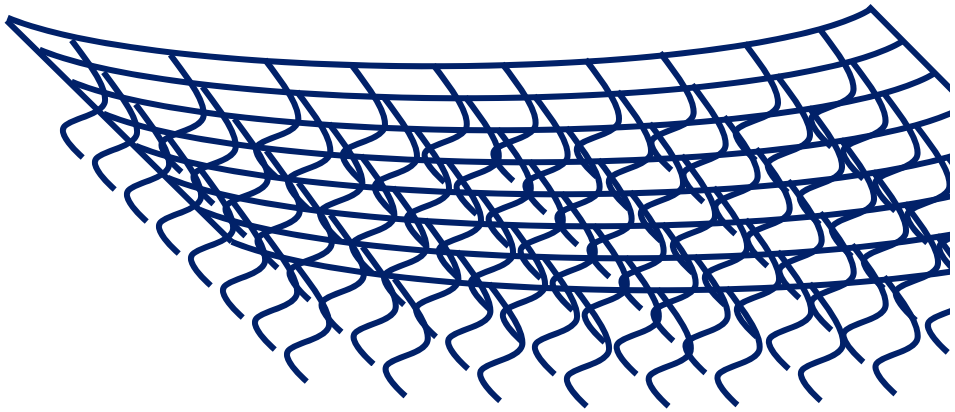
Modular system



Flexible structures

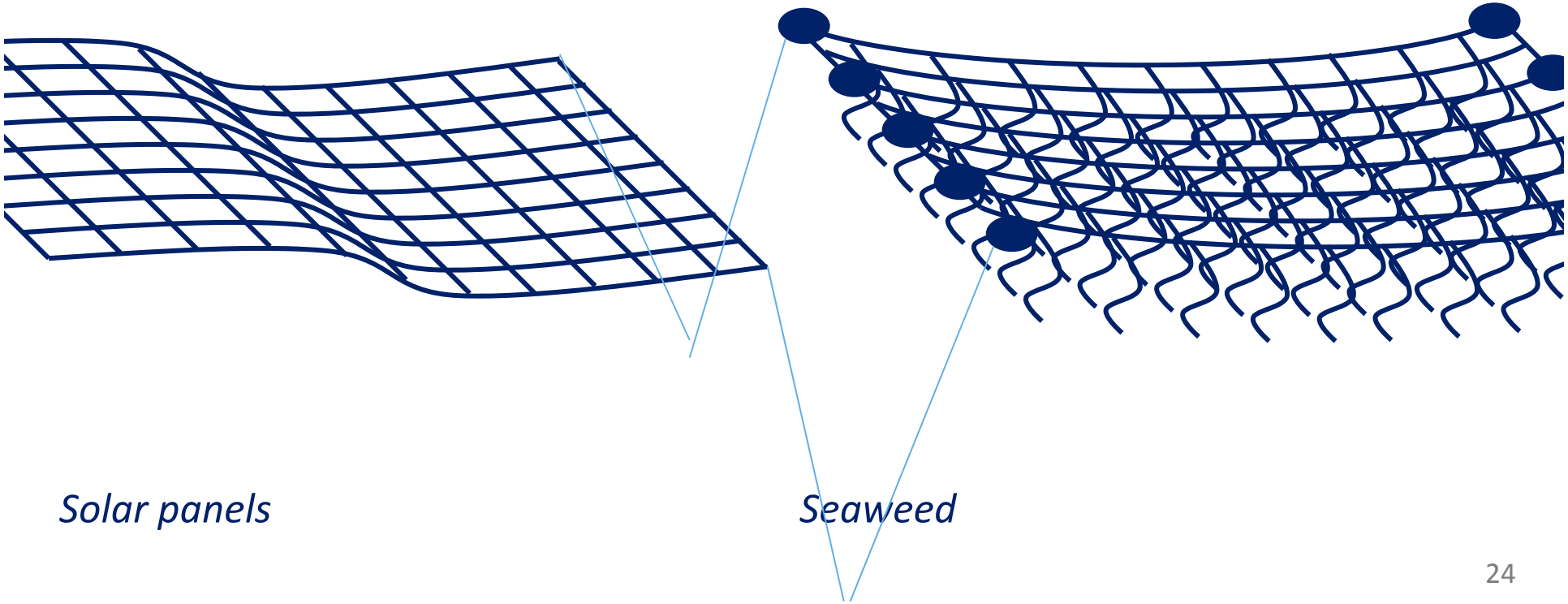


Solar panels



Seaweed

Flexible structures

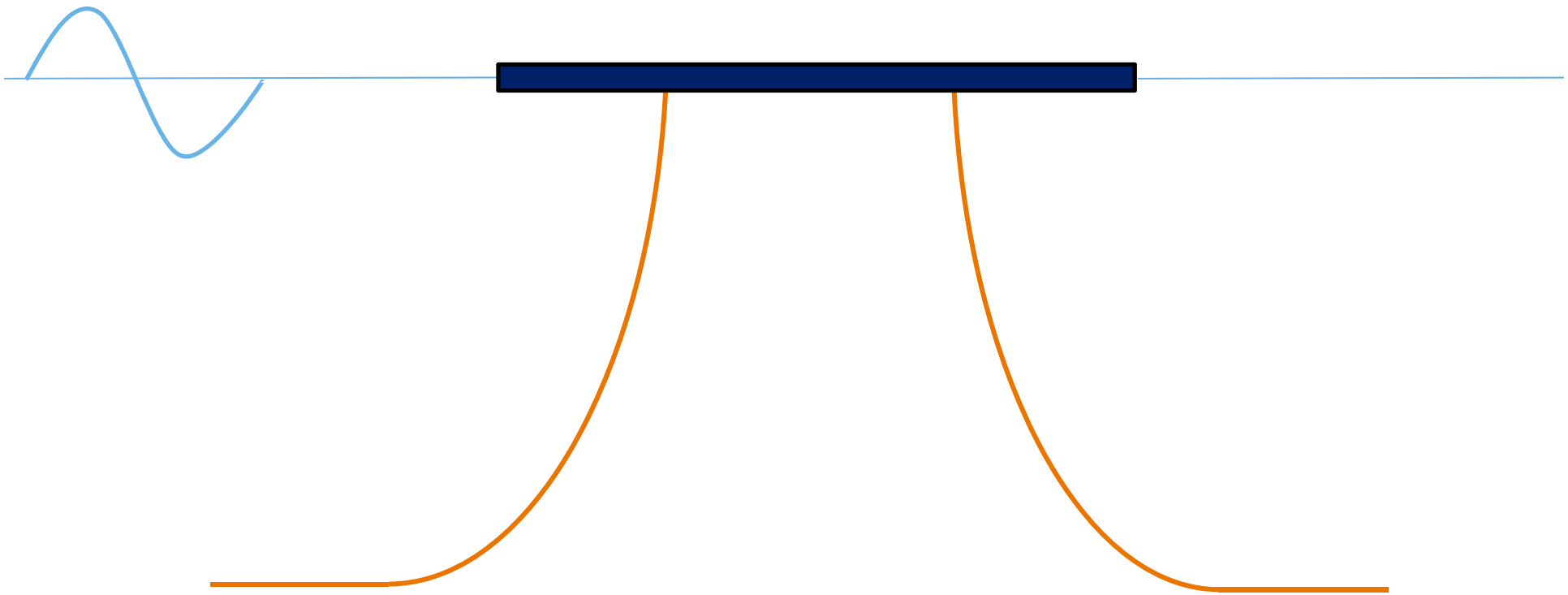


Solar panels

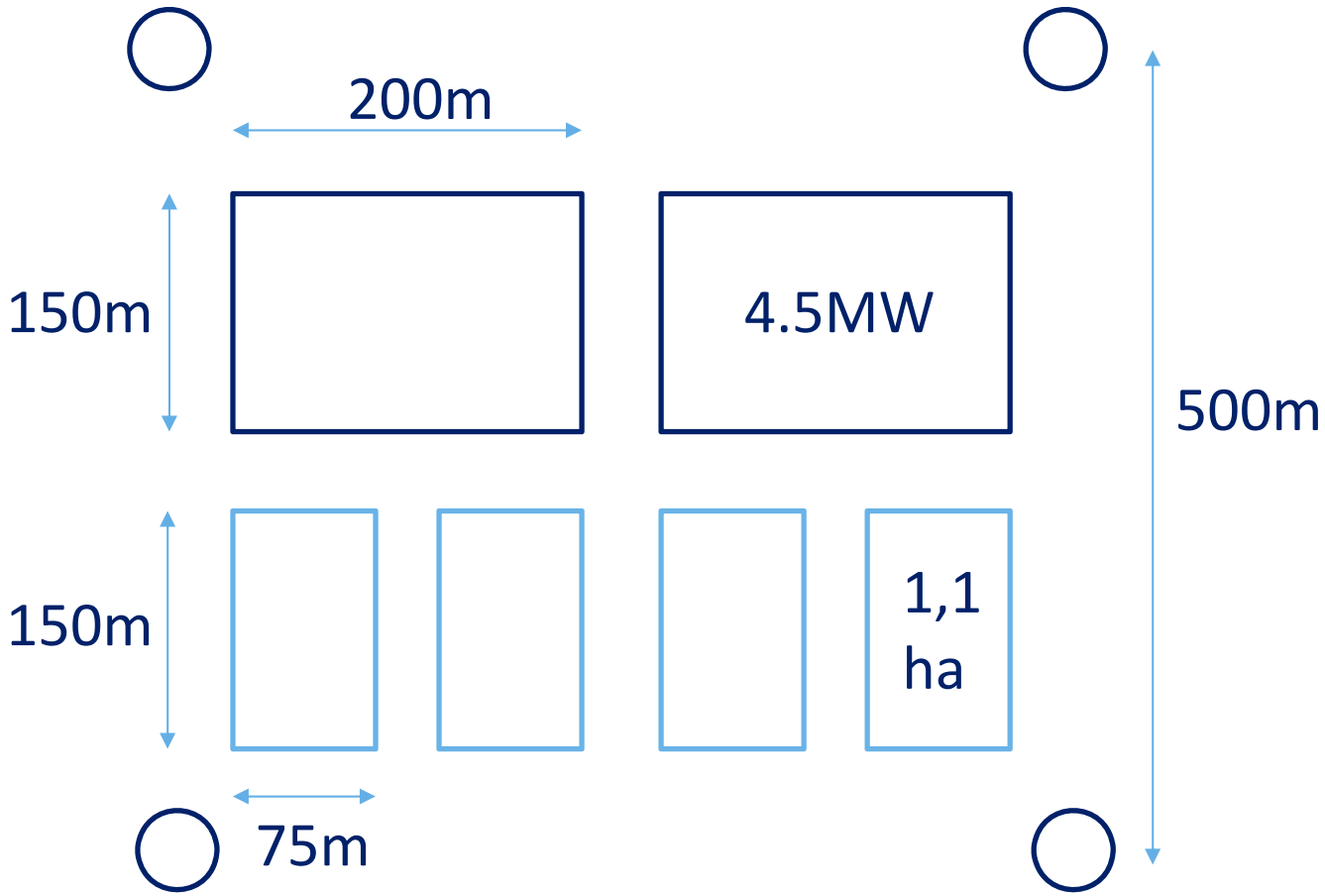
Seaweed

Mooring

Mooring

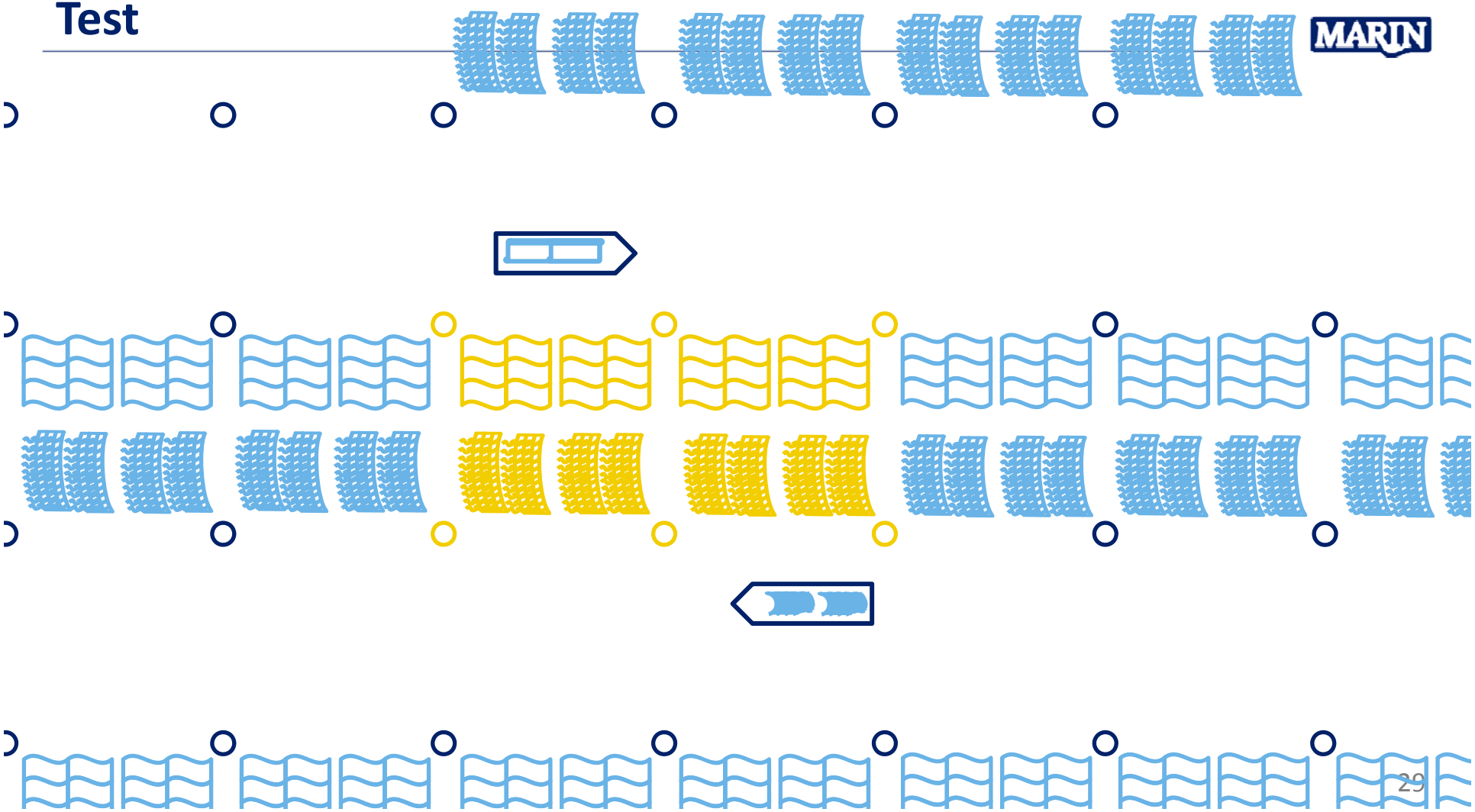


Dimensions

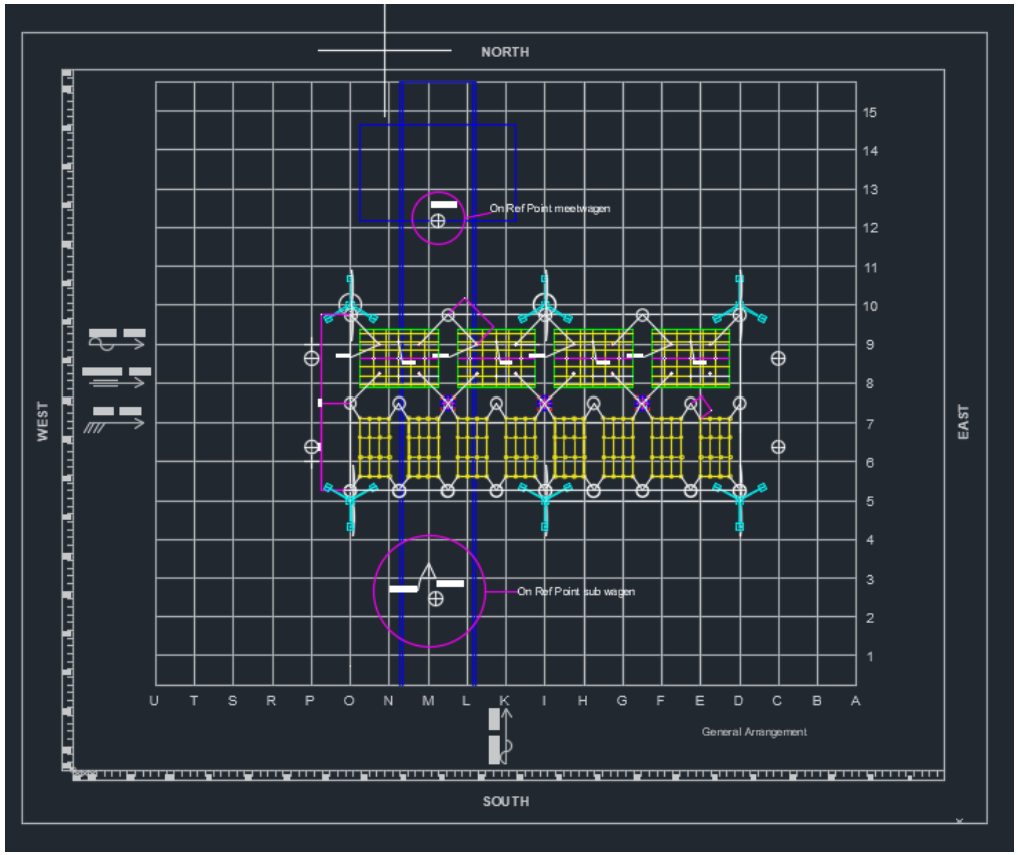


Testing on model scale

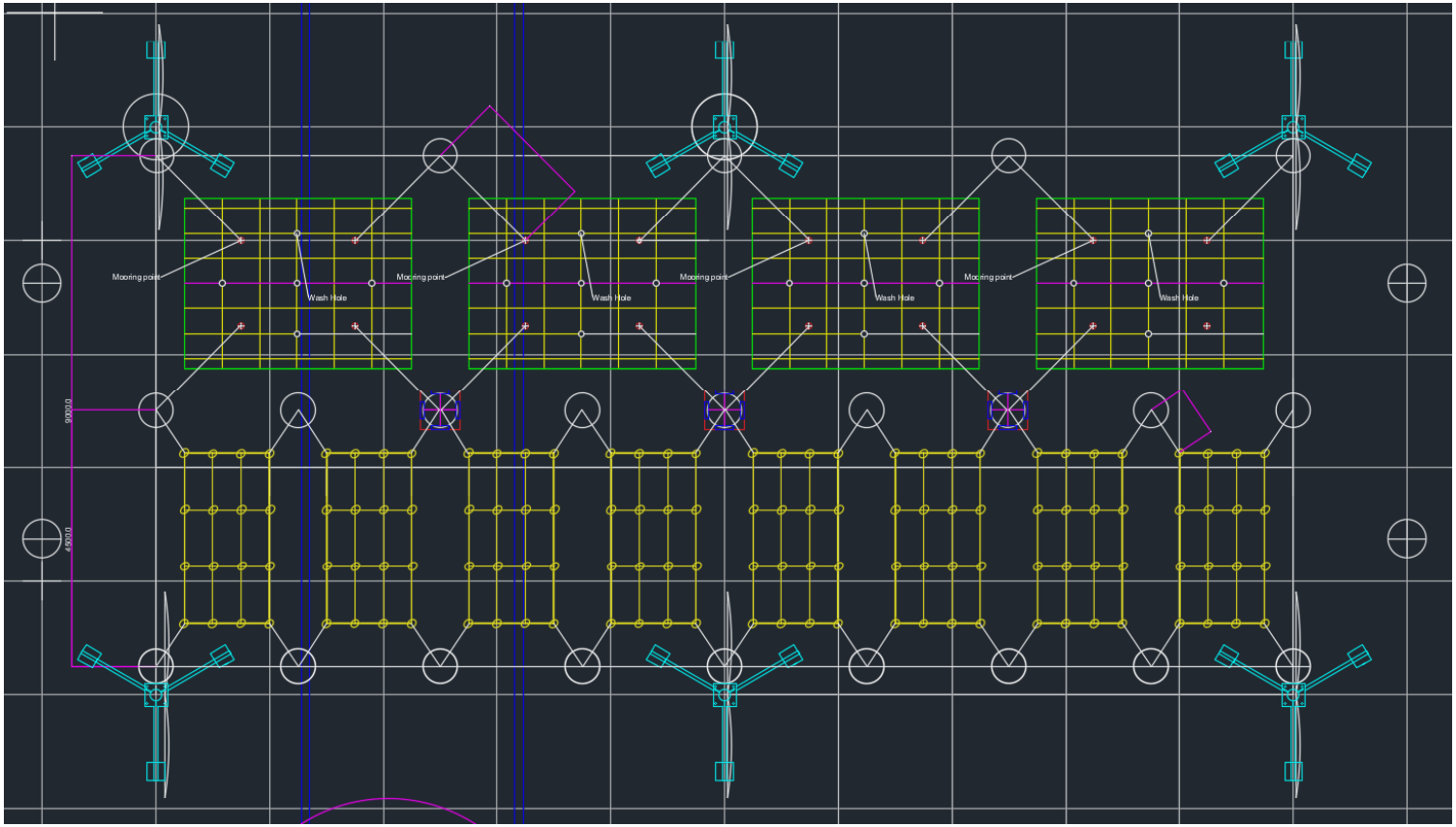
Test



Tank lay-out


NORTH
SOUTH
WEST
EAST
On Ref Point meetwagen
On Ref Point sub wagen
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
U T S R P O N M L K I H G F E D C B A
General Arrangement

Tank lay-out


Mooring point
Wash Hole
Mooring point
Wash Hole
Mooring point
Wash Hole
Mooring point
Wash Hole
90000
46000

Models

Model dimensions

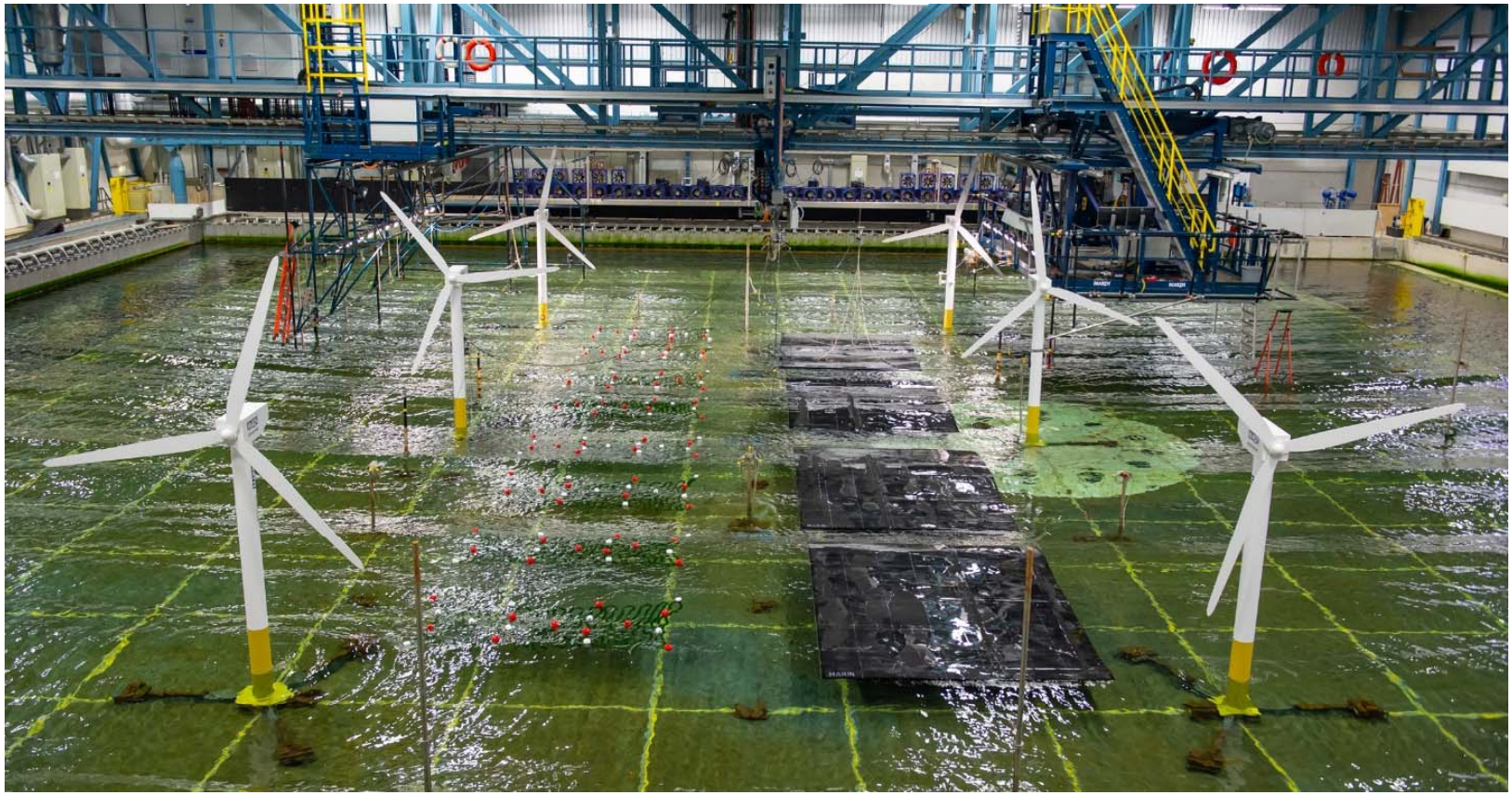
- Floating solar panels

Floating Solar panels		
Description	*Dimensions*	*Specifications*
Model 1 EPDM 488	0.25 x 200 x 150 m	rho 225 kg / m3
Model 2 EPDM 488	0.5 x 200 x 150 m	rho 225 kg / m3
Model 3 EPDM 488	1 x 200 x 150 m	rho 225 kg / m3
Model 4 EPDM 488	1.5 x 200 x 150 m	rho 225 kg / m3
Mooring Chain	146 m	16 x U2 OW 88kg/m BW 101 kg/m
Load Cells		16 x Type 144m max range 3843 ton

- Seaweed

Seaweed Farm		
Description	*Dimensions*	*Specification*
Model 1 - 8	75 x 150 m	Nylon Netting 100 x 100 mesh
Seaweed	Diameter 2 m	Christmas Garland
Mooring wire	60.25 m	27 mm steel wire OW 2.56 kg Gram BV 3.6 kg
Load Cells		32 x Type 147s 1281.25 ton
Floaters	L = 3.5 m D = 3.25m	19 floater per Sea Farm

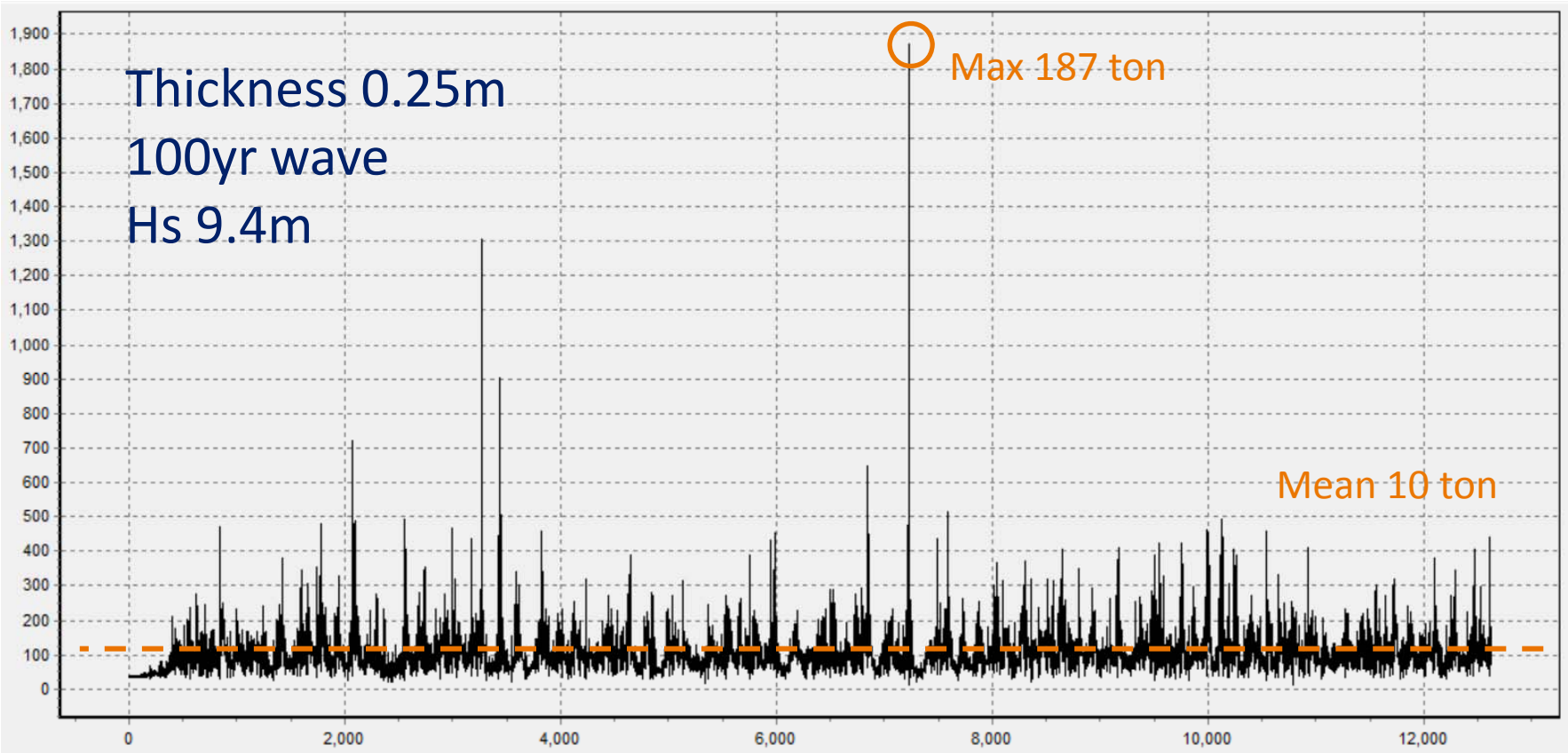
Tank



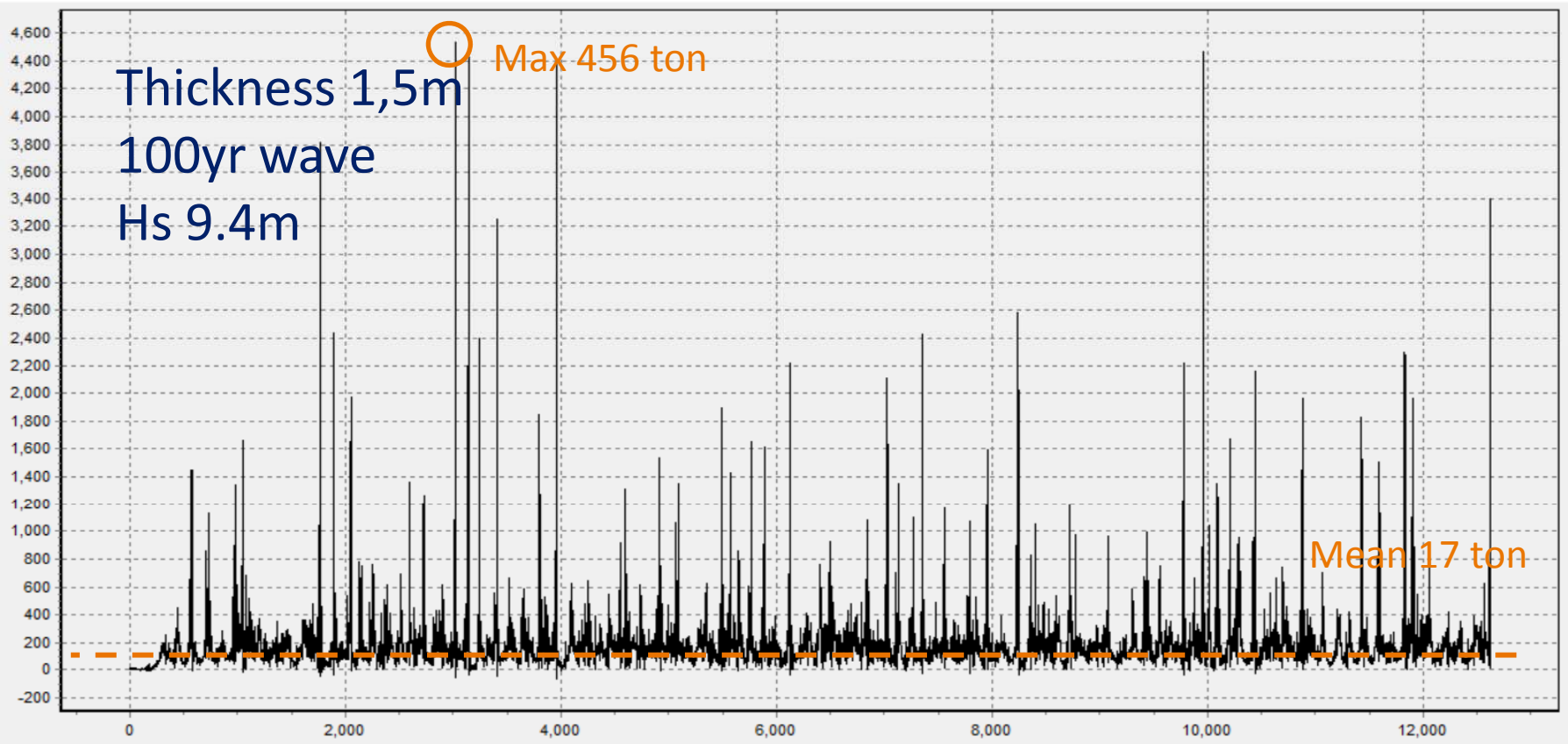
Preliminary results

Jonswap 100yr 180 Hs 9.40 Tp 13.10 Current 1.2

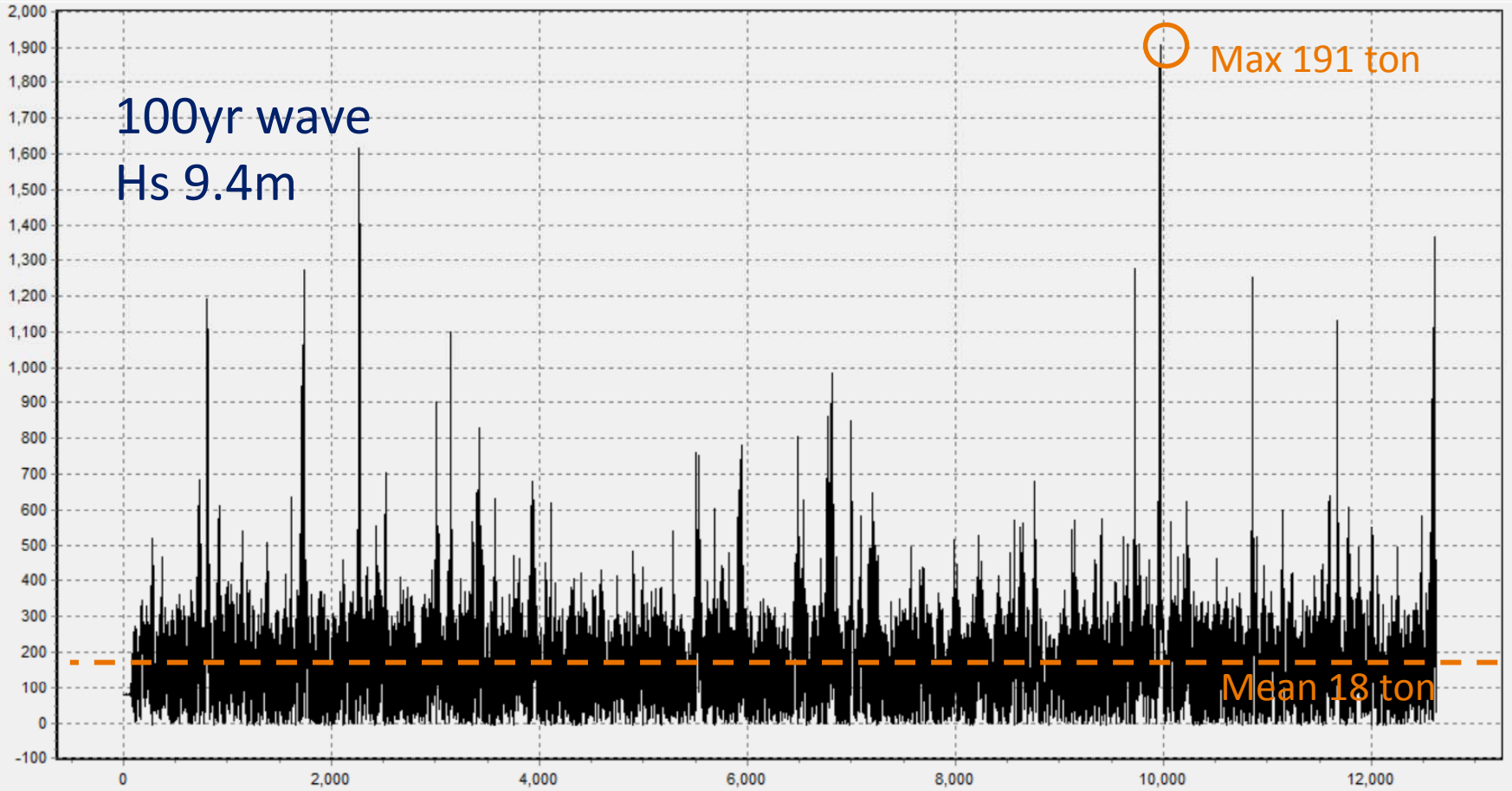
First results solar field



First results solar field



First results seaweed



Support the development by sharing the results.

Evaluation and outlook