

From one-off FPSO design to mass production of FOWT



June 5th, 2024



Engineering and Technology Company

Competence

- Hull design, structure, hydrodynamics, mooring, marine operations, digitalization

Organisation

- 32 employees
- Office locations: Oslo, Arendal, Bergen



Oslo, Norway



Arendal, Norway



Bergen, Norway



Engineering Our Future Together

A Premier Global Player with
Deep Engineering Expertise



Sevan Background and Experience



6 Floating Production Units



Piranema (S300)
First oil: 2007



Excalibur (S300)
(Hummingbird)
First oil: 2008



Voyageur (S300)
First oil: 2009/2013



Goliat FPSO (S1000)
First oil: 2016



Western Isles FPSO (S400)
First oil: 2017



Penguins FPSO (S400)
Commissioning

4 Drilling Units



Sevan Driller
2010



Sevan Brasil
2012



Sevan Louisiana
2014



Sevan Developer
At Yard

2 Accommodation Units

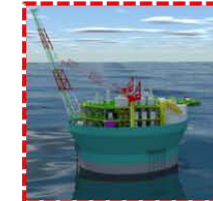


Arendal Spirit
2015



Stavanger Spirit
At Yard

FPSO Under development



Cambo FPSO (S650)
ON HOLD

- 22 years of experience with design, engineering and construction
- Close to 70 years of accumulated operation in harsh environment



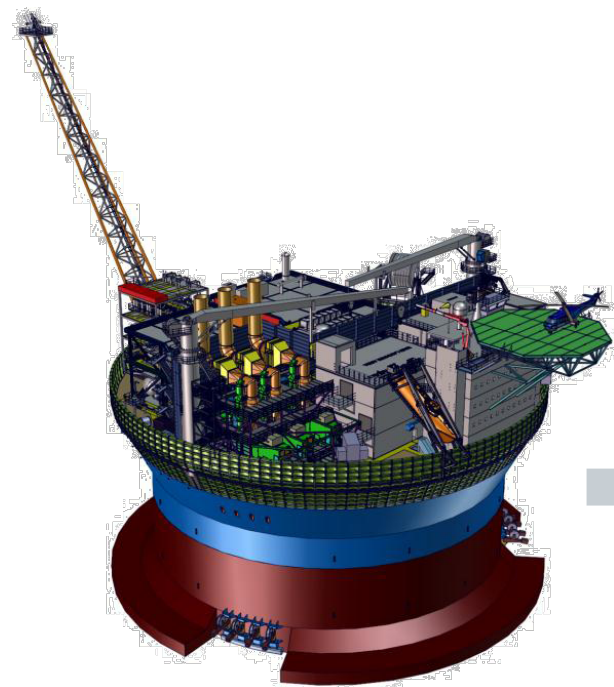
Basis for SWACH™ Concept (Small Waterplane Area Cylindrical Hull)



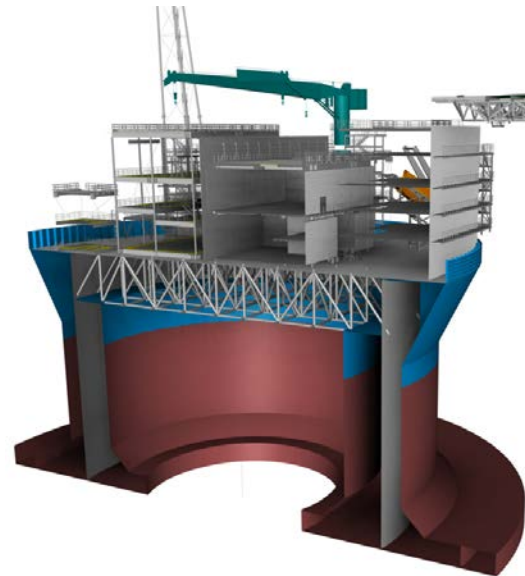
FPSO transformation to FOWT

SWACH Concept

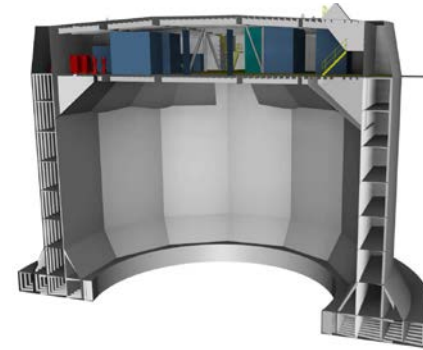
- Improved motions compared to conventional hull
- Motions comparable to SEMIs
- Suited for several other applications



FPSO



Production unit, no storage



Unmanned subsea
support unit



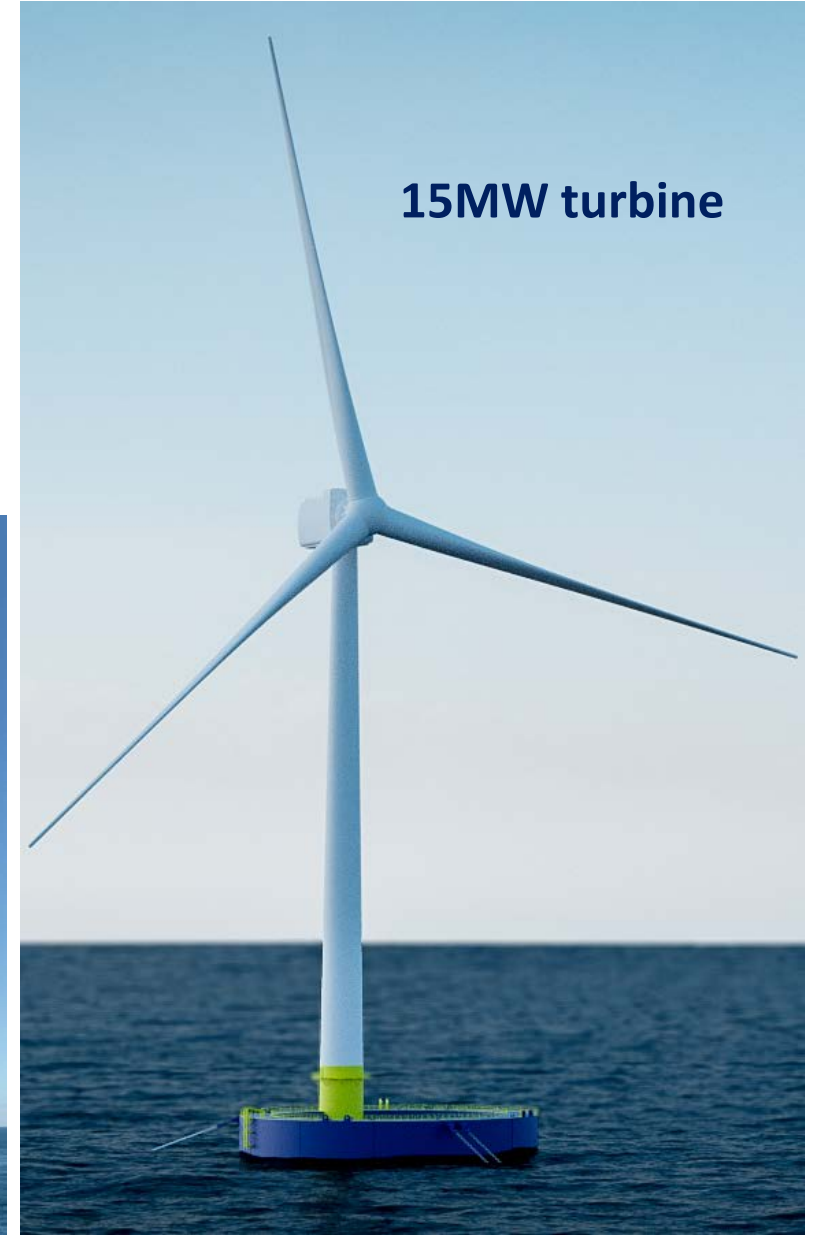
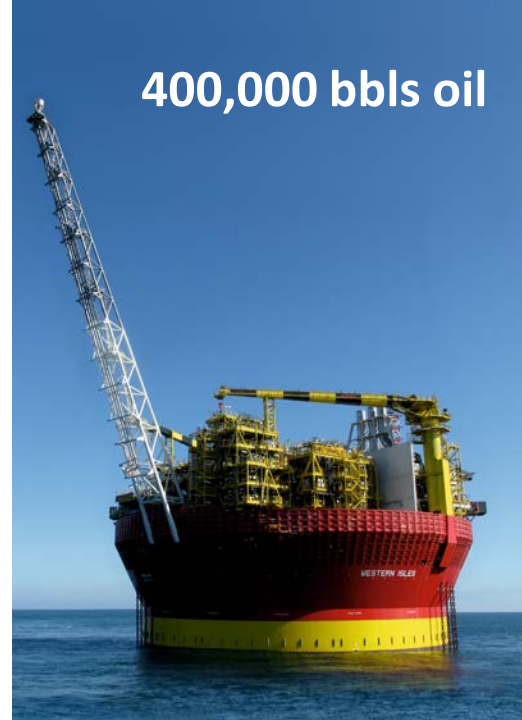
FOWT

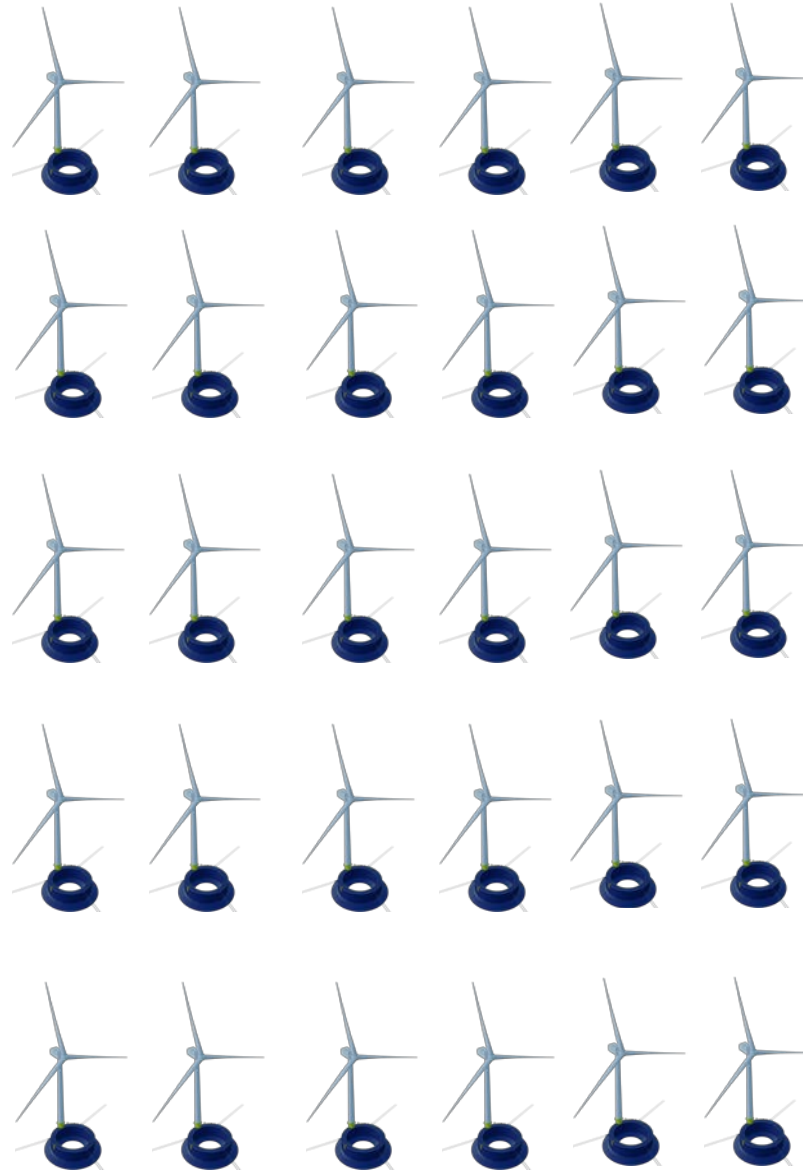
FPSO vs FOWT Size

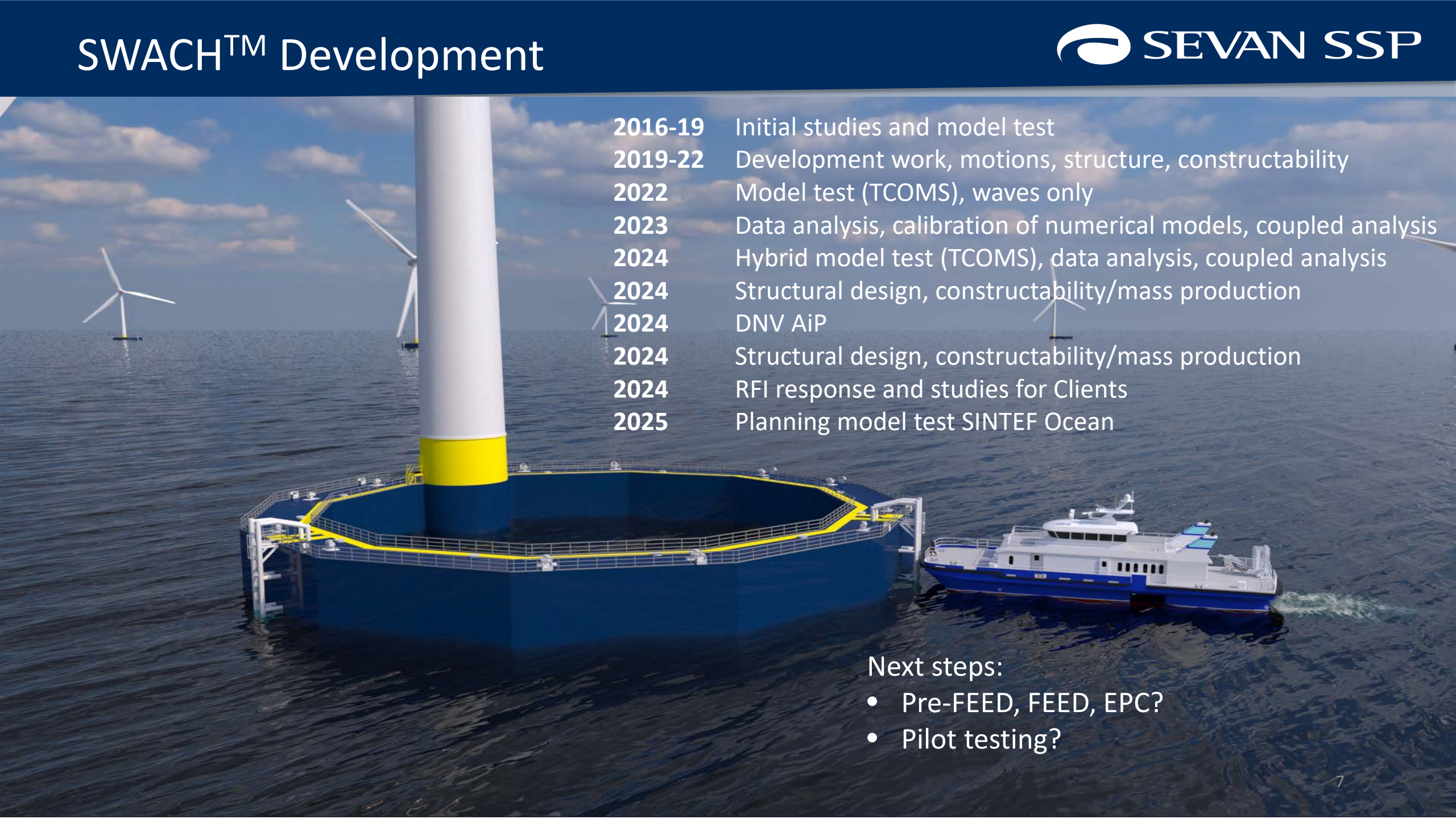
	FPSO	FOWT (15MW)
Diameter (m)	70	67
Hull depth (m)	32	26
Freeboard (m)	12	7

FPSO: Storage, topside capacity, stability, motions, mooring

FOWT: Totally different design and load picture





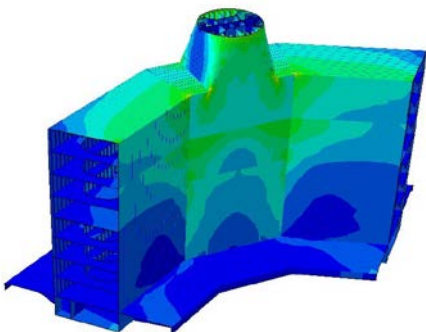
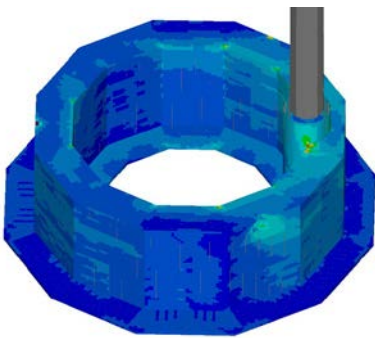
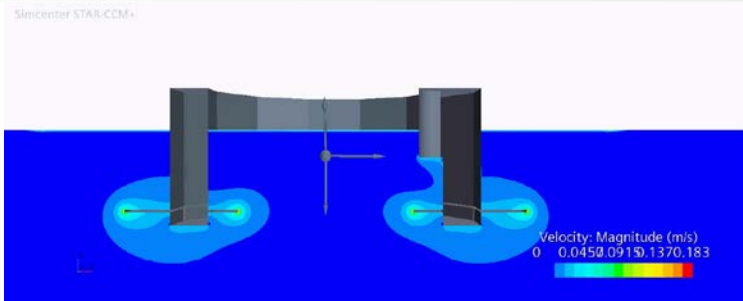
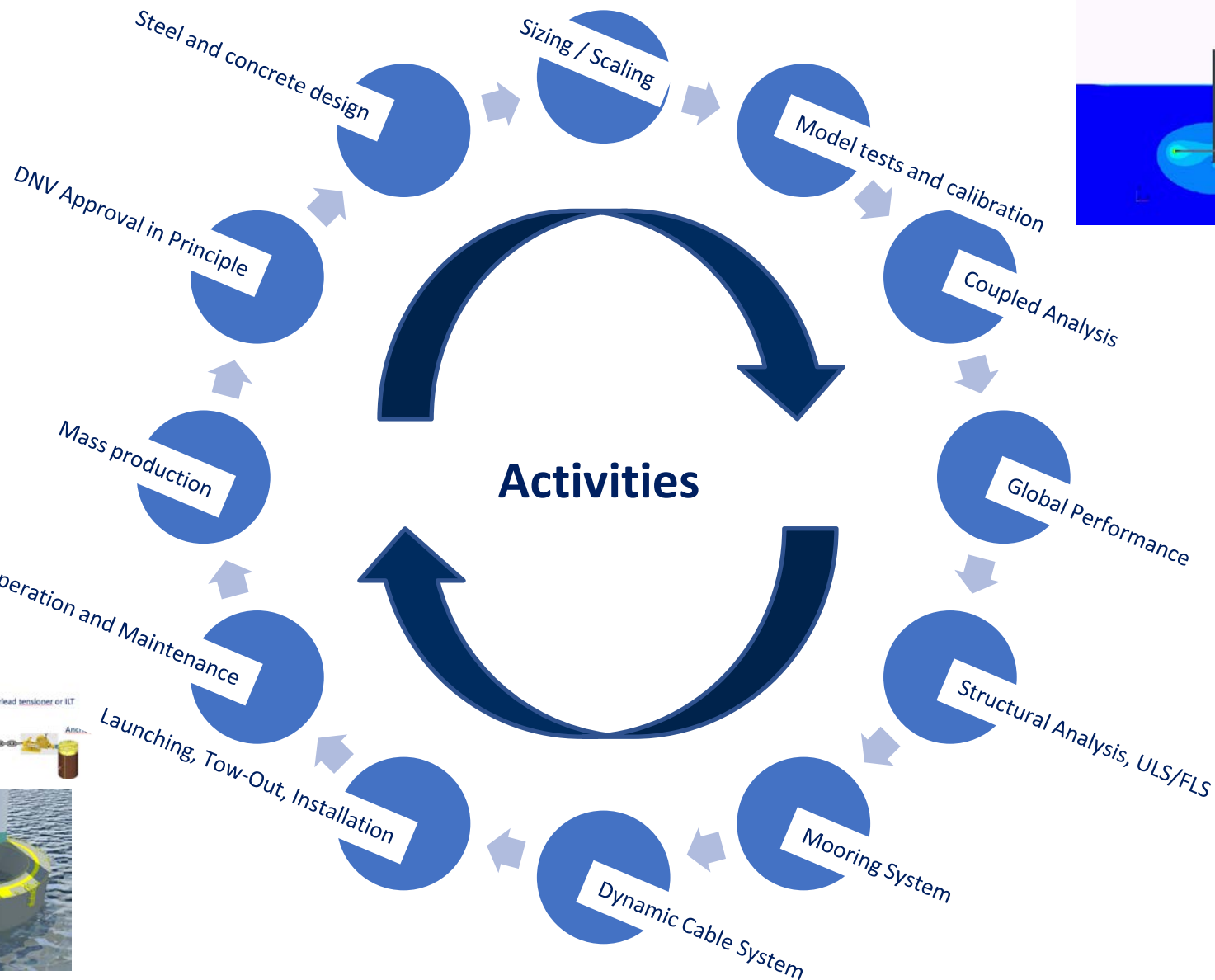
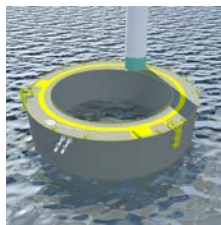
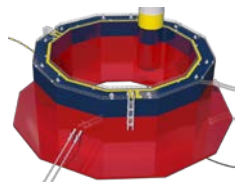
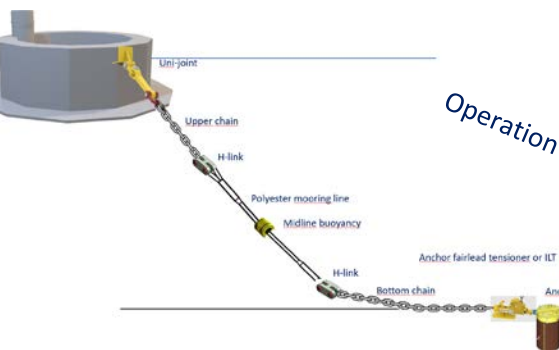
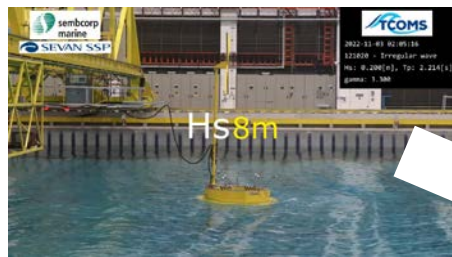
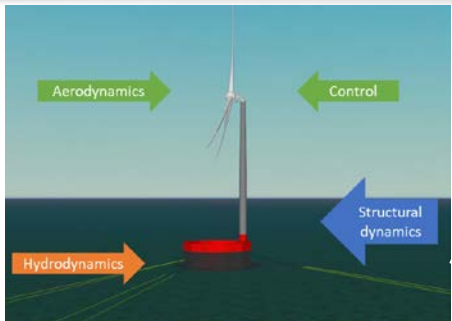
A large offshore wind turbine with a white tower and a yellow band near the base, mounted on a blue octagonal platform. The platform is surrounded by a yellow safety railing. A blue and white service vessel is docked at the platform. In the background, other wind turbines are visible on the horizon under a blue sky with scattered clouds.

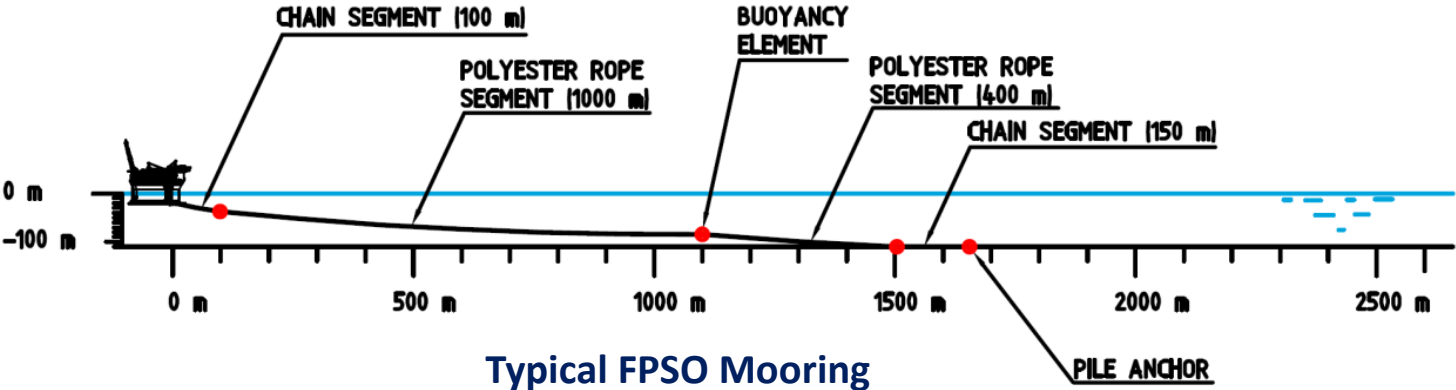
2016-19	Initial studies and model test
2019-22	Development work, motions, structure, constructability
2022	Model test (TCOMS), waves only
2023	Data analysis, calibration of numerical models, coupled analysis
2024	Hybrid model test (TCOMS), data analysis, coupled analysis
2024	Structural design, constructability/mass production
2024	DNV AiP
2024	Structural design, constructability/mass production
2024	RFI response and studies for Clients
2025	Planning model test SINTEF Ocean

Next steps:

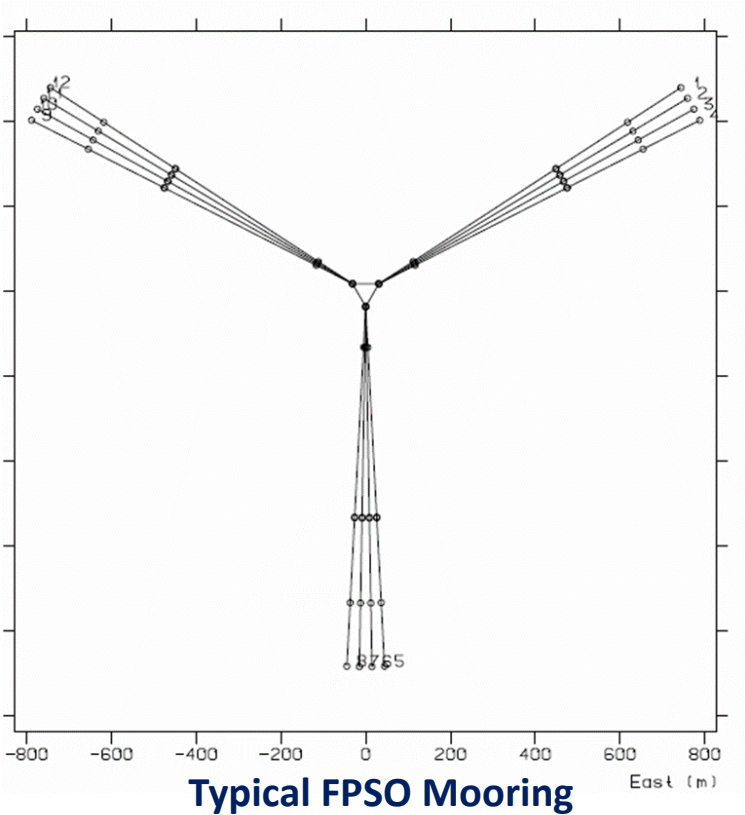
- Pre-FEED, FEED, EPC?
- Pilot testing?

Design Wheel – Moving Target





Typical FPSO Mooring



Typical FPSO Mooring

Mooring System	FPSO	FOW
Mooring clusters	3	3
Mooring lines	12-16	6-8
Configuration	Anchor-Chain-Rope-Chain Fairleads and Winches	Anchor-Chain-Rope-Chain Chain tensioners

Goliat FPSO (2016) Power from Shore

- HVAC Cable: 105 km
- 75 MW @ 123 kV AC



- Impact from turbine
- Coupling between wave loads and wind loads, (coupled time-domain aero-hydro-servo-elastic analysis).
- Elastic response of tower (>1P soft-stiff <3P, >3P stiff-stiff).
- Coupled vibrations of floater structure, tower and blade.
- Mooring: more load cases need to be checked due to effects from wind turbine.
- Model testing more complicated, real-time hybrid test.

Optimisation

- Motions
- Structure (fatigue, weight/cost, constructability)
- Mooring system

Funding

- No funding from clients

Competition

- Huge number of FOW concepts, find differentiators, stand out

Projects

- Huge number of projects worldwide, which ones to target?

Clients

- Huge number of clients/consortiums, which ones to target?

Equipment information

- Turbine OEMs very restricted on sharing information

Mass production / industrialisation / supply chain of foundations

- Steel block factories, oversea transportation, local assembly sites

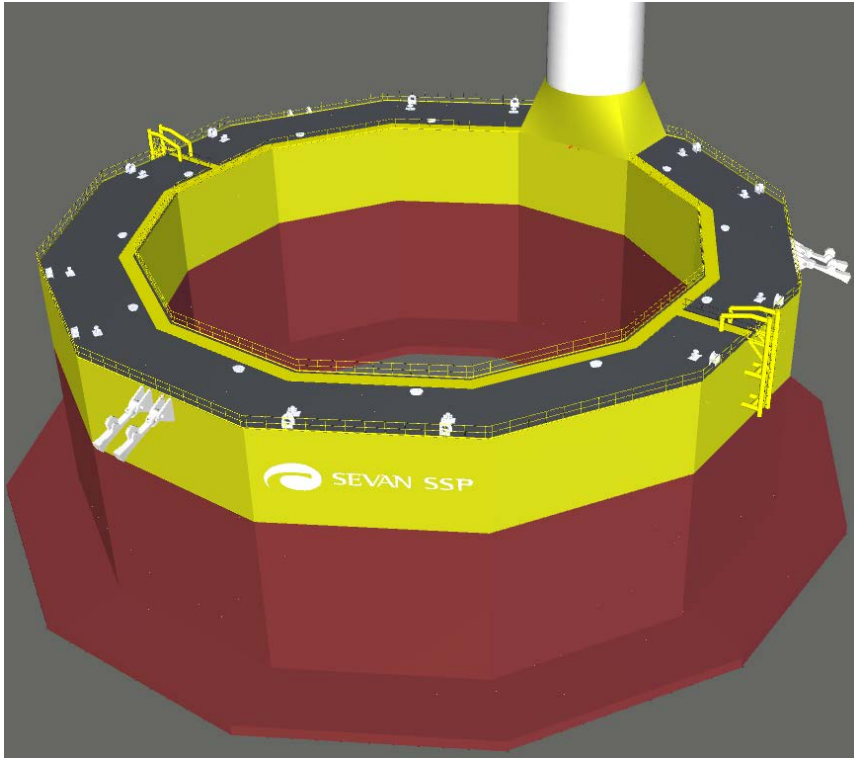
Scaling of Foundation

- Scaling to large turbines
- Scaling to different OEM requirements
- Scaling to environmental conditions

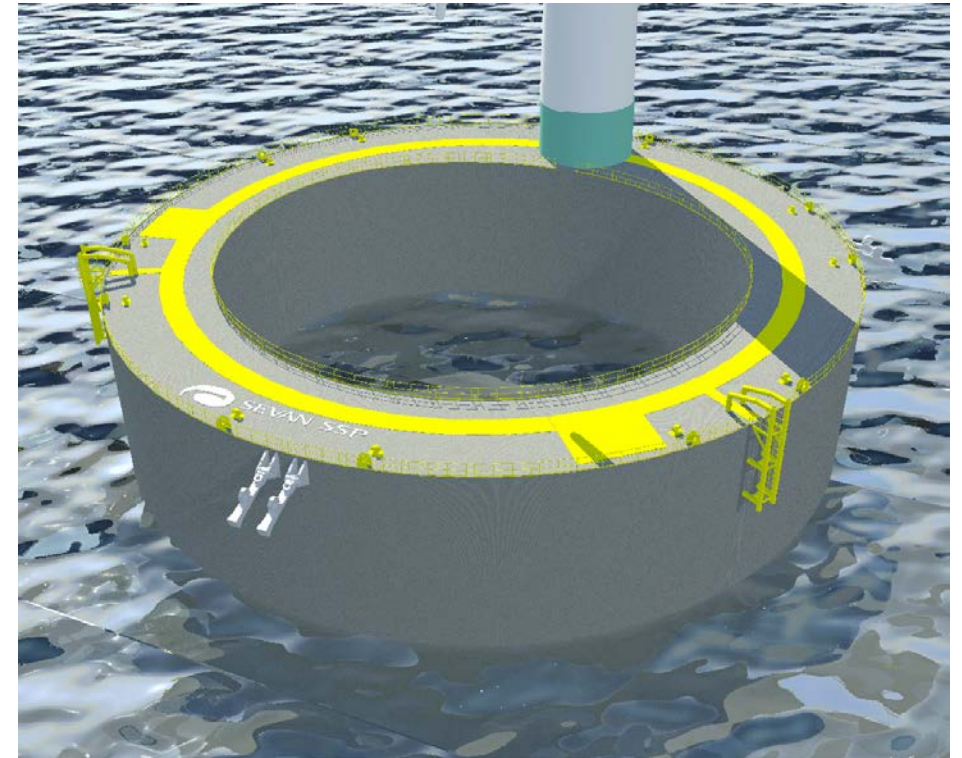


Steel or Concrete?

- Steel and concrete design will have similar main dimensions and global performance.
- Cost and delivery time.
- Location of wind farm, transportation and construction facilities.



Steel

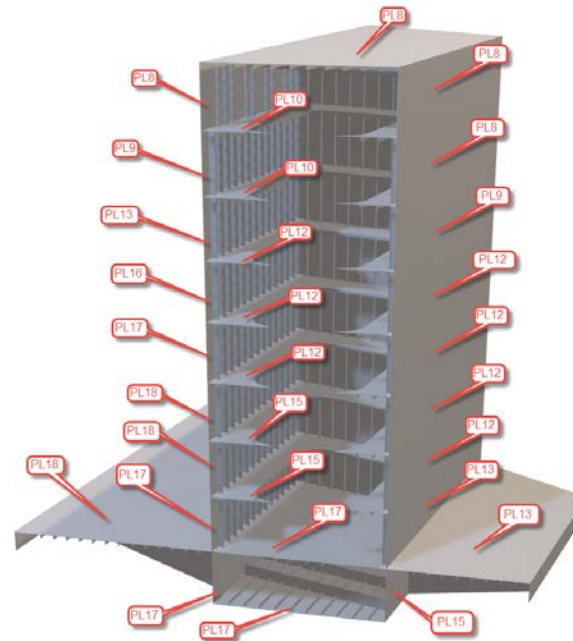


Concrete

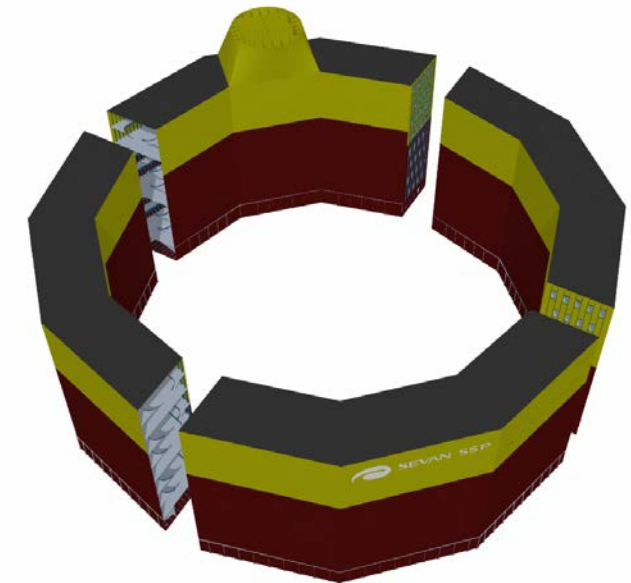
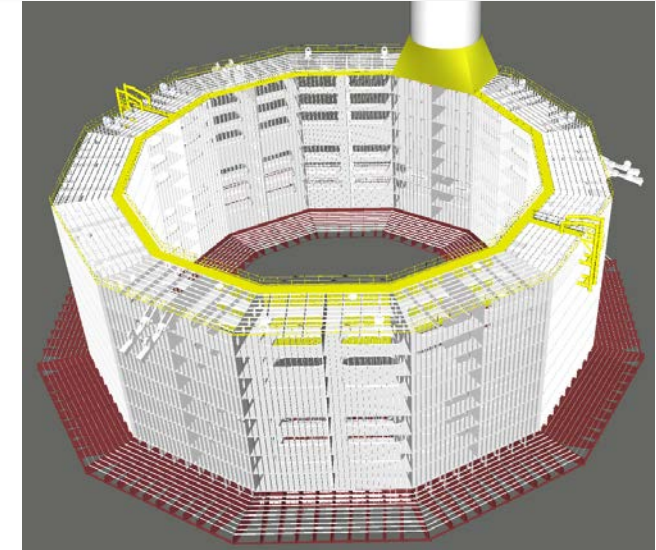
- Polygonal shape with 12 blocks and 4 sections.
- 1 section for tower support, 3 identical.
- Flat panels, thin plates, girders, frames, stiffeners: typical shipbuilding.
- Plate thickness of vary from 10-18mm (except tower section).
- Less complicated welding nodes, automatic welding.
- **Suited for mass production.**



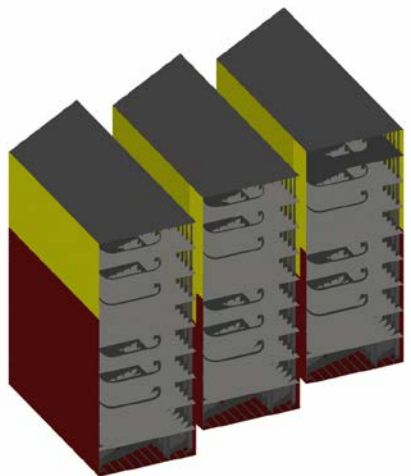
Flat panels



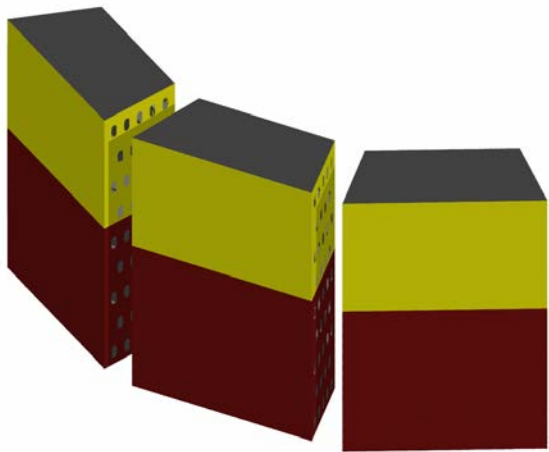
Identical blocks



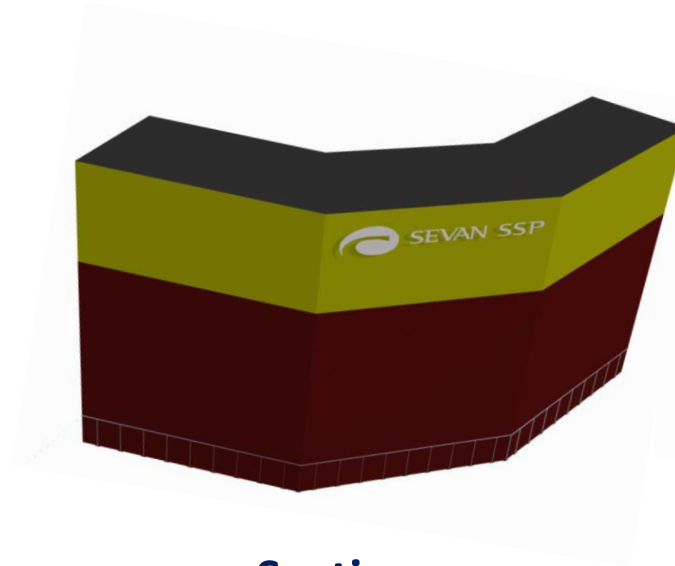
Identical sections



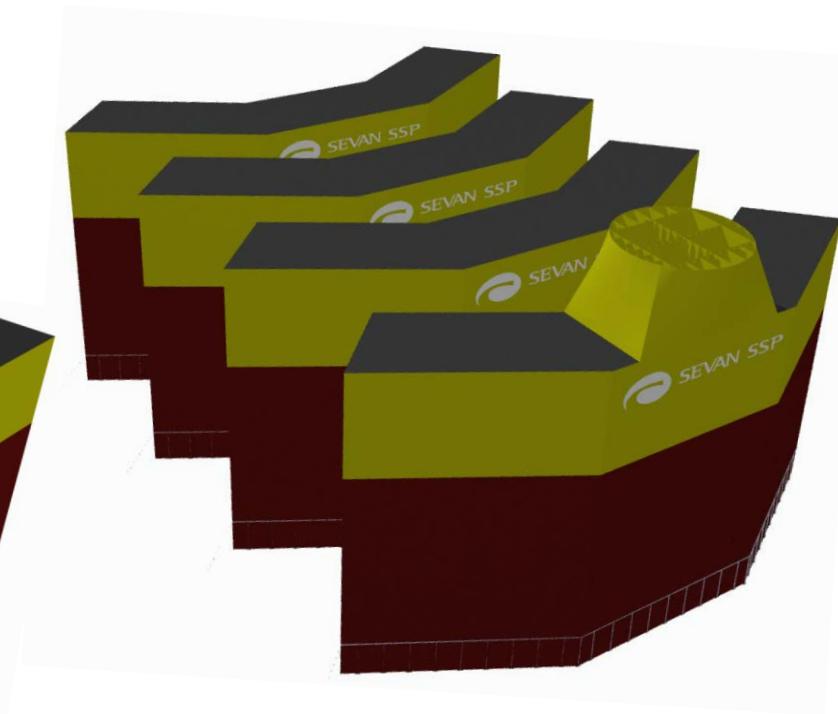
Blocks



Blocks

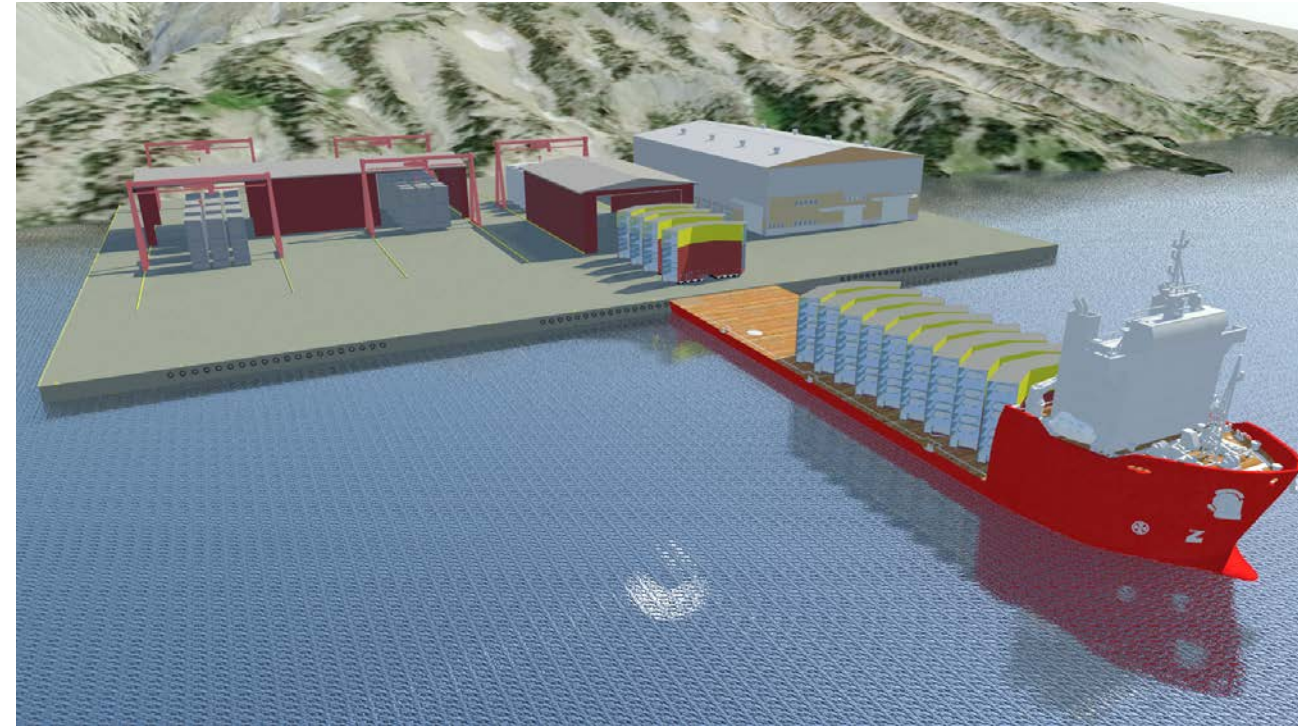


Section



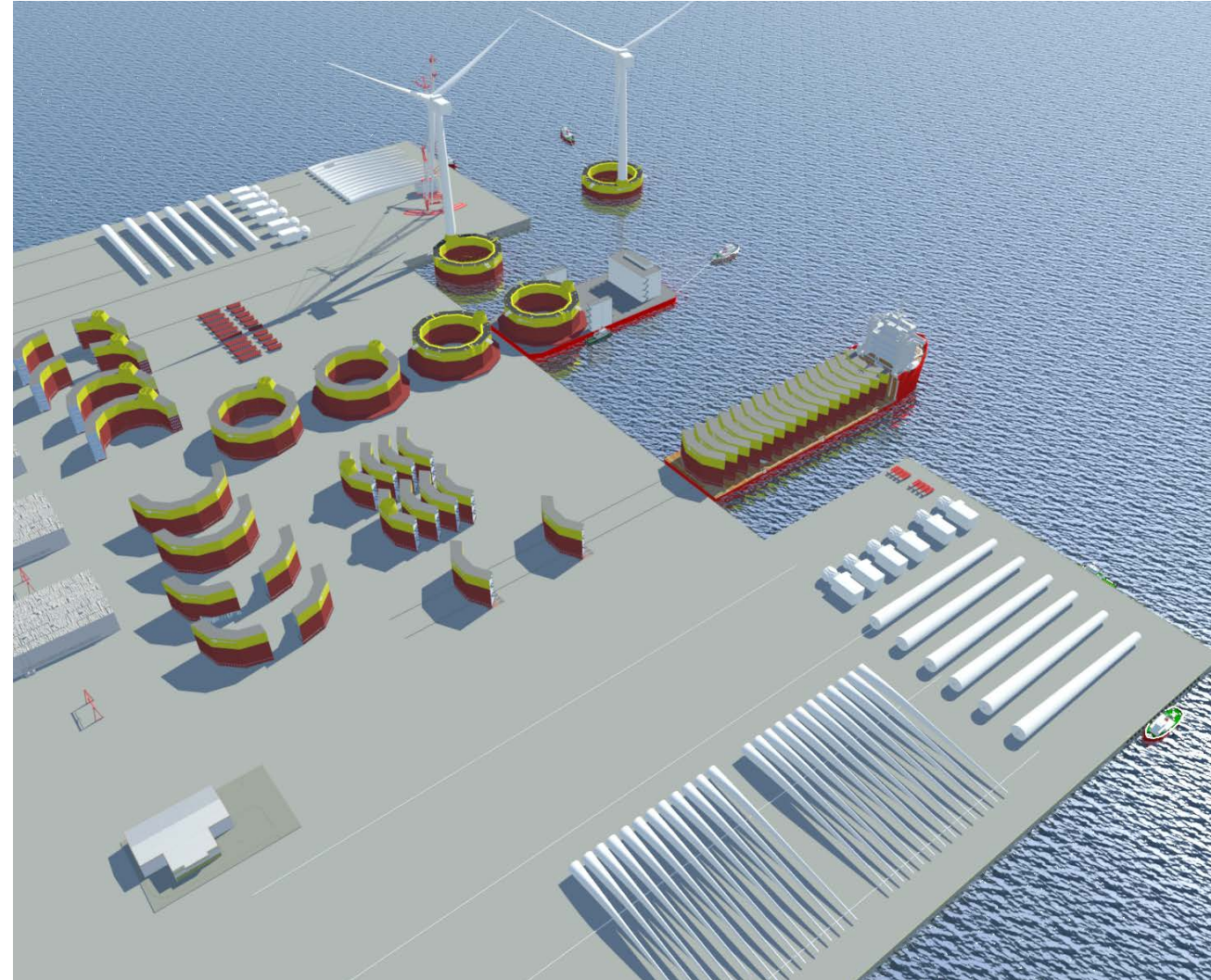
Sections

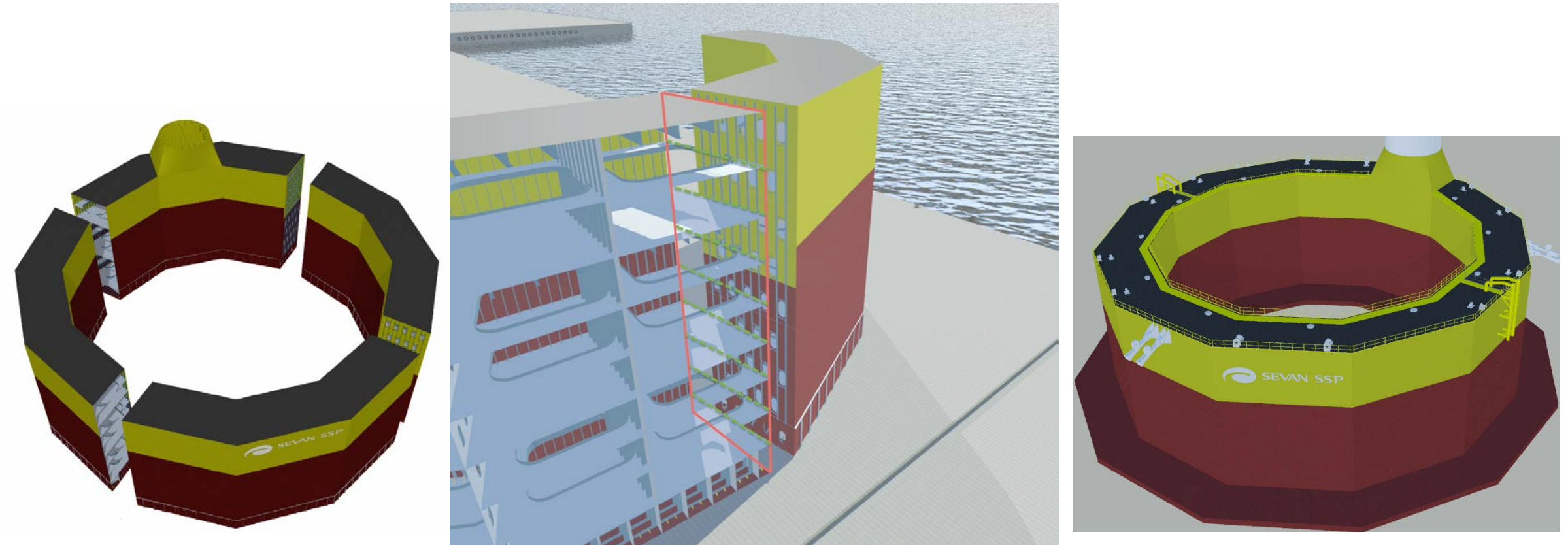
- Mass production of blocks at specialised steel fabrication yards/factories
- Fabrication of blocks also at smaller local yards
- Utilise various fabrication capacity



- 16 sections can be loaded on to large Heavy Lifters
- Corresponds to 4 foundations

- 16 sections on Heavy Lifter
- Assembled to 4 complete foundations
- 4-5 weeks to complete a foundation
- Delivery of one complete foundation per week





Reduced work at assembly site

- Scaffolding
- Full penetration welding on outer shell
- Wedge welding on inner decks
- Touch-up painting

Low draft

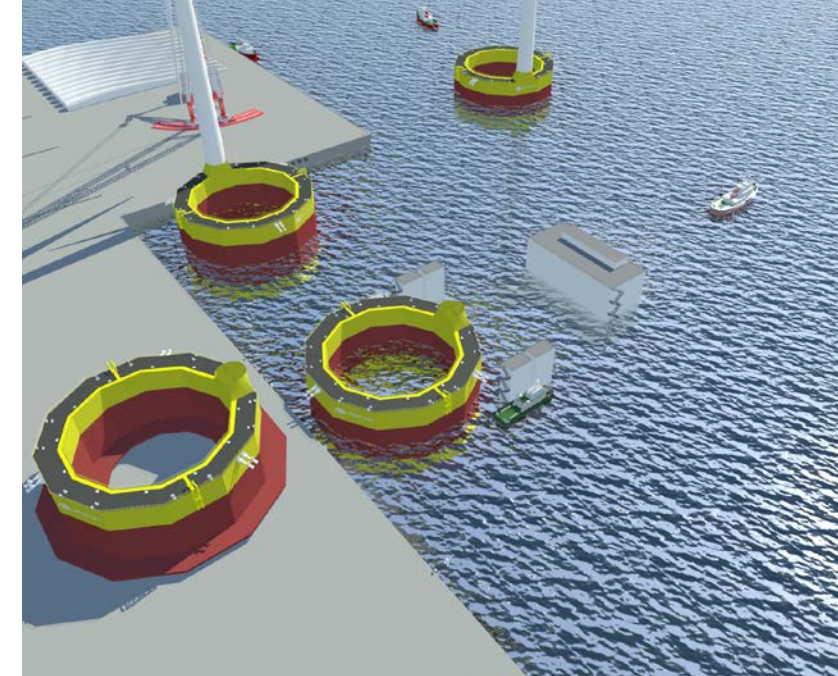
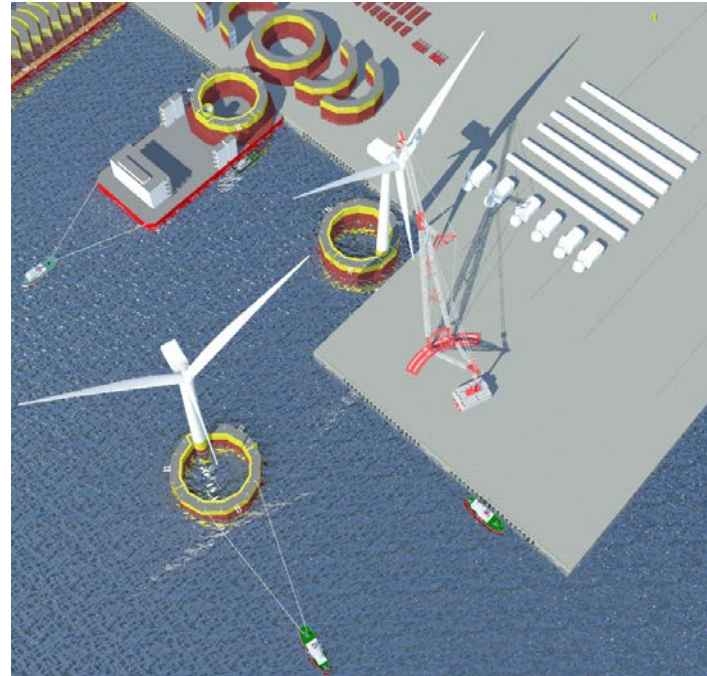
- Required depth at quayside
- Launching depth
- Port operations

Size of foundation

- Required quay length
- Area for wet storage

Crane operation

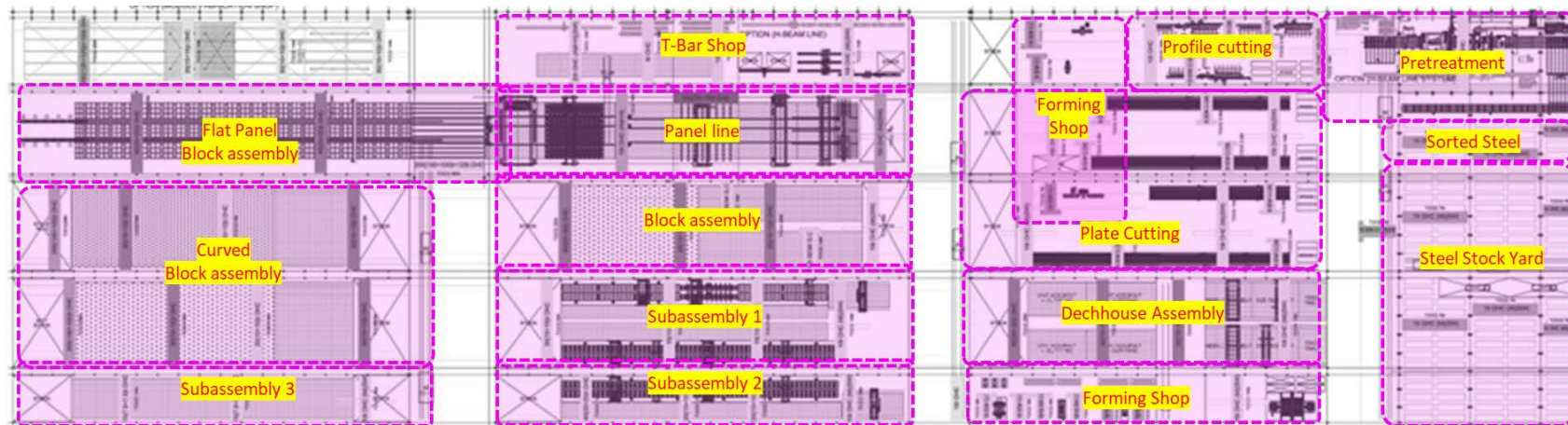
- Orientation of foundation
- Crane reach



Mass Production of Blocks/Sections



- Yard layout to suit the workflow with robotic welding
- Multiple lines each with steel capacity of 4,000tons per month
- 12Ha workshop is suited for 240,000tpa throughput
- 40-60 foundations pr year



Yard capacity:

- Indonesia
- Philippines
- Singapore

Seatrium Global Player in the FOWT Industry



