Temporary floating ports for offshore wind

Summary presentation slides

Created: July 2024 | Update: October 2024

Project background

The following slides formed the basis of a presentation in July 2024.
Updates made October 2024 following further information from some case study technology proponents.

Scottish Enterprise ARUP

Project background

Purpose of study

- This study considers floating port concepts and other technologies intended to augment conventional port capacity for OSW deployment.
- Used to inform Scottish Enterprise (SE) on:
  - Current development status of concepts
  - Potential role of floating ports alongside conventional ports in OSW deployment
  - Position of SE and wider Scottish public sector towards deployment of these technologies.

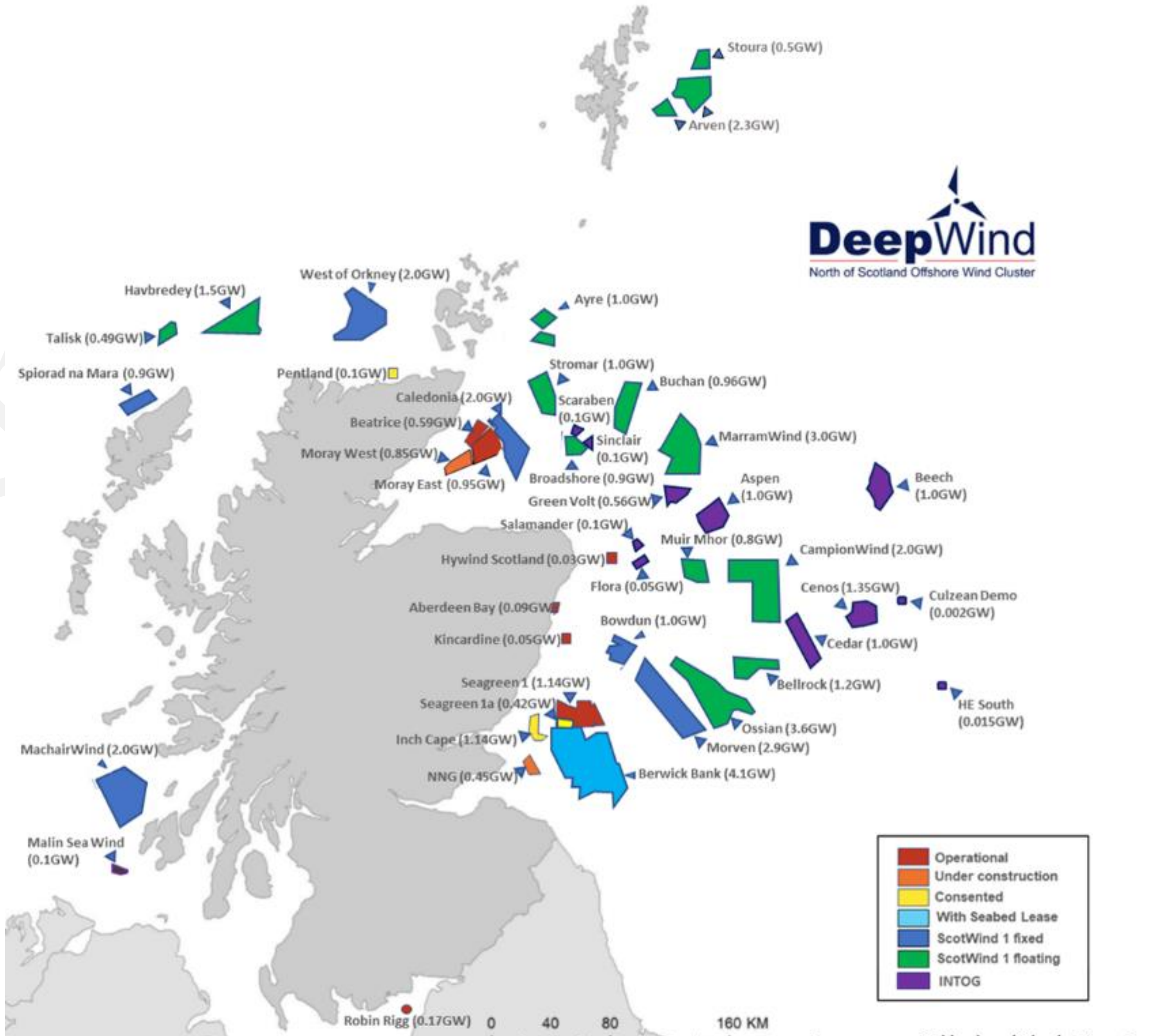
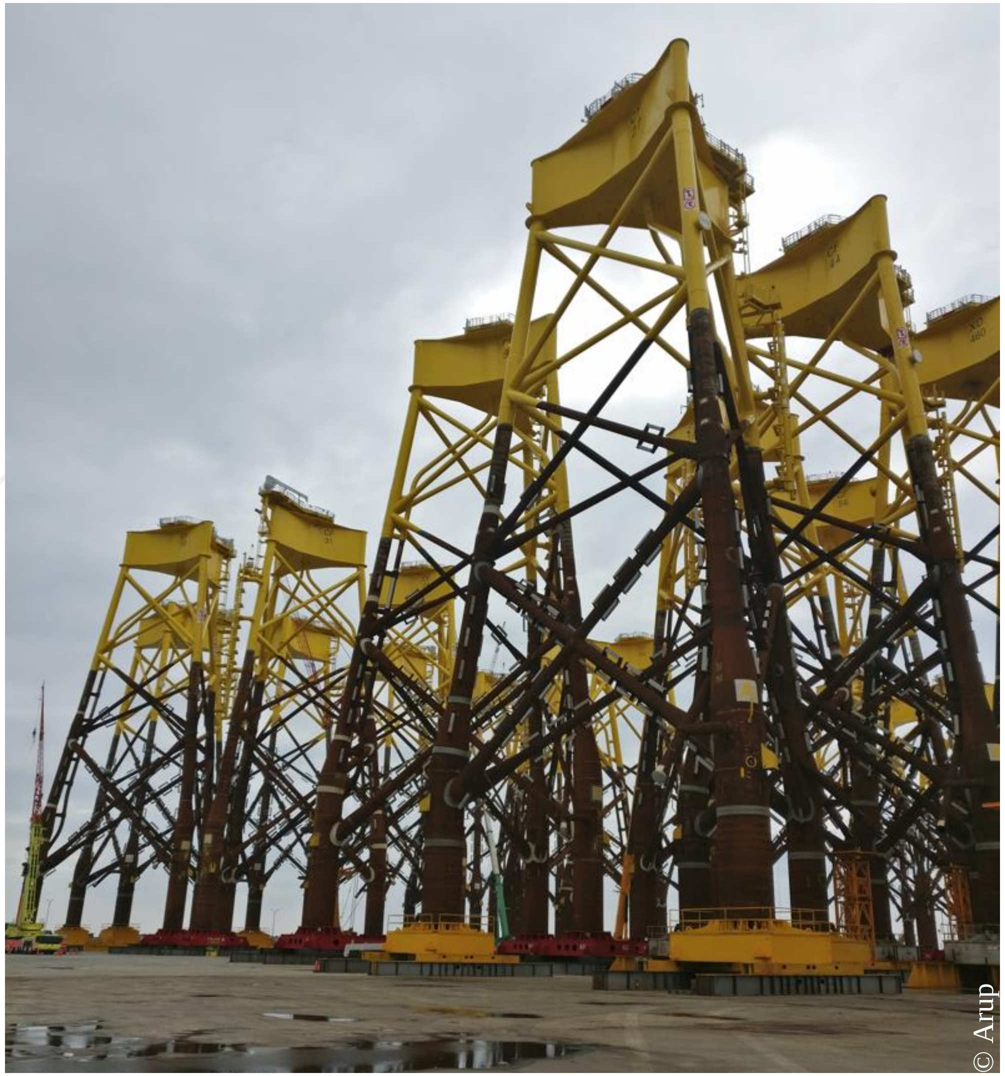


Image source: Highlands and Islands Enterprise

Project background

Methodology

- Review of case study technologies
- Comparison against conventional methods
- Qualitative criteria:
  - port functions addressed
  - technology readiness
  - implementation
  - consenting considerations
  - adaptability
  - cost
  - programme



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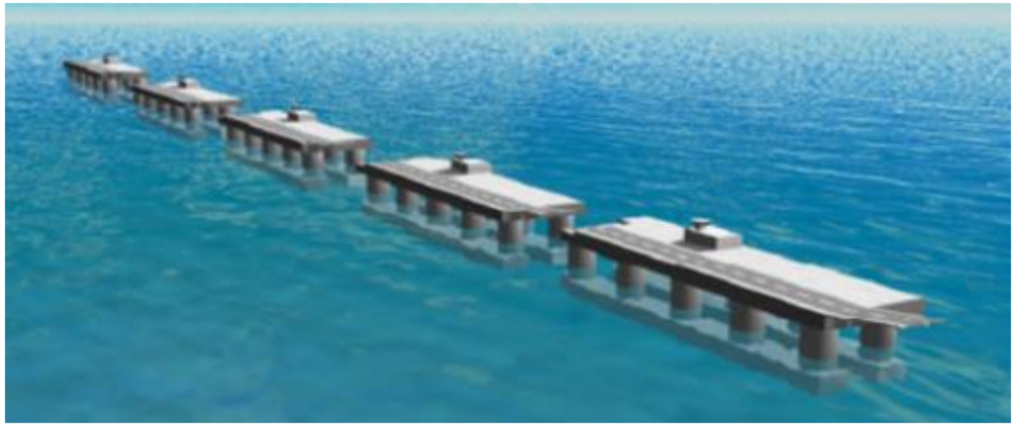
Precedents from other sectors

Megafloat Runway - Japan

Phase 1 Experimental Model

Phase 2 Experimental Model

Mobile Offshore Base (MOB), US Department of Defence



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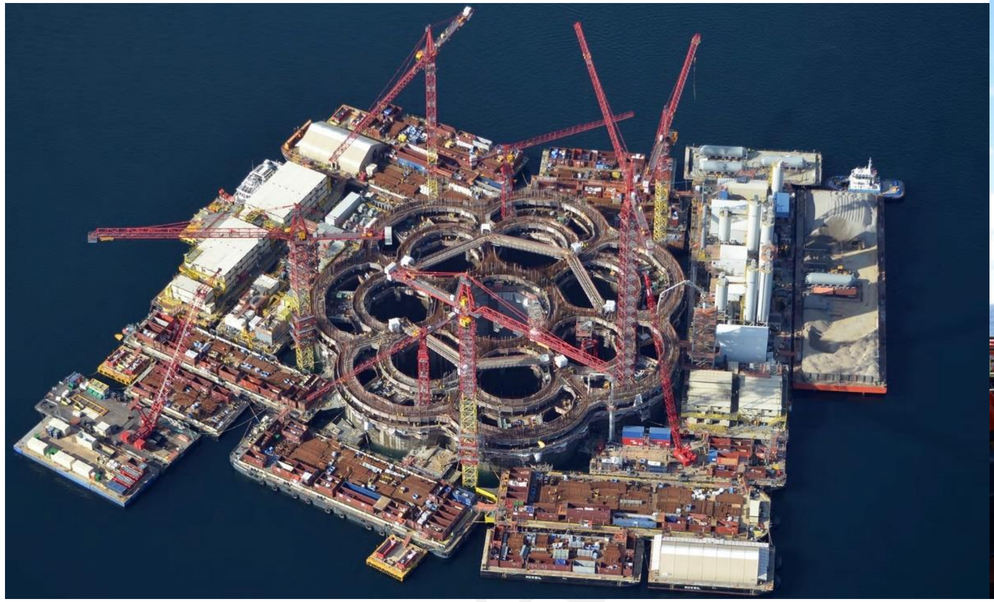
Precedents from other sectors

Barges

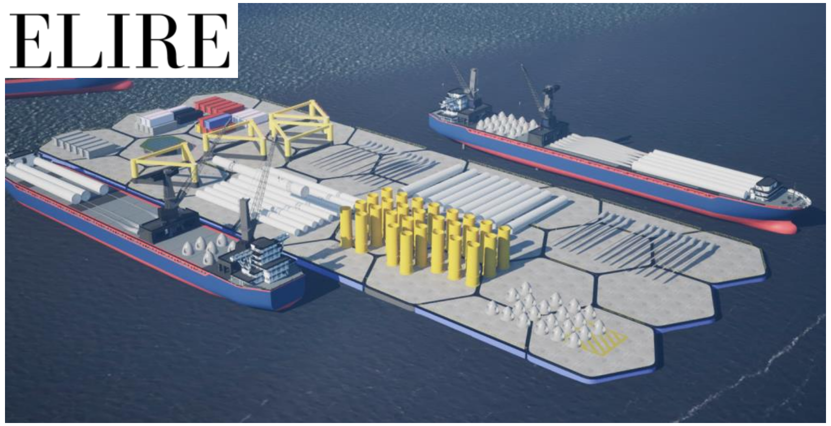


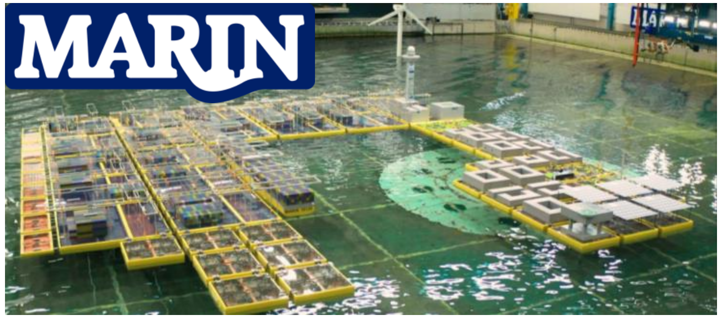
Floating oil and gas platforms

Case study summaries

Case Studies

Scottish Enterprise ARUP



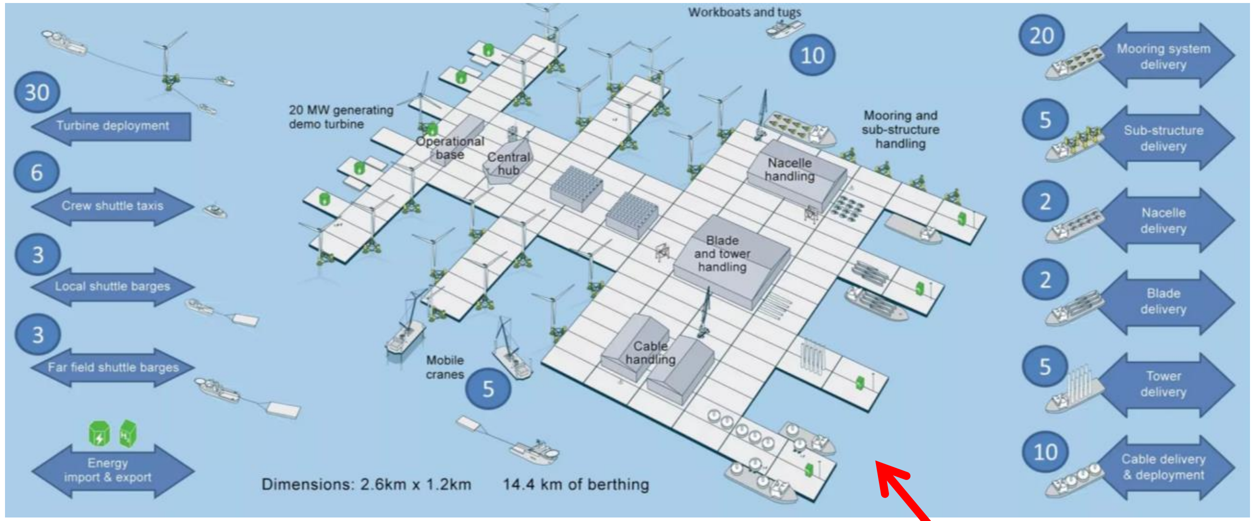


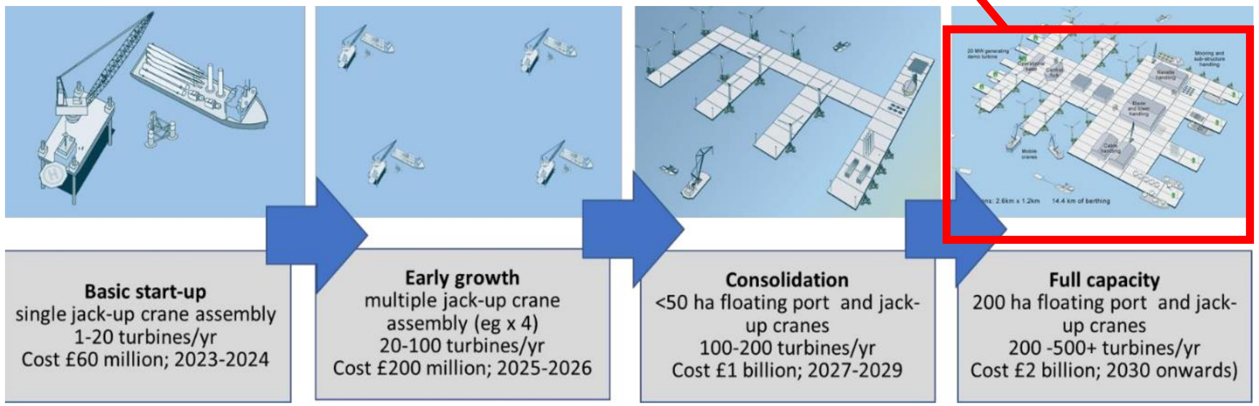
Summary based on information provided by technology proponents.

Scapa Flow Megahub

General information

- A **strategic port services hub framework** based around, flexible, floating, moored, jack-up assets
- Available for start-up use within 6 months with suitable finance (<£5M)
- Developed for **Scapa Flow (Orkney) as Strategic Sector Hub**
- Up to **10 km of berthing @ 25 m; 10 m to 50 m water depths; up to 50 moorings; 200 ha deck space; 20,000 ha** sheltered port area
- Component principles and technologies could be applied elsewhere at appropriate scale
- **Key components**: Wet storage; seabed storage; permanent moorings; flat-top barge marshalling; linked/rafted pontoons; mobile floating and jack-up cranes; floating dock(s); tow-out and installation fleet; port fleet; floating slipway linkspans and shuttle links to coastal laydown and support facilities; marine and port services workforce
- Potential for **reuse of existing assets**: flat top barges, crane vessels, floating docks, adapted drilling rig platforms
- High potential for **demonstration and application of novel solutions**





Port functions addressed

- Component storage
- FOW integration
- FOW integration craneage
- Modular
- Other applications – wet storage, turbine tow-out and install, major maintenance, decommissioning, offshore substation float-out, O&M, vessel vicuating (incl. clean fuels), innovation hub, workforce training

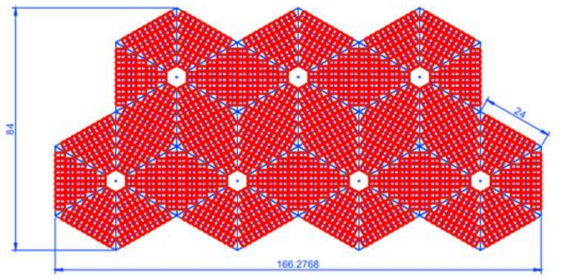
ELIRE

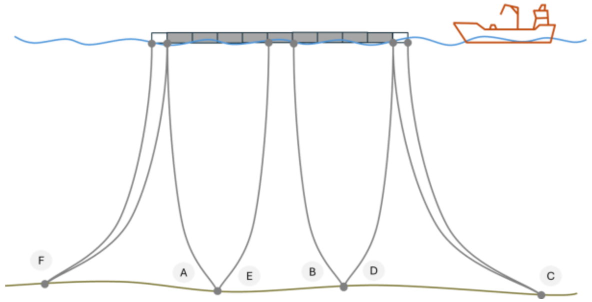
Floating Modular Platforms

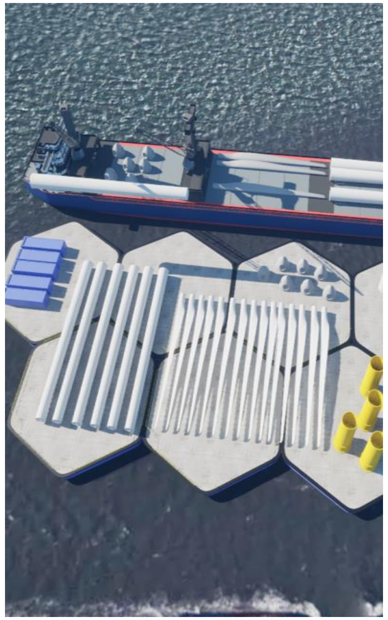
Scottish Enterprise ARUP

General information

- *"Floating Modular Platforms 'Smart Hubs' and the service offering to support them are a direct response to a lack of solutions available for ports to integrate new technology fast enough to make a positive impact or to create space at pace, with minimal (temporary) environmental impact."*
- **Modular hexagonal** and half-hexagonal framed platforms with options of: 24m (375m^2), 32m (675m^2), 40m (1050m^2), 48m (1500m^2) diameters
- **Load capacity :** Up to 1600t for 1500m^2 per hub is possible (current design).
- **Containerised** solution for transport- multiple options for construction materials
- Option for fixed, removable or inflatable **buoyancy tanks**
- **Simple assembly & launch** from quayside or extending from existing hubs
- Designed around **central core** unit for utility routing to/from shore (if required)
- Many options to provide **full berth and/or fendering** for outer hubs perimeters
- Configuration stabilised at pivotal hubs by **moorings to seabed**
- Optional on-board **craneage** central to a hexagon unit







Port functions addressed

- Component storage
- FOW integration berth
- FOW integration craneage
- Modular/ scalable growing/shrinking with project
- Other applications - Inshore/Estuary/Urban realm and for berthing/charging/cold ironing of vessels when alongside, last mile logistics hubs, smart grid and disaster relief support being explored

Summary based on information provided by technology proponents
For further information see *elireinfra.com/smart-hubs*

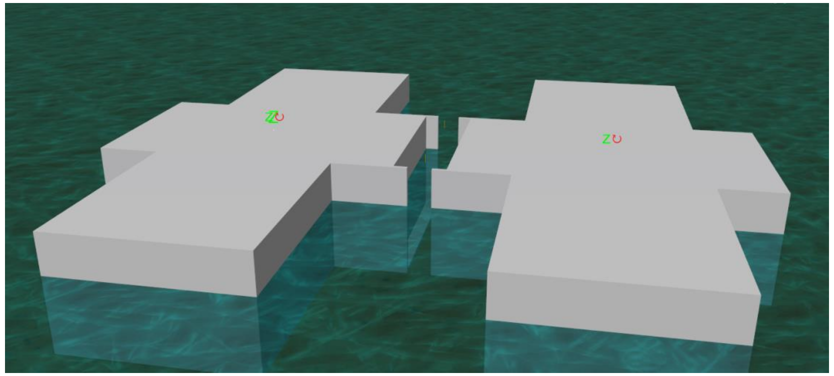
ALFowt C2C

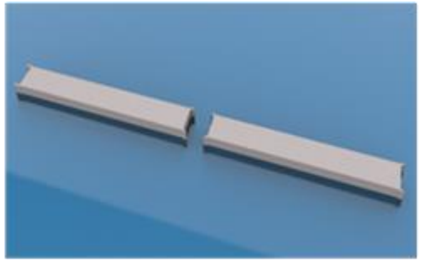
General information

- **ALFowt C2C** (Assembly Line Floating offshore wind turbine using Connect 2 Concrete) is "*an exclusively owned developed IP by Safier Ingenierie sas*" floating concrete platform concept
- C2C connection is **rigid** and is of **the same strength and durability** of caisson creating a monolithic platform from individual caissons connected by C2C at sea
- C2C is **derived from tried concrete submerged tunnel and bridge technology**
- **Single monolithic structure**
- **Low sensitivity to wave action** when moored to seabed or attached to quay
- **Collaboration with Bardex** to incorporate platform lift technology

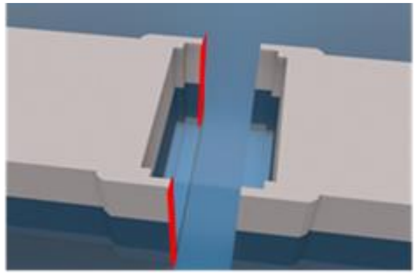
Port functions addressed

- Component storage
- FOW integration berth
- FOW integration craneage
- Modular

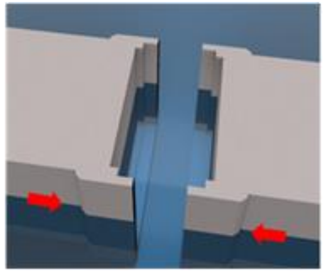




Independent floating caissons.



Pre-installation of an elastomeric joint
Technology proven on immersed tunnels



Bridge segments mating technics
transferred to marine conditions.

Floating Assembly Solution

W3G MARINE | Scottish Enterprise | ARUP

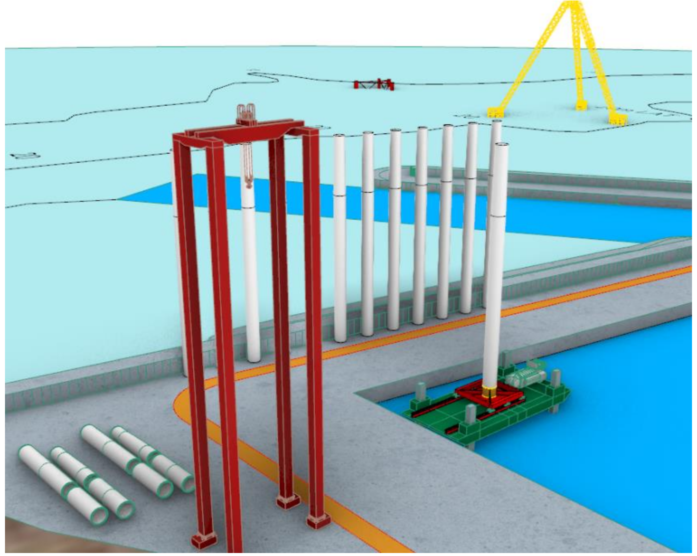
General information

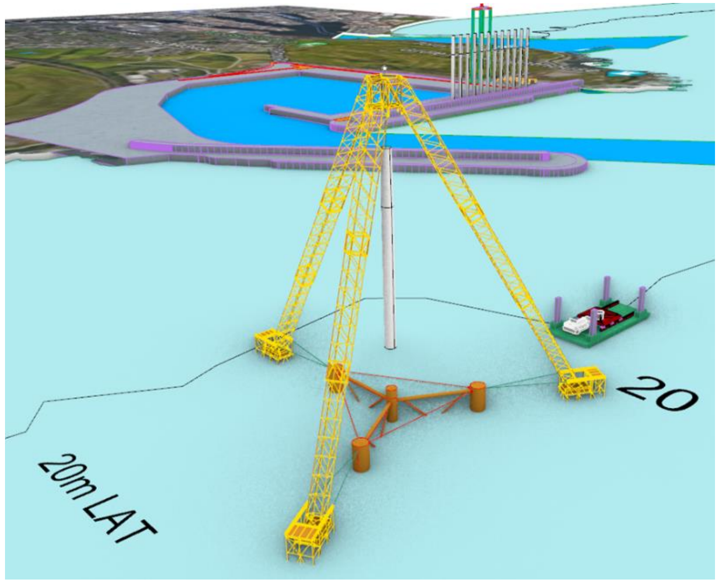
- Tripod lifting structure supported on the seabed in sheltered waters with greater than 20m water depth
- **Method:**
    - **Tower, nacelle and blades integrated** onto the floating substructure (tower assembled and commissioned ashore) OR
    - **A fully assembled turbine integrated** onto a floating substructure
- Floating substructure can be floating, grounded on the seabed or on a transport barge grounded on the seabed
- Assembled at sea by barge delivery
- Steel tower with **telescopic legs**
- **Re-deployable** around the world

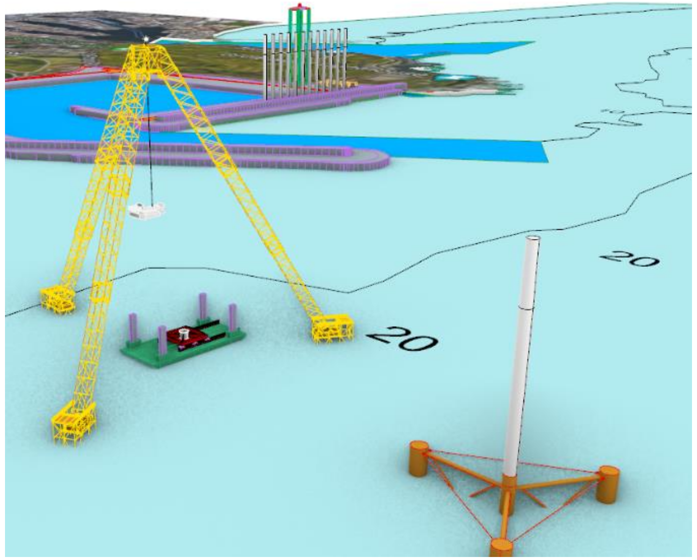
- *"Developed by W3G from their vast experience W3G have been Owner's Engineer on Kincardine offshore floating windfarm since 2018"*
- *"Any turbine onto any floating structure"*

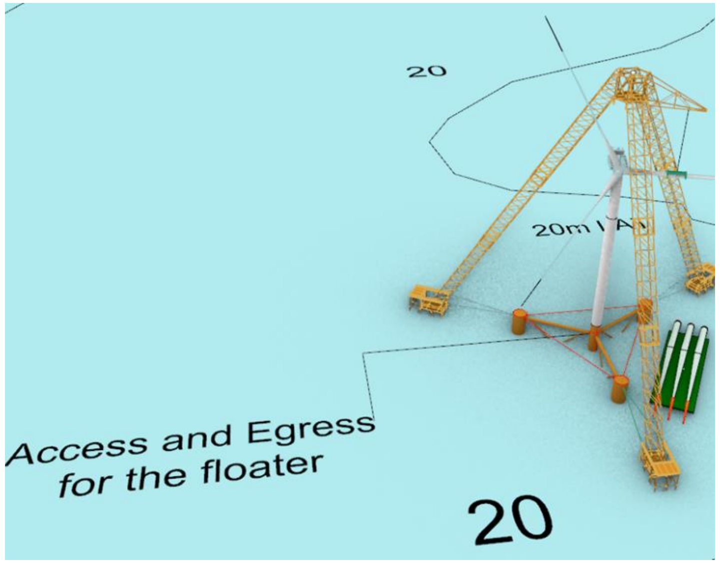
Port functions addressed

- FOW integration craneage









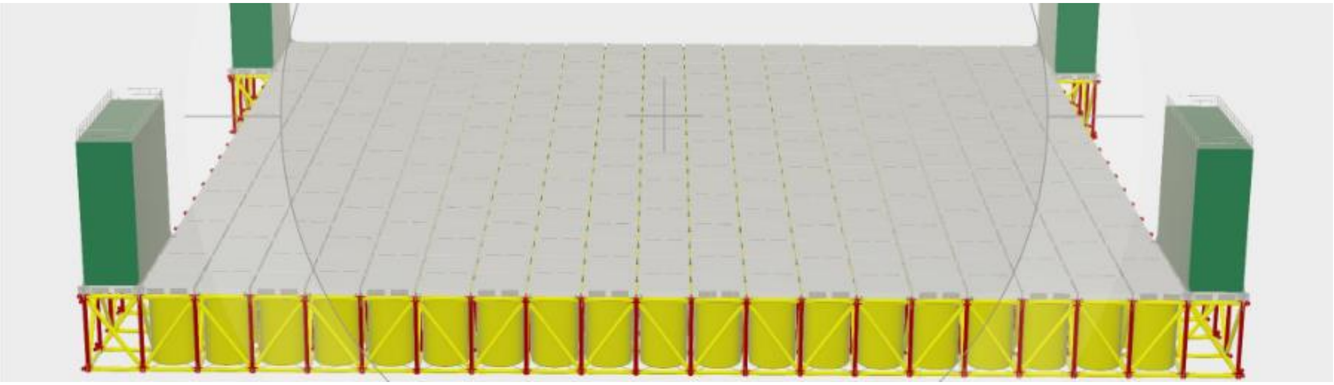
Tugdock Submerisble Platform (TSP)

General information

- **Modular steel framed air lift bags** (Tugdock Buoyancy Units (TBU)) with steel deck
- TBU air bag **uplift of 100te** each
- TBU **5x5m** plan, **7m deep**, **min. draft ~12m**
- TBUs can also be used to provide supplementary buoyancy to FOW substructures (e.g. EDF Provence Grand project)
- **Air ballasting** faster than water ballasting.
- Envisaged development **>100m x 100m** and **20,000te** lift capacity (e.g. a concrete FOW substructure)
- **Modularity** facilitates FOW substructures of different sizes

Port functions addressed

- FOW substructure assembly
- FOW substructure launch
- Component storage
- Modular



Summary based on information provided by technology proponents
For further information see *tugdock.com*

sonitus engineering solutions

Modular Pontoon

Scottish Enterprise ARUP

General information

- **Steel shipping container sized modules**, with patented connection system full vertical height
- **Floating barges** or supported **by jack-up legs** located on platform corners
- Platform bearing capacity up to **15te/m^2**
- Modules designed in **20ft and 40ft** versions
- Units have been fabricated but not yet deployed / tested (July 2024).
- Road/rail/ship transportable

Current designs (not OSW focussed):

- 1no. platform with 4no. jack ups approx. 25m x 25m
- 25m x 40m concept for salvage project (**ongoing**)

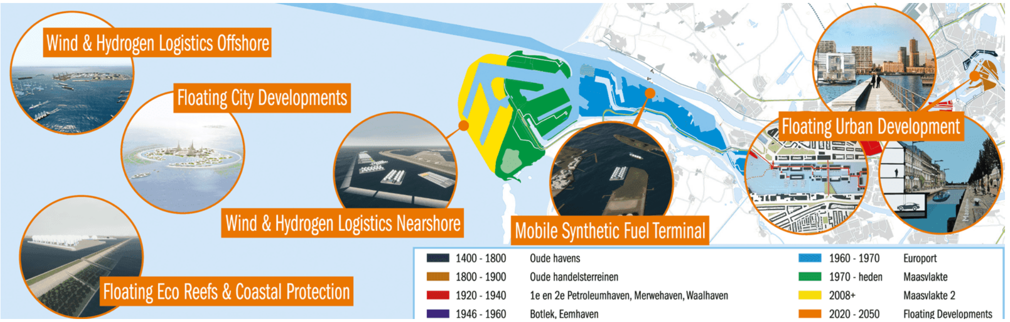
Port functions addressed

- Not explicitly targeted at offshore wind but see potential to target. e.g. Component Storage, FOW Integration craneage

Floating Futures

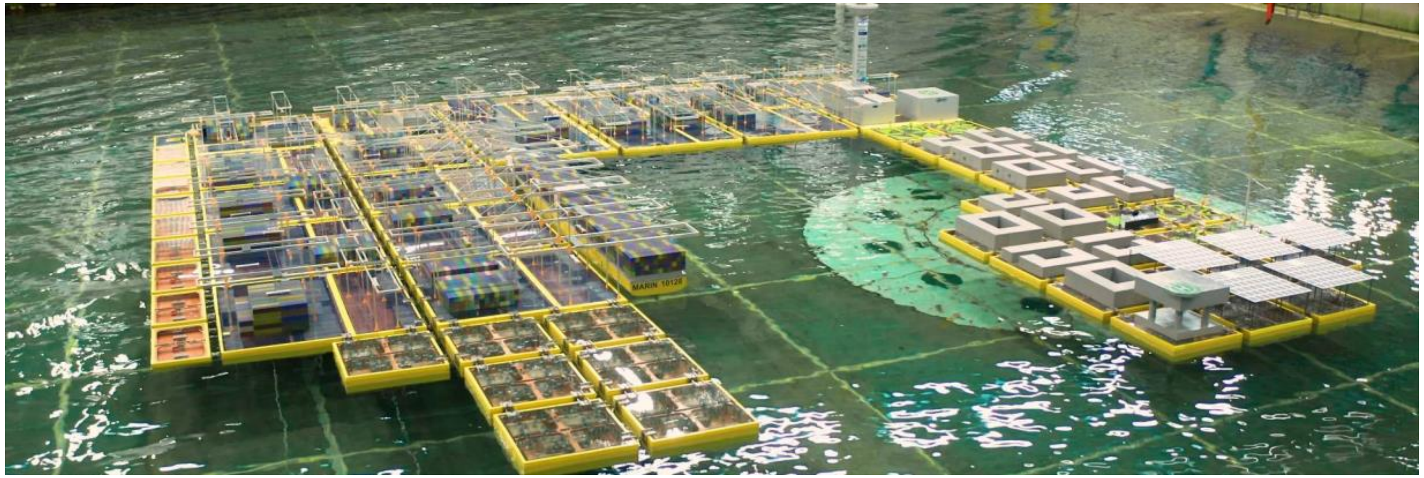
General information

- Consortium led by Marin + partners
- Series of research projects on large scale floating port or floating island concepts for deployment in the North Sea.
- Funding of **€5million** from Dutch Research Council (NWO) + **€1million** through other partners
- Funding allows **development for 2024-29**
- Multiple scaled system variants have undergone tank testing
- Offshore wind logistics, 'energy island', container terminal, synthetic fuels and urban realm among use cases considered.
- Scale would be unprecedented if deployed.



Port functions addressed

- Non-OSW functions
- Modular
- OSW port functions conceivable, including component storage, integration berth provision



Summary based on information provided by technology proponents
For further information *see marin.nl/; floating-future.nl;*

Case Study Summary Table

Scottish Enterprise ARUP

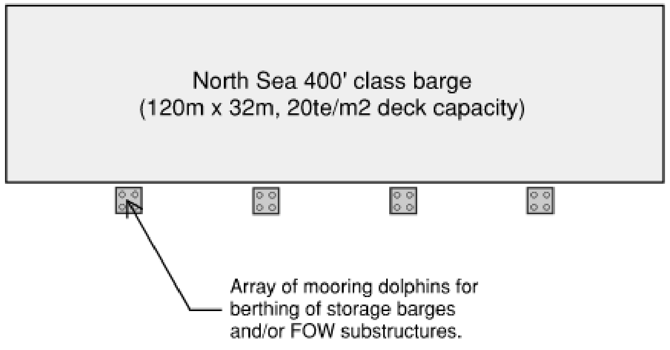
Concept	Main offshore wind capabilities targeted					Adaptability			Primary mooring type	Programme notes
	Component storage (generic)	FOW substructure assembly	FOW substructure launch	FOW integration berth	FOW Integration craneage onboard	Redeploy-ment	Urban realm develop. opportunity	OSW O&M and decommissi-oning		
Aquatera – Scapa Flow Mega Hub	X			X	X	X		X	Seabed (flexible)	4-6 years (<50ha, 100-200 turbines/year output) 7+ years (200ha, 200-500 turbines/year output)
ELIRE - Smarthubs	X	X		X	(X)	X	X	X	Seabed (flexible)	12-month target
Safier Ingenierie sas - ALFowt C2C (concrete caissons)	X	X	X		(X)	X	X	X	Quay or Seabed (flexible)	Confidential
W3G - Floating assembly solution					X	X		X	Seabed	18 months
Tugdock – Submersible Platform	(X)	X	X			X		X	Quay	2025/26 Deploy 50m x 50m TSP in US
Sonitus - Modular Pontoon	(X)	(X)	(X)	(X)	(X)	X		X	Jack-up legs or Quay or Seabed (flexible)	
Marin – Floating Futures	X	(X)		(X)	(X)	X		X	Seabed (flexible)	Funding secured for additional research and development until 2029

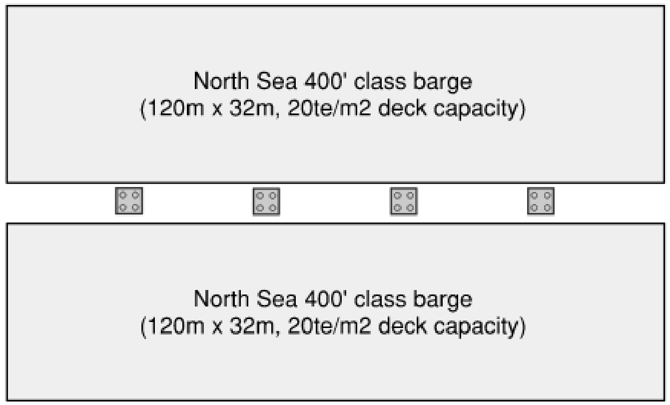
Summary based on information provided by technology proponents.

Arup ‘generic’ concepts for comparison

Scottish Enterprise ARUP

Standard barges & mooring dolphins

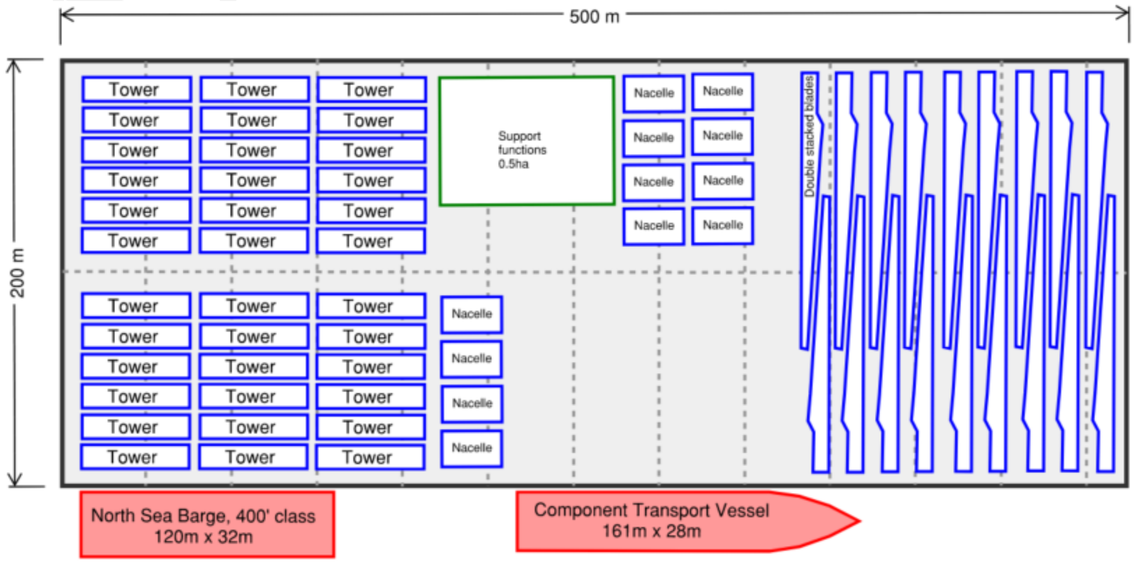




Mega-barge

10ha - (500m x 200m)

Steel or Reinforced Concrete



Costs comparison

Early stage – highly indicative

Concept	1ha platform	10ha platform	Notes
Megafloat Japan Runway Phase 2 (as-built)	£24m	£240m	Based on sources reviewed, pro-rata, 20+ years inflation and currency conversion
Mobile Offshore Base US DoD (estimate)	£260m	£2,600m	Based on sources reviewed, pro-rata, 20+ years inflation and currency conversion
Case studies in this project [range]	**£20-50m**	**£180m-£500m**	**Range of estimates provided by technology proponents**
Arup estimate – standard barges and mooring dolphins	£30-40m	£300-350m	
Arup estimate – mega barge, reinforced concrete	-	£400-500m	
Arup estimate – mega barge, steel	-	£550-650m	

+100% / -50% typical early-stage uncertainty range excluding optimism bias allowance.
All concepts subject to further development.

Case study summaries

Conclusions

General

- **Technically feasible** subject to project and site-specific study.
- **Site- and project-specific design development** is generally required for the case study technologies, with **greater engagement from the OSW sector to refine functionality provision.**
- Potentially **quicker** to develop than conventional port infrastructure.
- Could **facilitate additional capacity where land reclamation is not feasible** (e.g. for environmental, consenting or land ownership reasons).
- **Unlikely to be cheaper** than conventional port infrastructure, subject to design life considered. Higher cost than a single OSW project could bear.
- Potentially best suited to addressing **individual OSW deployment needs**, as opposed to all port capacity needs from a single platform.
- **Opportunities to deploy conventional technologies** at a larger scale or in new ways as part of ‘floating ports’, e.g. large scale uses of barges, wet storage moorings and ‘inshore’ jack-up crane vessels.

Conclusions

Barriers to development

- **Funding and procurement**
  - routes uncertain
  - different approaches needed than for conventional port infrastructure
  - consortium of parties likely required

- **Proprietary technology**
  - Technology proponents naturally want to protect their IP
  - This may be inhibiting awareness of the technologies and engagement from the range of stakeholders and investors that would be needed

Conclusions

Suggested next steps

- **Develop a clear 'brief'** from the OSW sector to floating port / port augmentation technology providers
- **Objective to support focussed development** of the technologies and **promote OSW sector engagement** with them
- Use an existing grouping (e.g. the SIM group)
- The brief should be **location** and **functionality** specific
- Location specific issues expected to be material to viability, cost and programme
- Provisional functionality 'asks', to be expanded/developed as part of the brief:
  - Function 1: Component storage (10ha+ scale).
  - Function 2: Substructure launch.
  - Function 3: Turbine integration.
  - Function 4: Conventional quay extension. In-line, perpendicular 'finger' quay, and/or quay spacer to deeper water.
  - Function 5: Tow-to-port O&M facility (20m+ quay with light craneage)

Contacts

Arup

James Robinson
Project Manager

Callum McLean
Project Engineer

Arup
1 West Regent Street
Glasgow
G2 1RW

ARUP