Start

The Wonderful World of Floating Offshore Wind

Rory Morrison

Floating Offshore Wind (FOW) is still very much in its infancy. We are at an interesting time where many different concepts are being floated (pun intended). These will undoubtedly reduce in number as the industry matures but each design hopefully serves to better inform the next. In these slides, I go through some of the less main-stream designs and concepts.

TwinWind

Company: Hexicon

Country: Norway

Status: Demonstrator under development

Concept: 2-turbine topside

The idea behind a 2-turbine topside is that per megawatt costs are lowered thanks to shared infrastructure. Additionally, more turbines for a designated area may be possible.

The TwinWind platform weathervanes around a single mooring point (presumably the front of the triangle). Hexicon look to have a demonstrator under development, but the size is unclear at this point.

Link: https://www.hexicon.eu/twinwind/

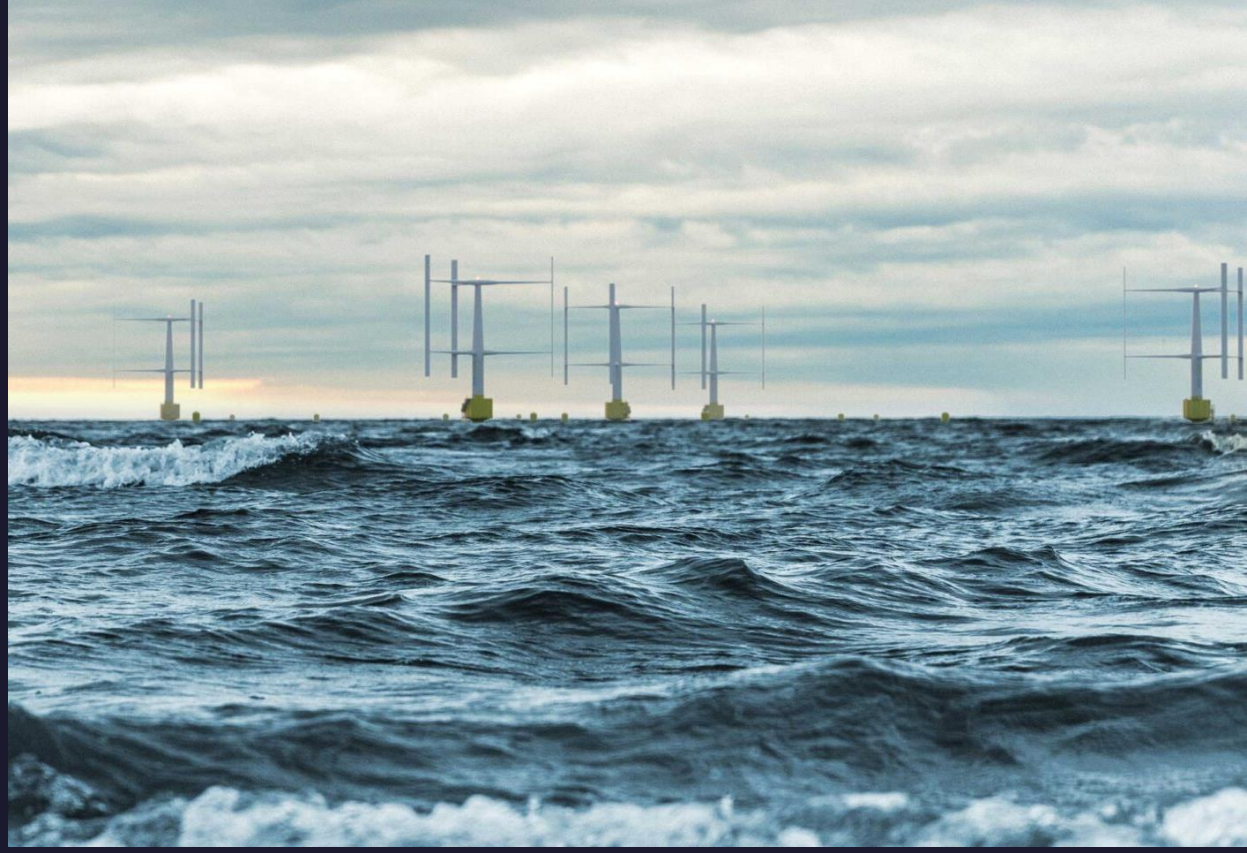
SeaTwirl S2

Company: SeaTwirl

Country: Sweden

Status: 1MW demonstrator planned 2023

Concept: Vertical Axis wind turbine



Vertical-axis wind turbines (VAWTs) for FOW seemed to be quite a popular area of research in the early 2010's, but few examples survive today. In theory, VAWTs could be better suited to the rocking motion of FOW as they could have a lower centre of gravity due to avoiding the heavy nacelle/rotor situated at the top of the tower.

The leading FOW-VAWT is the SeaTwirl S2 by the eponymously named Swedish company. A 30kW demonstrator was deployed in 2015, the company plans a "full scale" 1MW unit for 2023. It is not clear if they intend to go larger in future or if they intent to target the small-turbine market.

Link: https://seatwirl.com/products/seatwirl-s2/

Eolink

Company: Eolink

Country: France

Status: 1:10 scale demonstrator in 2018

Concept: towerless topside

Eolink claim their design saves steel, reduces interference between blades and tower, and better spreads the rotor load so making a better fit for floating platforms. Note that the platform turns around a single mooring point far off to the image left.

Eolink say an off-the-shelf generators/rotors in the range of 5-13MW would only need a “front transition piece” fitted to be suitable for their system. Beyond this, and up to the 20MW envisioned, modifications would be necessary to better leverage the 4-mast system.

Link: http://eolink.fr/en/

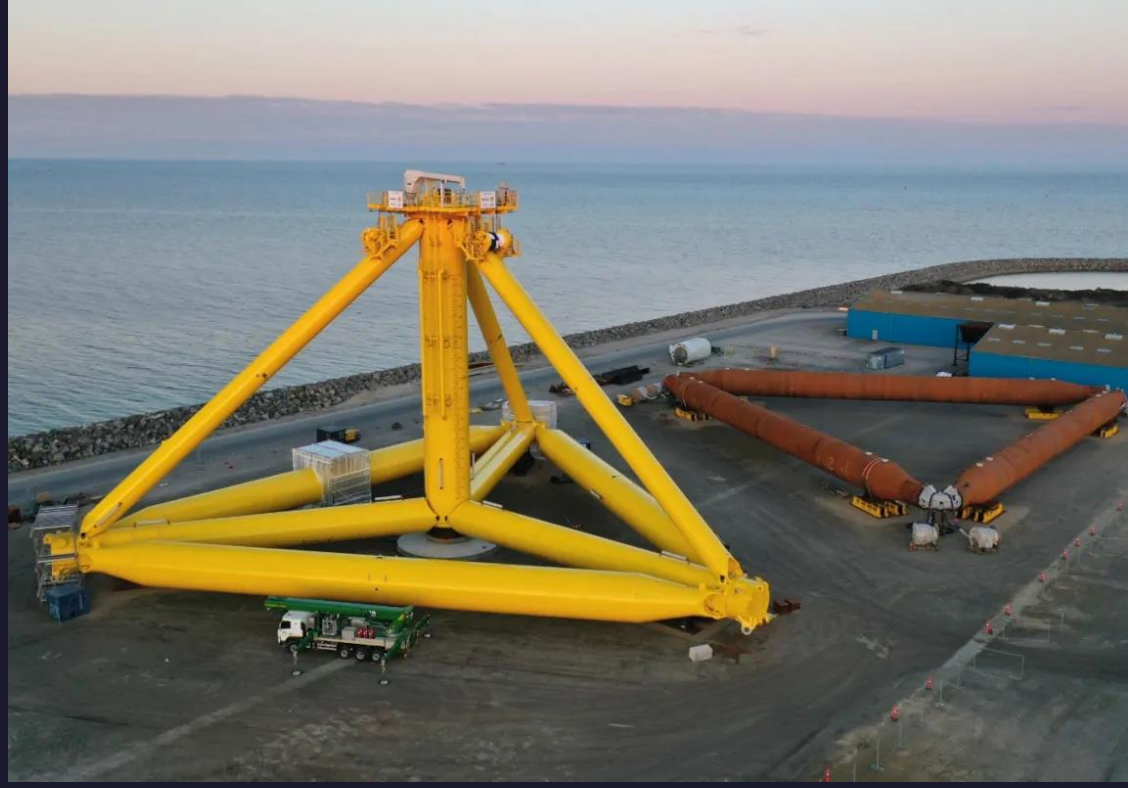
TetraSpar

Company: Stiesdal Offshore Technology

Country: Norway

Status: 3.6MW demonstrator active

Concept: advanced foundation



This foundation design includes a triangular keel structure (in red) suspended from the floating structure. TetraSpar have designed their foundation for manufacturability, all members are fairly simple and bolt together at assembly, hence avoiding welding. A 3.6MW demonstrator is currently running in Norway.

The idea behind the dangling keel is to move the centre of gravity far below the centre of buoyancy. By doing so with tendons, this cuts down on material use as well as weight.

Links: https://www.stiesdal.com/offshore-technologies/the-tetraspar-full-scale-demonstration-project/
https://www.researchgate.net/publication/344329187_Technical_Definition_of_the_TetraSpar_Demonstrator_Floating_Wind_Turbine_Foundation

HexaFloat

Company: Consiglio Nazionale Delle Ricerche, Saipem

Country: Italy

Status: Demonstrator planned for 2022 but current status unknown

Concept: suspended counterweight, clump-weighted mooring

The HexaFloat is like the TetraSpar design and hangs a "pendulum" from the floating foundation. The weight and depth of the pendulum can be tuned to best minimise platform motions. Additionally, the moorings also have clump weights, so changing their platform-keeping dynamics.

Interestingly, HexaFloat has been discussed a few times to provide power to Oil & Gas facilities and avoid tiebacks, likely due to Saipem being a huge O&G company. A demonstrator was due to be deployed in Ireland in 2022 but not much has been said for a few years now.

Link: https://jpt.spe.org/offshore-windfarm-integrated-subsea-field-development

Honeymooring

Company: Semar

Country: Norway

Status: Under development

Concept: shared moorings

In the topic of moorings, Honeymoorings stands out. Whilst a lot of attention in this topic is being paid to material development and "multi-segmented" moorings Semar has taken an altogether different approach with shared mooring.

Whilst there is little technical information to go on, Semar claims the arrangement reduces mooring hardware costs by 50%. Presumably, this is mostly from anchor cost savings rather than the lines. Semar also claim their solution enables FOWT deployment in shallower waters, but no explanation is given as to why. This is possibly a reference to chain-catenary moorings which need some depth work, hence FOWTs moored together might be a better solution to station keeping.

Links: https://semar.no/floating-wind/
https://www.offshorewind.biz/2022/02/15/honeycomb-inspired-floating-wind-solution-attracts-major-backer/

DualSub

Company: Marine Power Systems

Country: UK

Status: Under development

Concept: Wave Energy

Link: http://www.marinepowersystems.co.uk/dualsub/

The DualSub is a combination of floating wind and wave energy generators. In theory, the two energy generators sharing infrastructure should reduce overall cost. This is an interesting project to watch as typical floating foundations aim to reduce the influence of waves on the topside as much as possible, never mind harnessing energy at the same time.

The DualSub is a combination of MPS's 2 existing designs: the WaveSub and WindSub. The WaveSub is a wave energy device, a 1:4 scale demonstrator has already been tested. The WindSub concept is a floating wind turbine but currently looks to be untested.

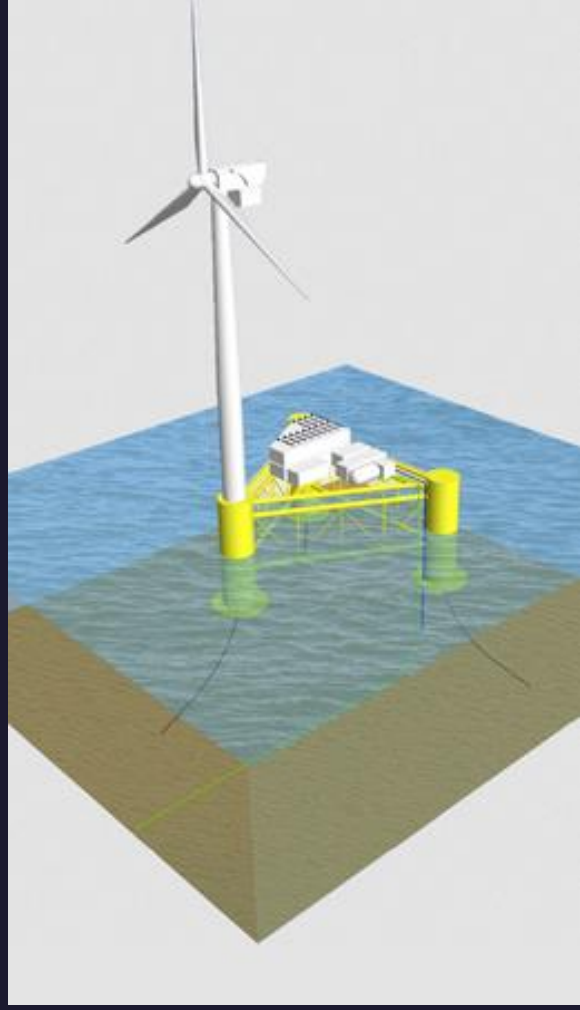
Dolphyn

Company: ERM

Country: UK

Status: Pre-commercial unit planned "early-mid 2020s"

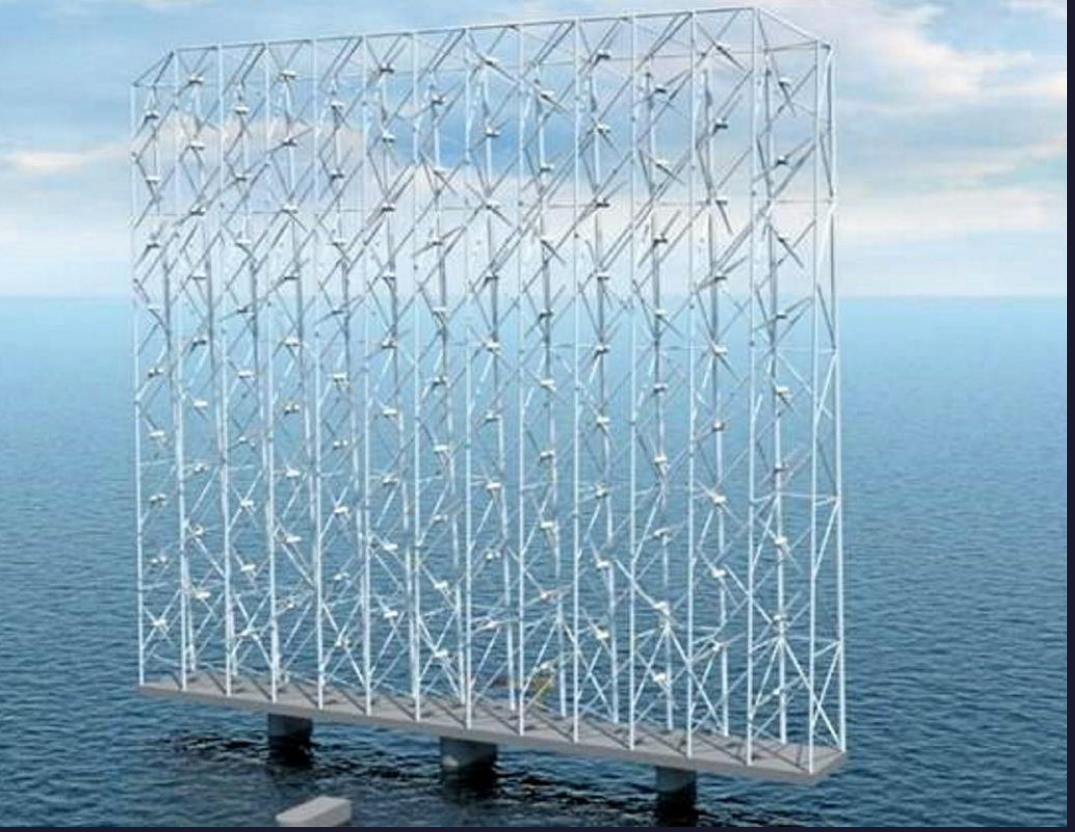
Concept: Onboard hydrogen production



Dolphyn pairs FOW with an on-board hydrogen electrolyser. To be viable, this decentralised offshore hydrogen production concept must be better than either centralised-offshore or centralised-onshore hydrogen production. This requires that, for some distance from shore and/or quantity of energy, it becomes more cost effective to pipe energy as hydrogen than transmit it as electricity. Additionally, the cost of a FOWT with a deck suitable to house the electrolyser, as opposed to one without such as a spar-type, must be considered.

The Dolphyn project is developing at a rapid pace. In 2020, it was announced that a 2MW demonstrator (unclear if that refers to both the WT and the electrolyser) was planned off Aberdeen circa "early-mid 2020s" and a 10MW pre-commercial soon after. A year later, the demonstrator idea was scrapped in favour of advancing the 10MW pre-commercial unit. In March 2022 it was announced that a GW-sized farm is planned for the Pembrokeshire coast with the company Source Energie. This is high confidence in a concept that does not have a demonstrator yet.

Link: https://ermdolphyn.erm.com/p/1



Wind Catching System

Company: Wind Catching Systems

Country: Norway

Status: Development

Concept: Wall of turbines

The Wind Catching System concept consists of a wall of 126 turbines (so I'm told, I haven't counted) rated at 1MW on a floating base. However, it's stated these are smaller than usual at rotor diameters c. 30m, whilst a typical 1MW HAWT is c. 50m.

The company claims their design will make FOW competitive "as soon in 2022-2023", "cuts acreage use by 80%" and "five times as efficient as a conventional offshore wind turbine". There is, unfortunately, very little information on this system hence I remain beyond sceptical of these claims. For now, my take is that, at worst, the physics don't add up for this design, at best, this would be a power regulation nightmare.

Link: https://www.rechargenews.com/wind/futuristic-multirotor-design-could-make-floating-wind-competitive-as-soon-as-2022/2-1-1021312

Thanks for reading

End

I am a PhD student at Glasgow University. My PhD is in the application of Machine Learning for offshore wind turbines. More specifically, I am researching the convergence of ML, Digital Twins, and floating wind turbines. If you have access to resources which you think might be useful such as:

- Datasets
- contacts to floating and offshore designers, operators, developers
- wind industry contacts who practice Digital Twins

then I would be more than appreciative if you got in touch.

Rory Morrison