Forget about Offshore Wind Parks. Let's talk about Ocean Energy Parks!

Albert Einstein:
If at first the idea is not absurd, there is no hope for it.

High Wind 2025
Paal Norheim, CEO - Stationmar

The Stationmar way to make the offshore wind industry profitable in harsh environment areas

Floating wind turbines:

- **Short term: Neutralize the heave, pitch and roll motions of the foundations**
- **Long term: Utilize also the power of the waves**

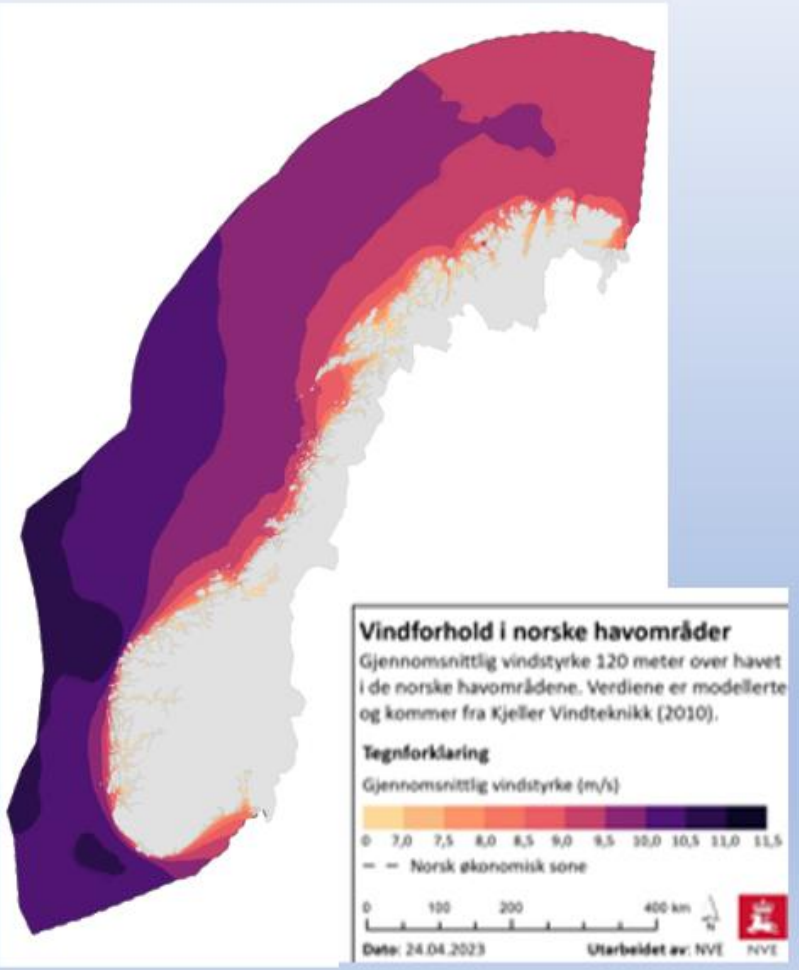
Bottom-fixed wind turbines:

- **Short term: Utilize also the power of the waves**

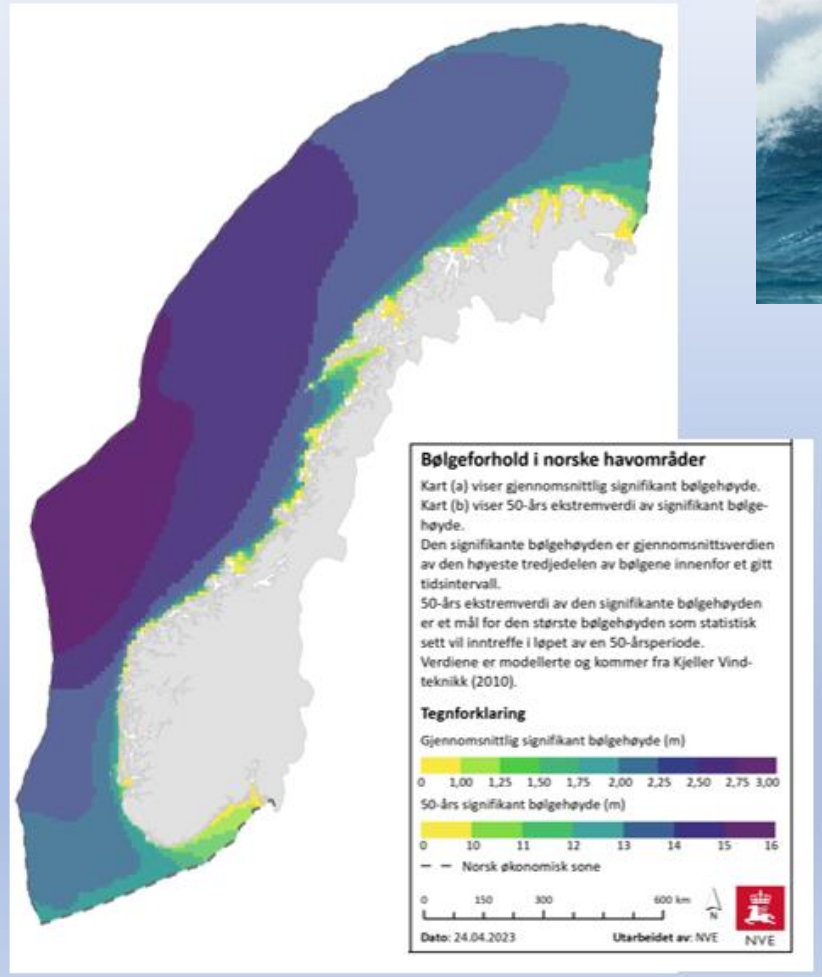
Focus on OCEAN ENERGY PARKS!

On the Norwegian shelf we have the natural conditions with the combination of a lot of wind and high waves. It is precisely this that we must utilize to our advantage and talk about Ocean Energy and not Offshore Wind.

Average wind speed (m/s)



Average significant wave height (m)



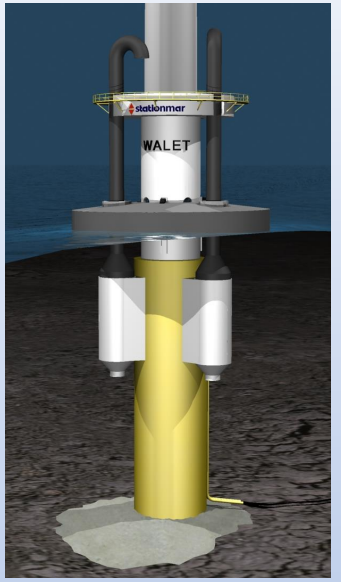
We have natural prerequisites for success in Norway. We just have to think a little "outside the box"

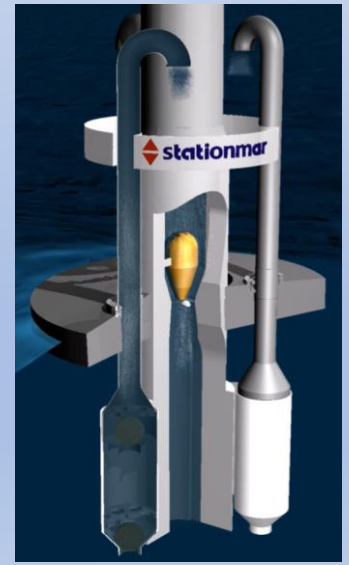
WALET - Wave Artificial Lift Energy Turbine

- A annular shaped floating device, that floats on the sea surface and moves up and down with the waves, is installed around the wind turbine column. The float carries three risers, with check valves at the top and bottom.

- When the float moves up with the waves, seawater is sucket into three tanks fixed to the column below. When the float moves down, the water is further «pumped» up to a annular shaped equalizing tank, which is installed at a certain height above the sea level.

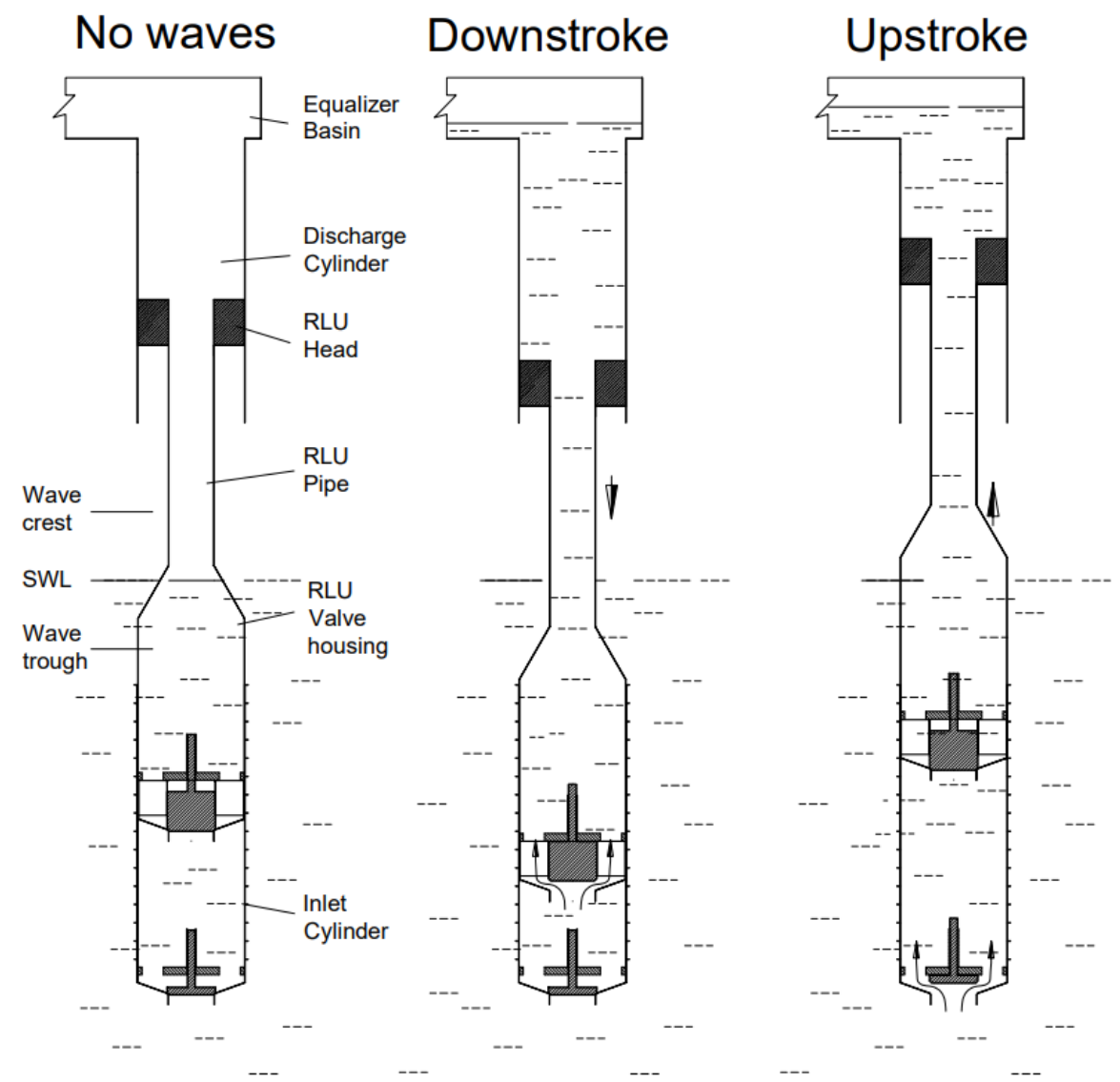
- From the upper tank the water flows down in a riser at the inside of the wind turbine mono-tower and into a turbine and a generator, similar to turbines used in hydropower stations on land. Such turbines are well proven, have a high efficiency, and good flexibility related to varying amount of water.





WALET details under development, February 2025

The Riser Lift Unit (RLU)

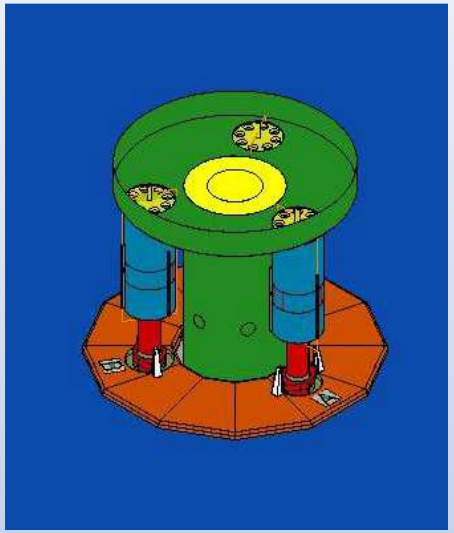


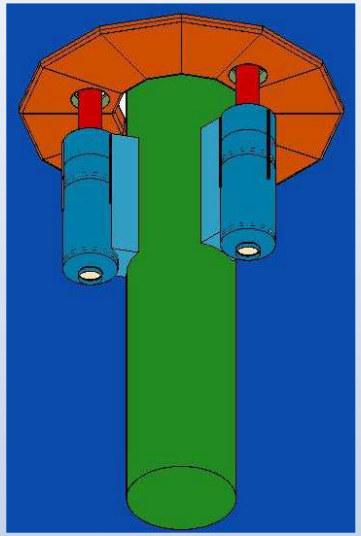
The WALET system comprises the following main components:

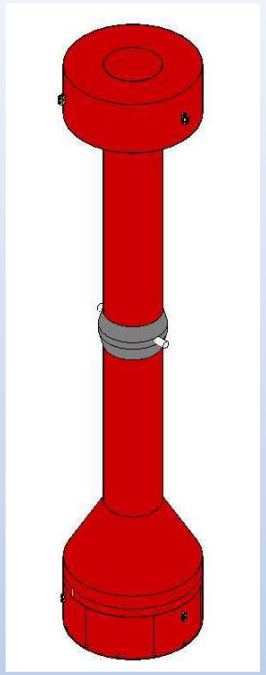
1. **The Bobber – float / barge**
2. **The RLU – Riser Lift Units**
3. **Inlet cylinders**
4. **Discharge cylinders**
5. **Equalizer basin**
6. **Drop pipe to the generator**
7. **The bulb Kaplan turbine with the electric generator and control system**
8. **The exhaust water collect tank and discharge.**

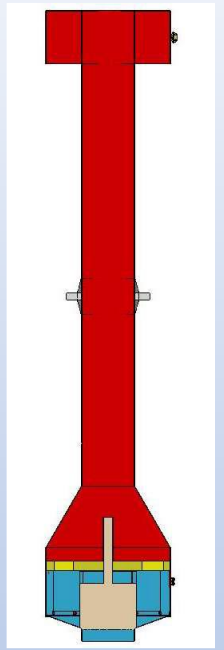
Designation: WALET 15-20-9,5
Electric energy rated power: 15 MW
Turbine water head: 20 m
Max. wave height operation: 9,5 m
Column diameter: 14 m
Water depth: 30 – 80 m

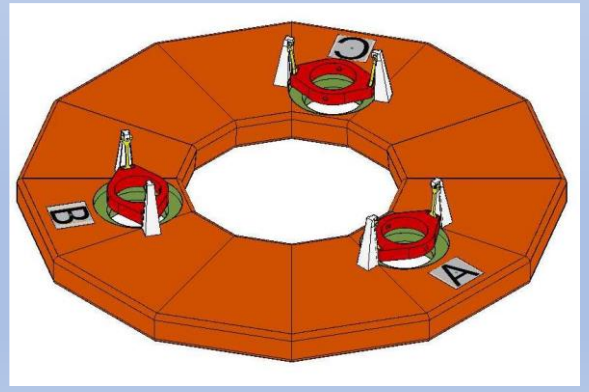
WALET details under development, February 2025

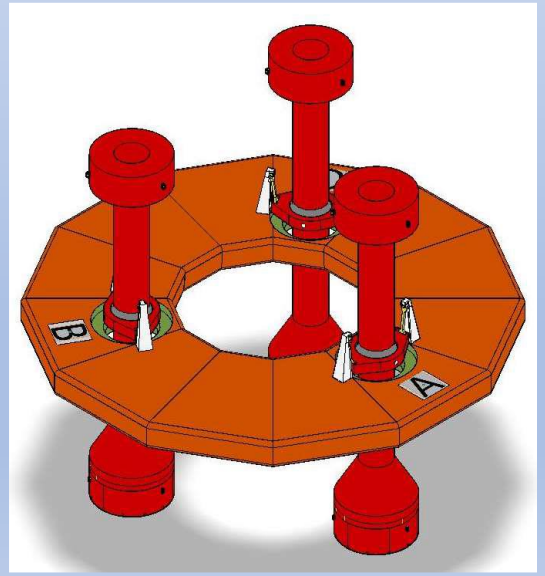


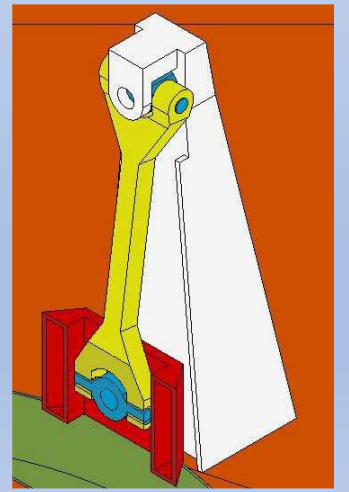












Ongoing simplified WALET model tank testing

Wave power energy in the North Sea Basin

- The island of Great Britain acts as a natural barrier against the Atlantic Ocean that causes the wave climate to be less aggressive, and this feature makes the North Sea Basin attractive for wave energy conversion.

- Norway's offshore expertise and extensive sector of the North Sea Basin, position the country perfectly to realize wave energy's role in achieving a successful energy transition for Norway, Europe and several other areas in the world.

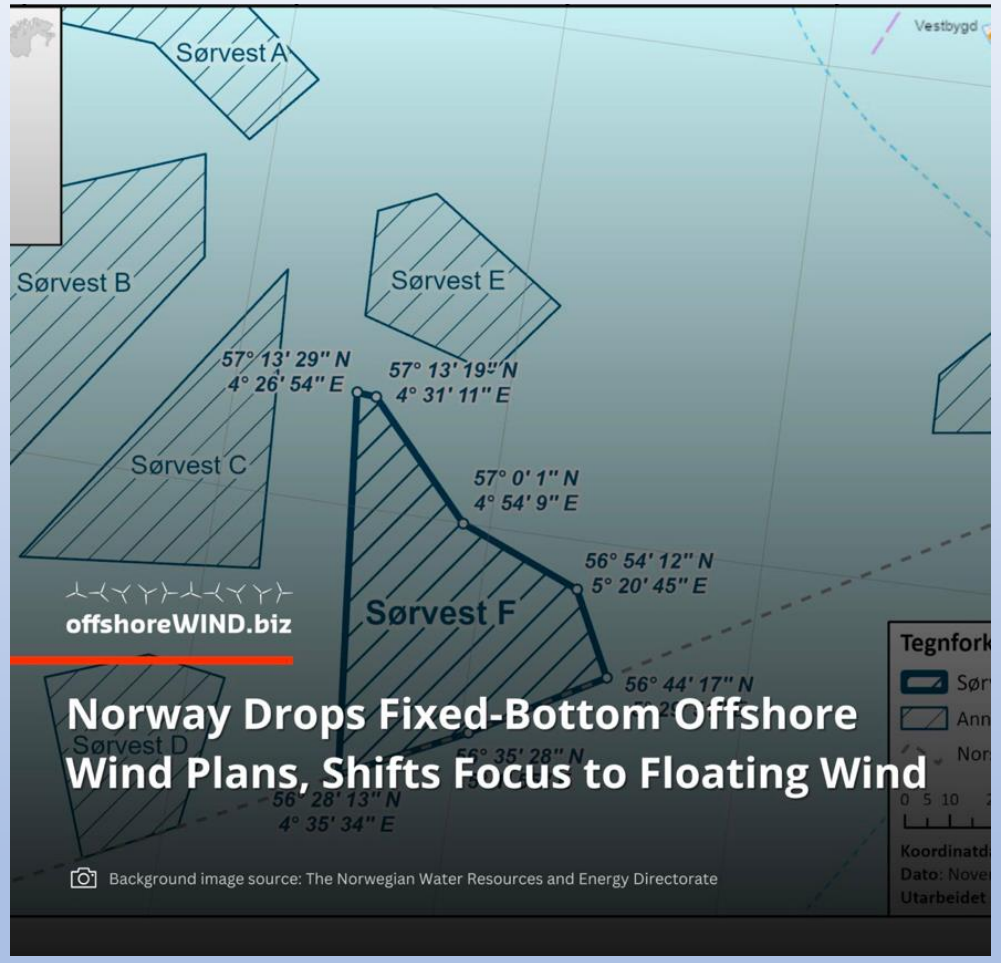
The North Sea Basin is about to become the Energy-Hub for Europe

Minister of Oil- and Energy:

16.02.24: «The North Sea basin can be an important climate- and energy-hub for Europe, but will also be particularly important for Norway».

27.08.24:"The Norwegian Directorate of Water Resources and Energy (NVE) is now carrying out an impact assessment to determine how much capacity can be developed in the so-called Sørvest F area. Aasland talks about a potential for up to ten gigawatts that was uncovered in an initial study. That alone makes up a third of Norway's goals for 2040."

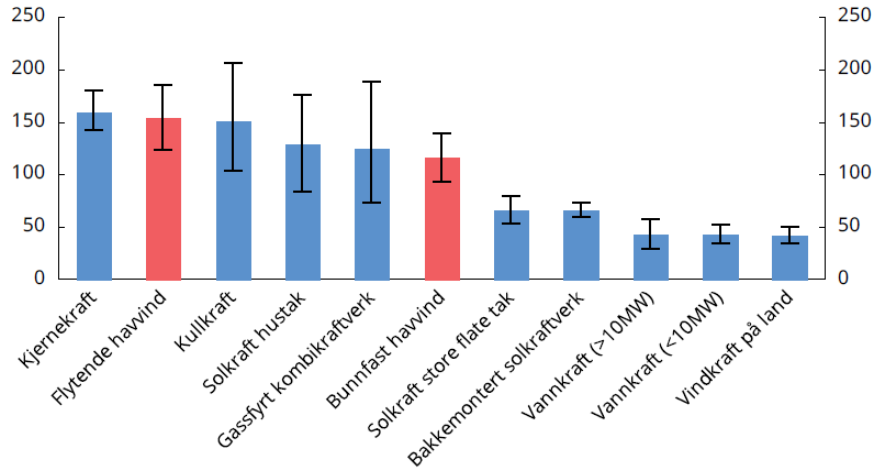
In Norway we must harvest the low-hanging fruits first, with development of the bottom-fixed parks, and try to make these considerably more profitable



This is the only way for Norway to be even close to have 30 GW capacity by 2040!

The report issued by a Fiscal Policy Committee 6th February, concluding that offshore wind in Norway should be put on HOLD, should have distinguished between floating and bottom-fixed offshore wind

Figur 5.2 Kostnader for kraftproduksjon over levetiden – LCOE [øre/kWh]



LCOE står for *levelized cost of energy*. Spennet i figuren viser høyt og lavt anslag for LCOE.

Kilde: NVE

In most North Sea areas the waves are a persistent and predictable power source

Wave statistics Hs	% of time	Walet power generation
1.5	22.57	4,073
2.5	23.8	5,990
3.5	19.2	7,503
4.5	13.2	9,647
5.5	8.38	10,668
6.5	4.8	12,608
7.5	2.5	14,547
8.5	1.3	15,000
9.5	0.62	15,000

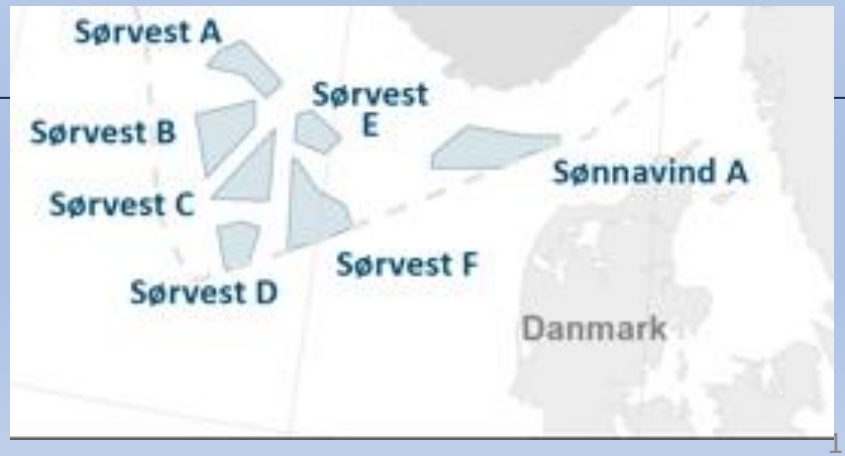
In the North Sea wave energy has its peak value about 6 to 8 hours after wind energy has reached its peak value. This is a typical situation where low-pressure systems are following each other and is the base for wave generation.

Potential bottom-fixed wind turbines in the Norwegian part of the North Sea basin, to be installed after phase 1 of Sørlige Nordsjø II (assumptions only)

Area	Water depth	Installed capacity (Assumptions only)	No. of 15 MW conv. wind turbines	No. of wind turbines with WALET installed
Sørvest A	80m	1000 MW	68	34
Sørvest B	65m	2000 MW	134	67
Sørvest C	60m	2000 MW	134	67
Sørvest D	70m	500 MW	34	17
Sørvest E	75m	500 MW	34	17
Sørvest F*	60m	1500 MW	100	50
Sønnavind A**:		500 MW	34	17
Total		8000 MW	538	269

* : Phase 2 of Sørlige Nordsjø II
**: Partly suitable for bottom-fixed

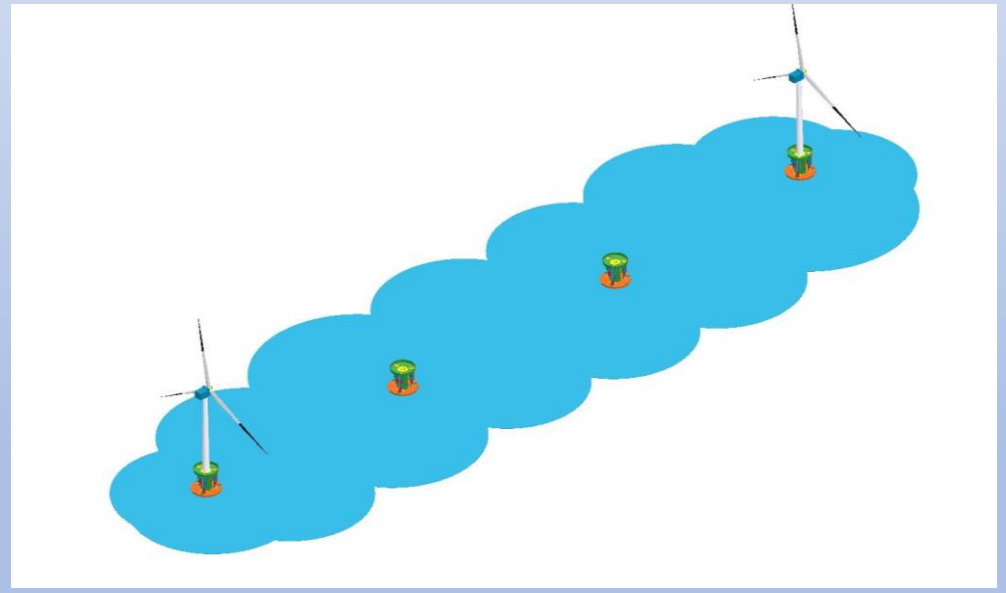
Total savings with WALET: 269 conventional 15 MW wind turbines

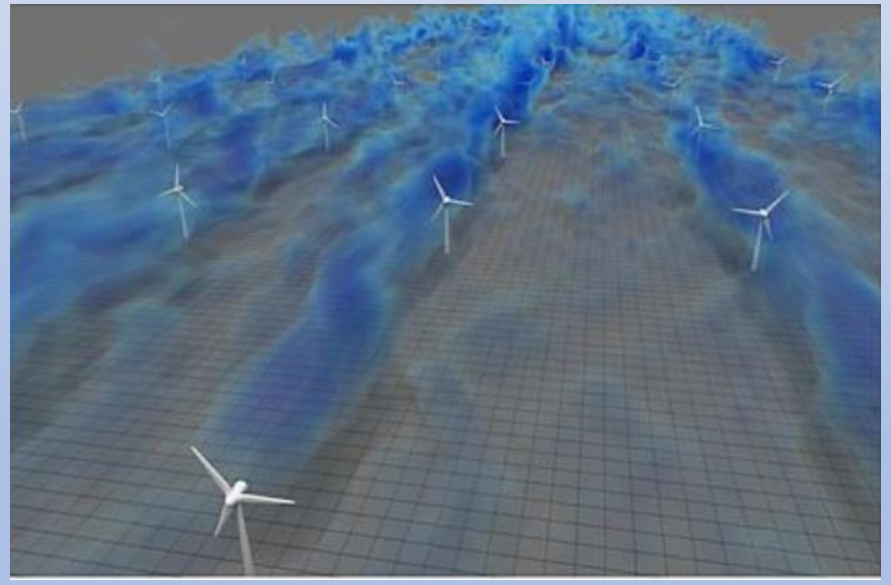


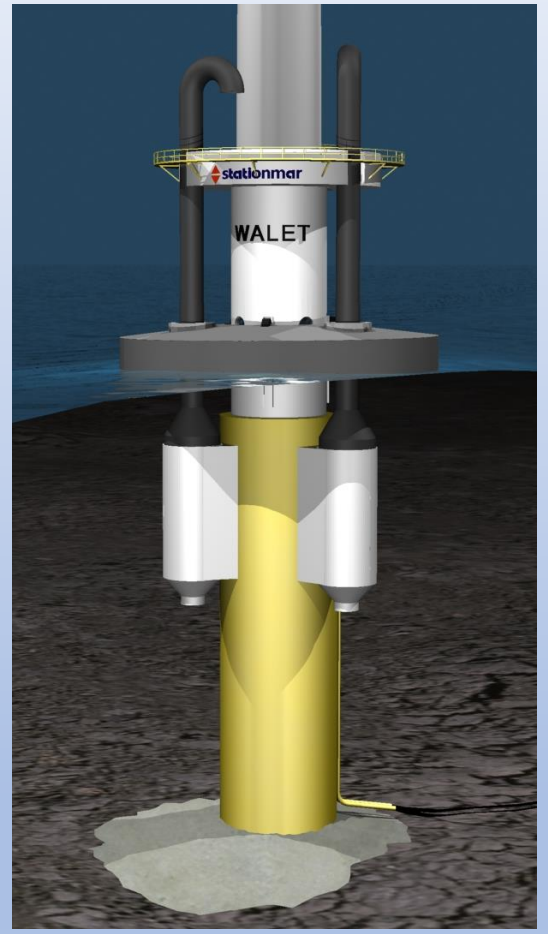
Potential use of bottom-fixed stand-alone WALET structures, without wind turbine on top of the monotower

- The space / seabed areas in-between or adjacent to bottom-fixed wind park turbines, normally required to avoid the wake effects, can be used to install stand-alone WALET systems, without the rotor blades and the nacelle on top of the monotower.

- Wind shadows pose a serious threat to offshore wind, according to experts. In Sørlige Nordsjø II, the loss could be 20 per cent, new model calculations indicate.





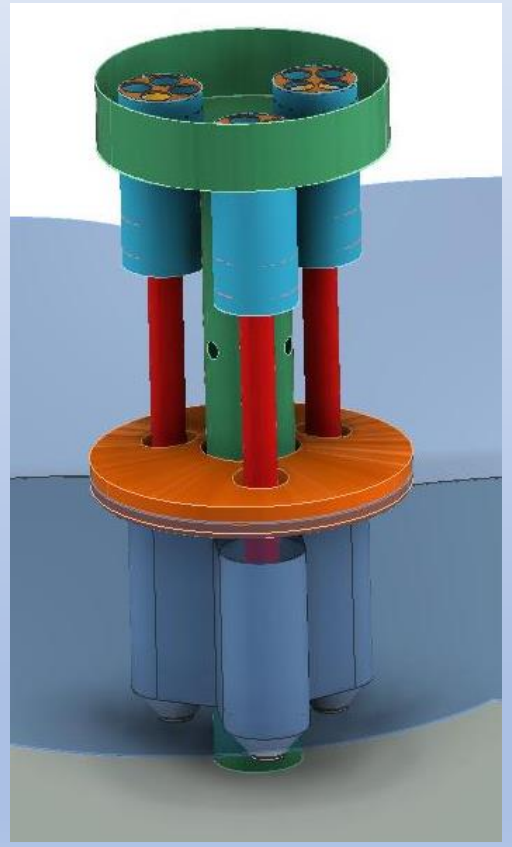


WALET 15 SAB

Note: Stand-alone WALET structures can be installed in-between any bottom-fixed turbines.

The proposed project will be to conduct a scaled pilot testing of a stand-alone WALET system, with a 2.5 MW hydropower turbine installed, in a suitable location with about 20 meters water depth.

Electrical generator :	2,5 MW Kaplan turbine
Fall height:	12 m
Turbin suction capacity :	24 cub.m/s
Waterdepth :	20 m
Wave height for full generator load:	4,5 m
Max wave height for 'survival' :	8 m
Column diameter :	5 m
Upper tank diameter :	16,4 m
'Bobber' / Float diameter :	18 m
Float draught :	Less than 0,5 m
Riser diameter :	1,98 m
Riser mating cylinder diameter :	4 m
Riser outflow cylinder diameter :	4 m
No. of risers:	3
Electrical energy with 1,5 m waves:	1055 kW
Electrical energy with 2,5 m waves:	1552 kW
Electrical energy with 3,5 m waves:	1944 kW
Electrical energy with 4,5 m waves:	2500 kW
Electrical energy with 4,5 - 7 m waves:	2500 kW



The purpose of the pilot test will be to demonstrate that:

- **The WALET technology can be used in combination with monotower bottom-fixed turbines, and on a long-term basis also for floating turbines using the HMN technology.**
- **Standalone WALET systems, without the wind turbine on top of the monotower, can be installed in the seabed areas in-between or adjacent to bottom-fixed wind park turbines, normally required to avoid the wake effects.**

Proposed 8-12 months de-risking phase activities, WALET technology (incl. stand-alone structures)

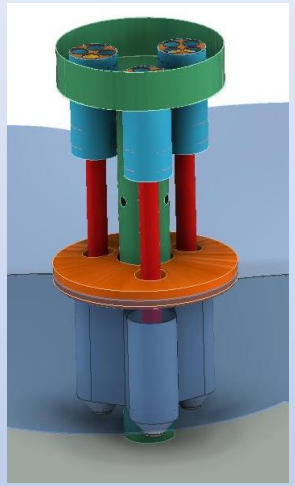
Objective: To create confidence for potential investments in the WALET technology development phase towards commercialization

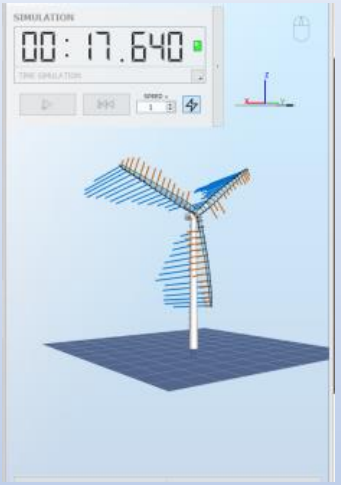
Activities:

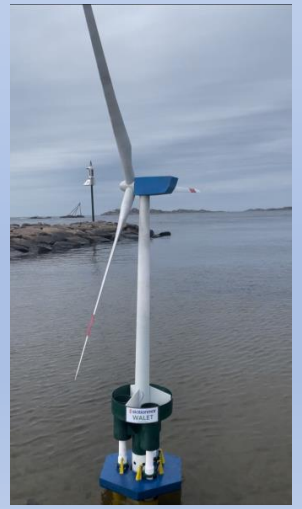
- Pre-engineering/FEED activities.
- Profitability analysis, incl. capacity factor and LCOE estimates.
- Perform dynamic analyses by the Ashes state-of-the-art aeroelastic software, by company Simis. Includes simulation of electricity production for various Meteocean data.
- Proof-of-concept model tank testing, scale 1:60, to demonstrate the physical principles behind the concept.
- DNV technology qualification (Statement of feasibility/Approval of design).
- Planning and preparations for scaled pilot testing in approx. 20m water depth.
- Apply for potential EU funding.

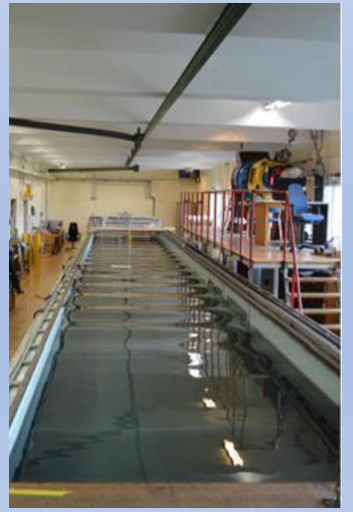
Preliminary budget estimate: Euro 1 million

(External share issue planned with Innoventus Sør shorthly)









Sakayan HMN - The Heave Motion Neutralization system for floating wind turbine foundations

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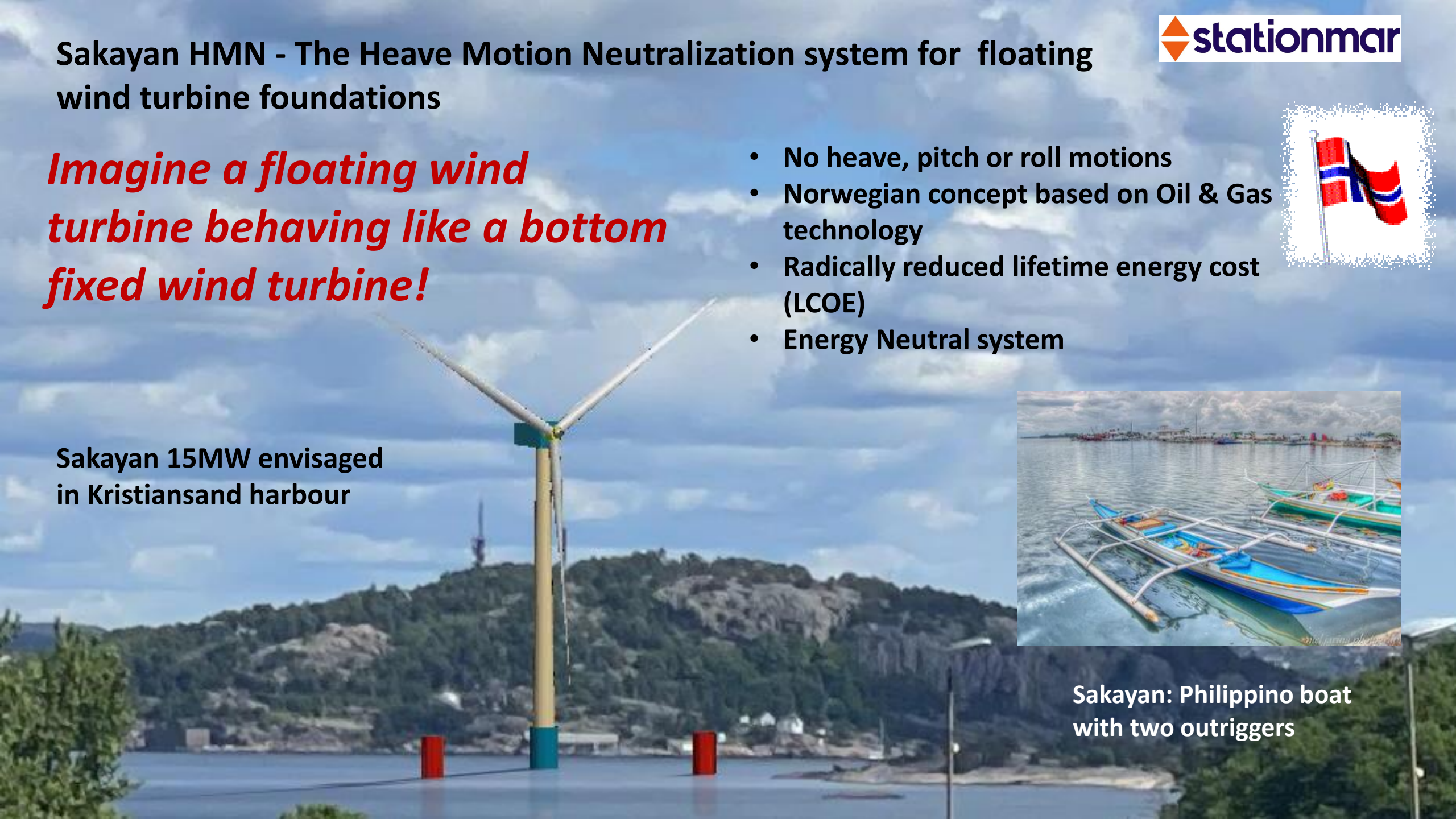
Imagine a floating wind turbine behaving like a bottom fixed wind turbine!

- No heave, pitch or roll motions
- Norwegian concept based on Oil & Gas technology
- Radically reduced lifetime energy cost (LCOE)
- Energy Neutral system



Sakayan 15MW envisaged in Kristiansand harbour

Sakayan: Philippino boat with two outriggers

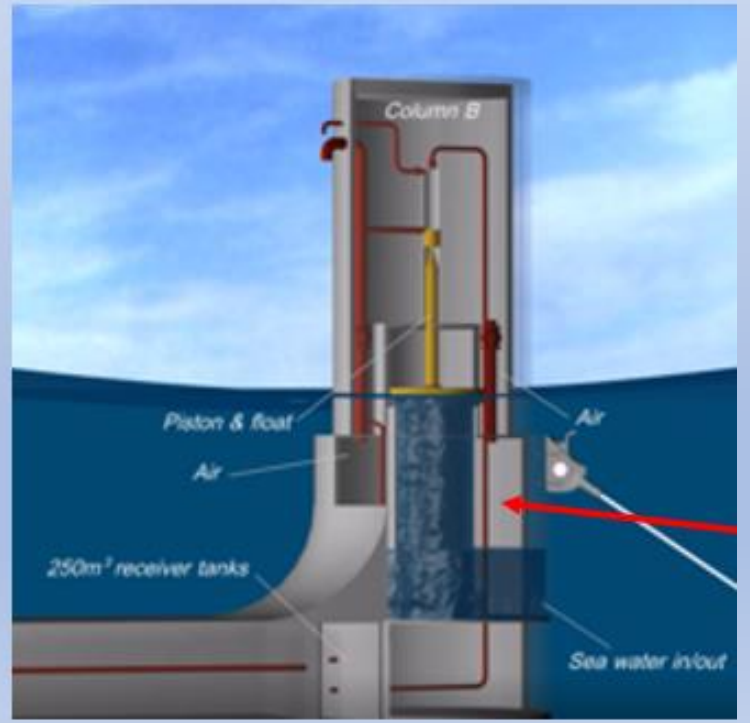
The Stationmar Heave Motion Neutralization (HMN) technology for floating wind turbines

- In the wind turbine foundation, below the lowest water level, there is an annular shaped enclosed chamber with trapped pressurized air above a water column, that is open to the sea at the bottom.

- The pressurized air balances the water level in the chamber, and as the wave passes by the water level around the foundation rises or lowers, causing more or less of the foundation to be submerged. This will increase or decrease the buoyancy of the foundation, which will tend to lift or lower the foundation in relation to the seabed.

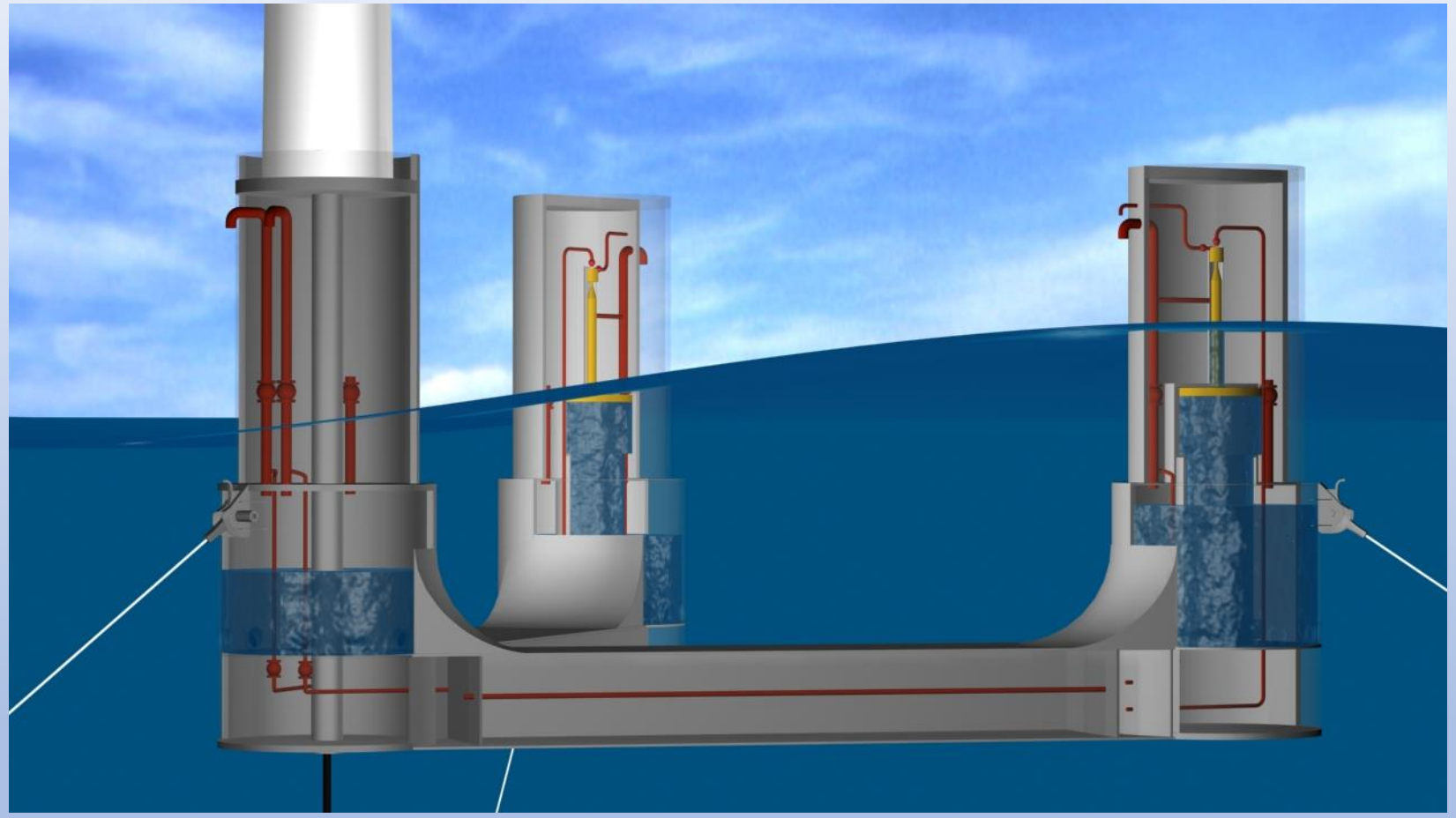
- The change in the water level will change the hydrostatic pressure of the trapped air above the water in the canister, which is compressed or decompressed, and will change the buoyancy of the foundation, corresponding to the change in the buoyancy of the foundation above.

Note: See animations at www.stationmar.com



Air chamber

SAKAYAN 15

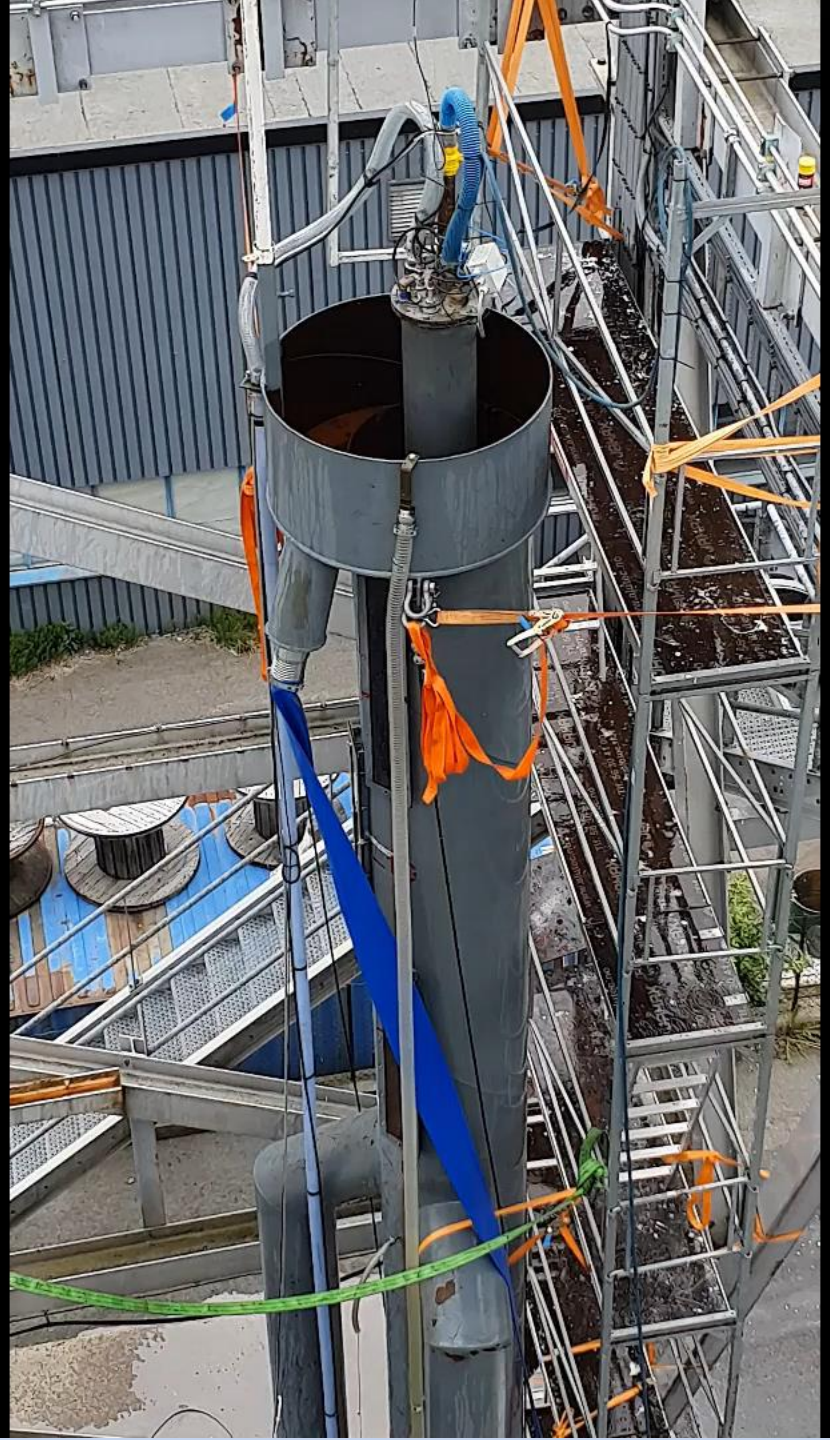


(ENPAC = Energy Neutral Predicative Advanced Control system)

- In the main column, which carries the wind turbine (payload), only the HMN system is installed.
- In the two «support/utility columns» (outriggers), both HMN and ENPAC systems are installed.
- Air adjustments in main column provided by ENPAC in the support columns.
- Actively and predictively control of the air pressure individually in the columns, to eliminate the motions of heave, pitch and roll.

The Functional Verification Test September 2021

Witnessed by DNV



DNV statement:

«The test results validate the heave neutralization of the Stationmar floater»

Floating wind turbines for harsh environment:

First nail it – then scale it!

Is conventional semi-submersible drilling rig design principles applicable for floating wind turbines in harsh environment?

The combination of aerodynamic wind loads, and hydrodynamic ocean loads, creates a very complex loading environment.

There is a reason why only a handful drilling rigs can operate in the harsh environment waters!

Larger and larger turbines require new technology for foundation design

Mingyang Smart Energys 16 MW, with Rotordiameter «only» 260 meter.

A Chinese company plans to build 22 MW turbines, which will have a rotor diameter of more than 300 meter.

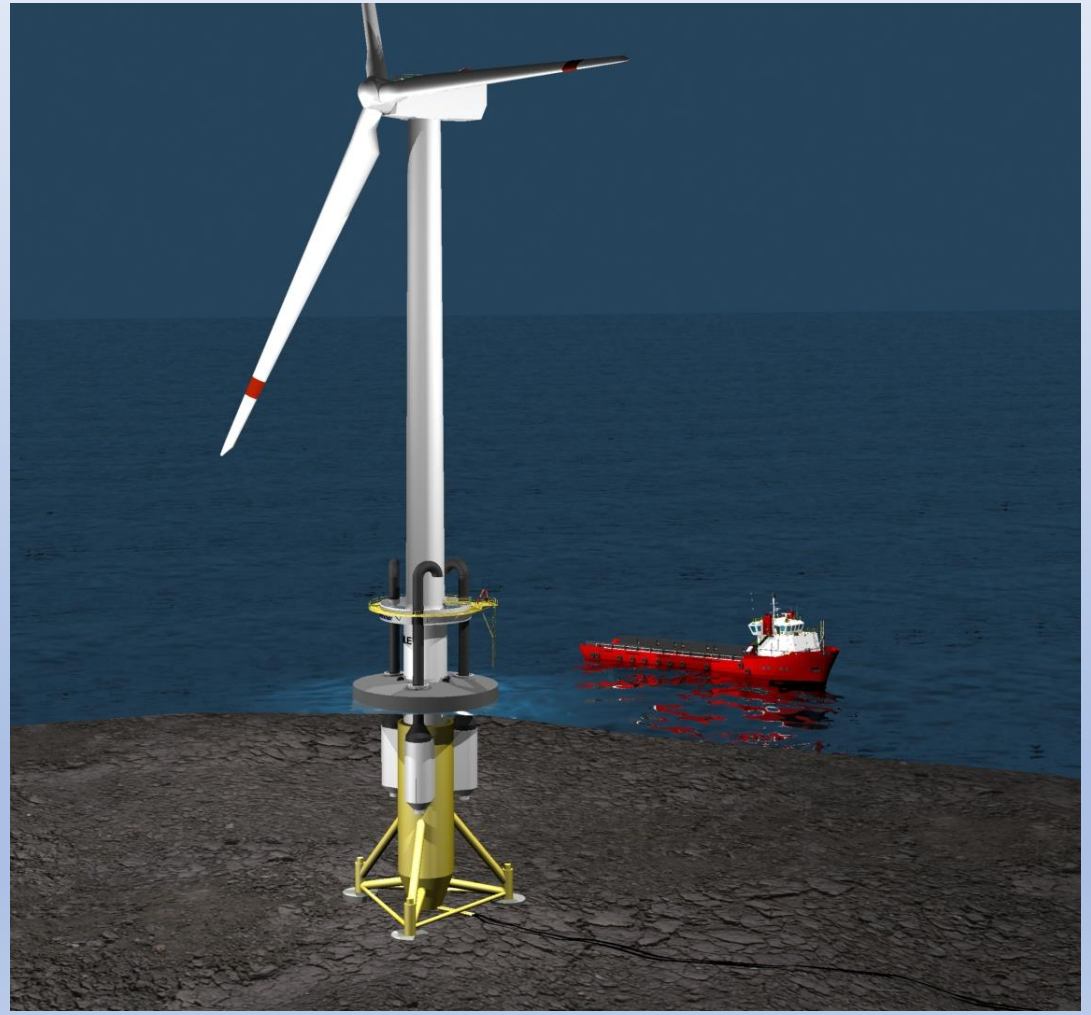
This implies that the forces from 3 x 150 meter+ long rotor blades will have the loads acting typically 175 meter+ up on the turbine tower/column above the mean sea level.

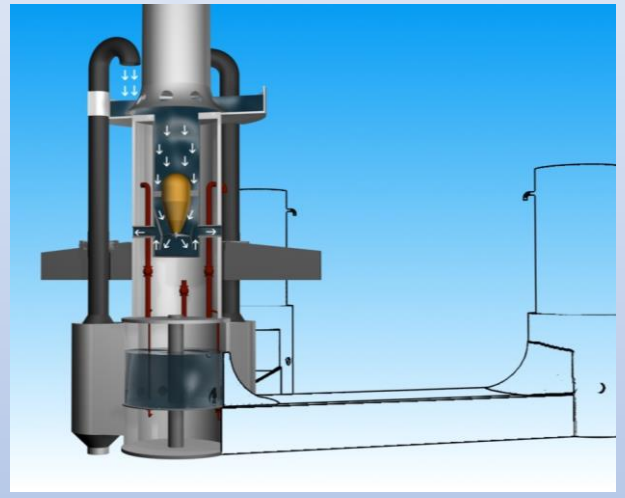
Lessons learned from existing floating wind parks:
Two of the Kincardine 5 x 9.5MW «semi-sub» floating turbines towed to shore after 1 and 2 years in operation respectively (2022 and 2023)

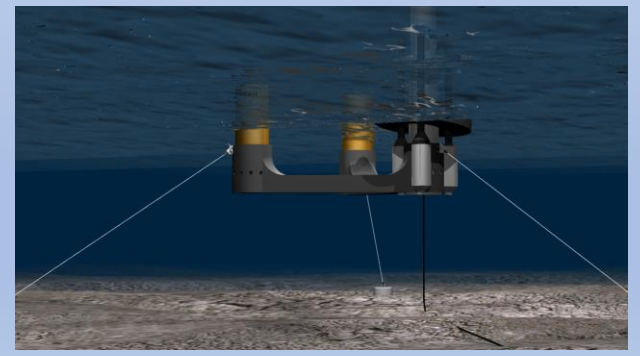
- **Time from disconnection to the end-of post reconnection activities: <u>94 days</u>**
- **This comes in addition to shutdown period required at the field, prior to suitable vessel and yard availability, and any waiting-on-weather requirements.**

Reducing the motions of floating wind turbines must be regarded as a considerable technology improvement

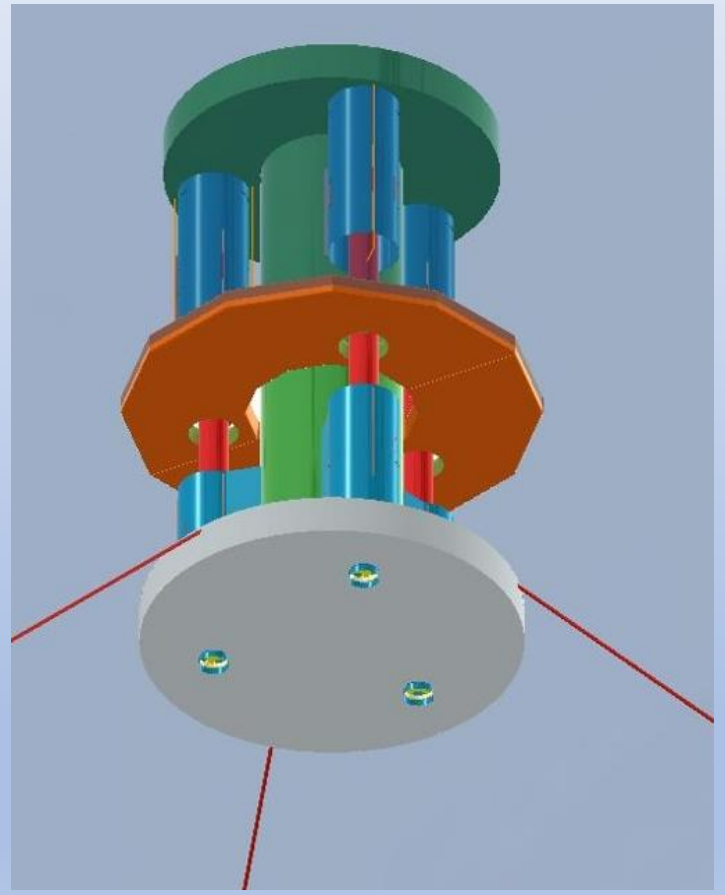
The Stationmar WALET concept can be integrated in the column of a bottom fixed wind turbine, or in the main column of a floating wind turbine with the Stationmar Heave Motion Neutralization system

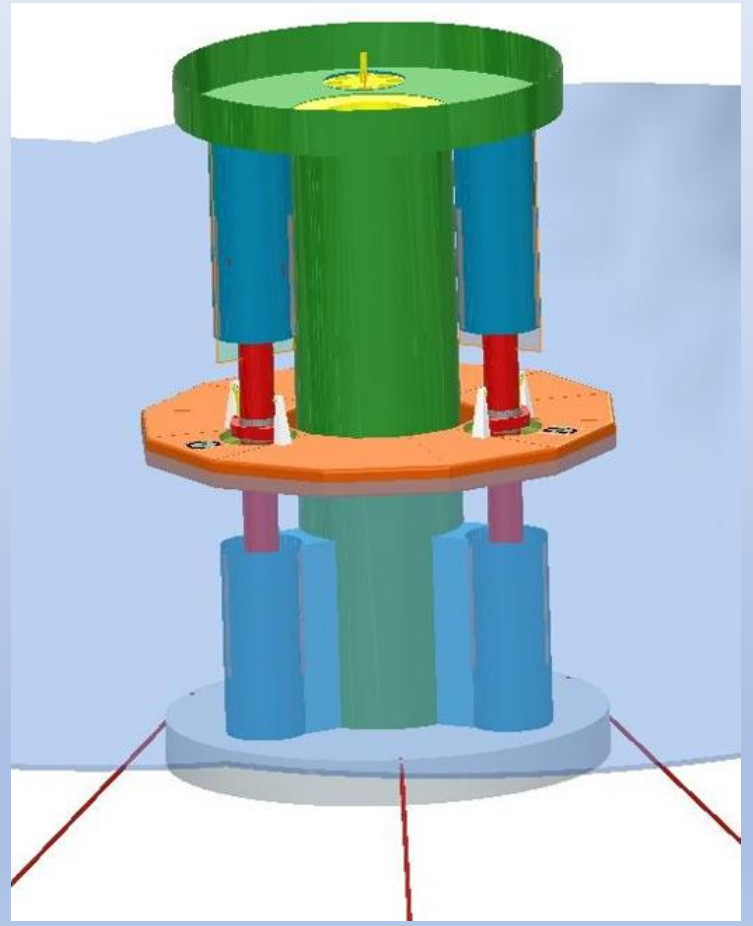


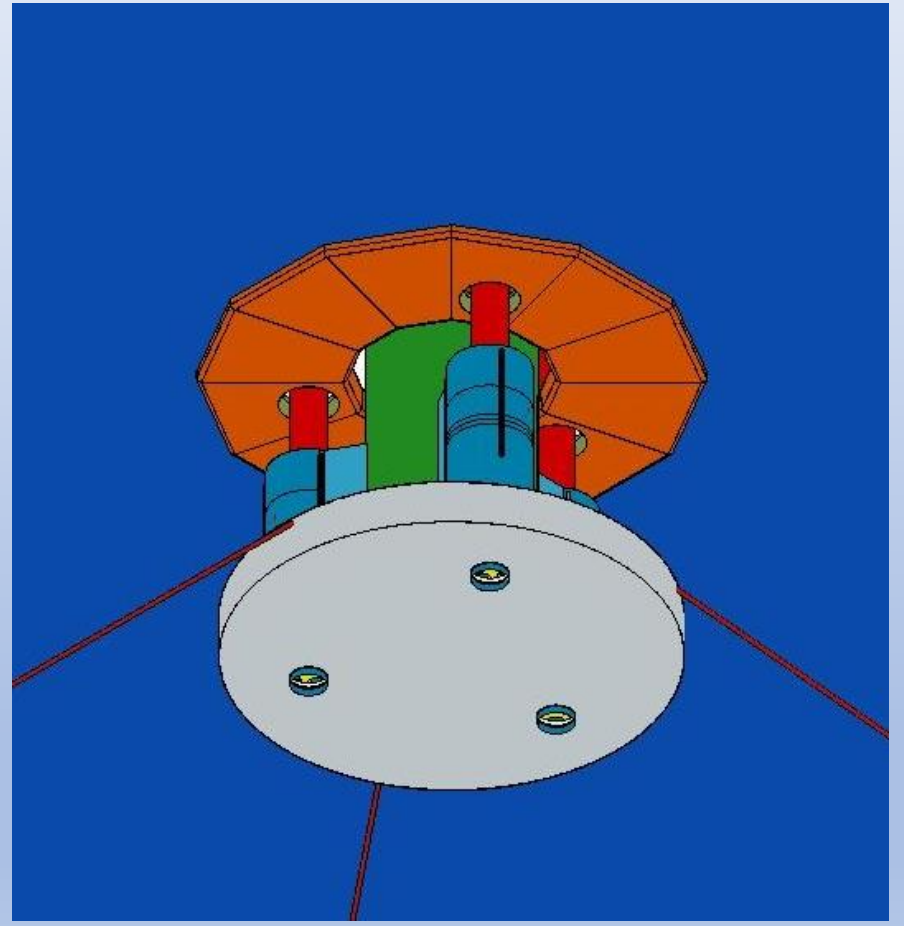




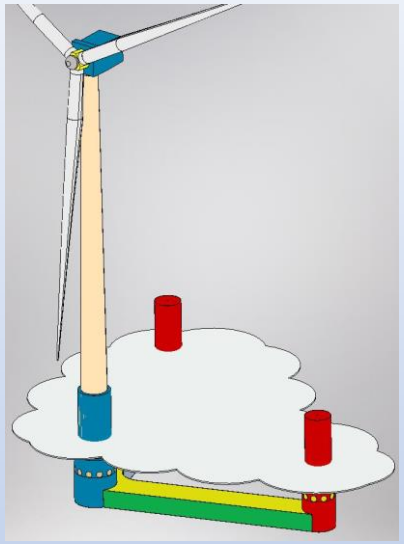
Potential use of floating stand-alone WALET structures, without wind turbine on top – WALET 15 SAF

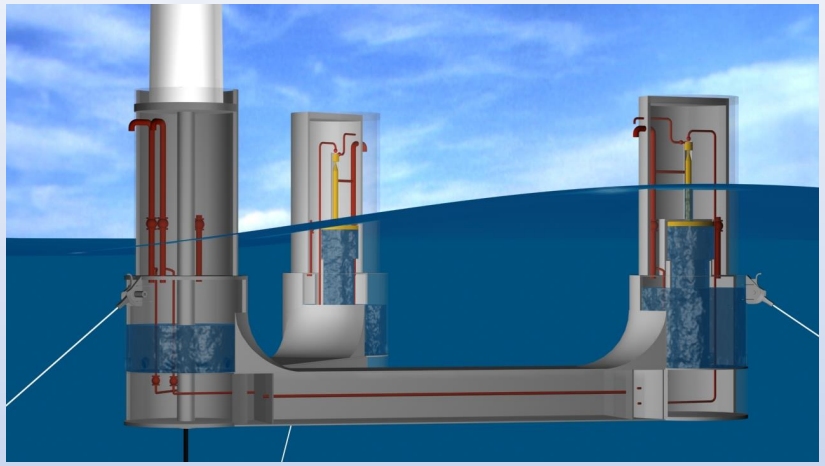






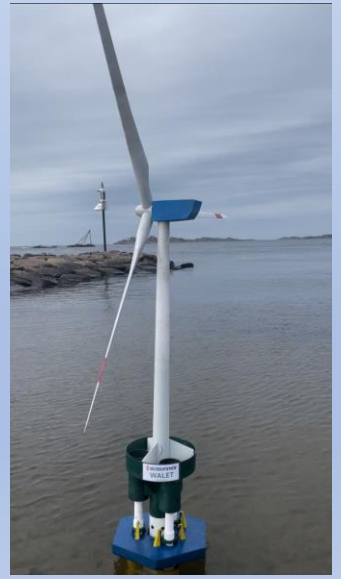
The Stationmar road map to reliable and profitable offshore wind

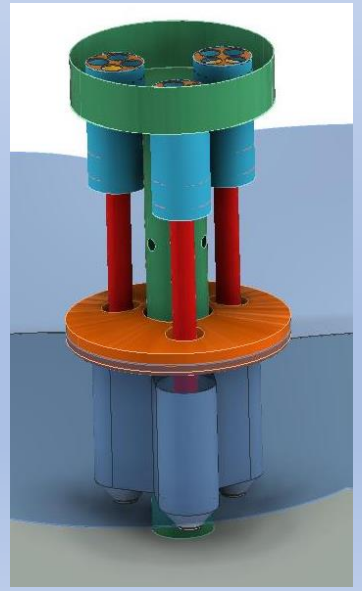




Short-term

Long-term





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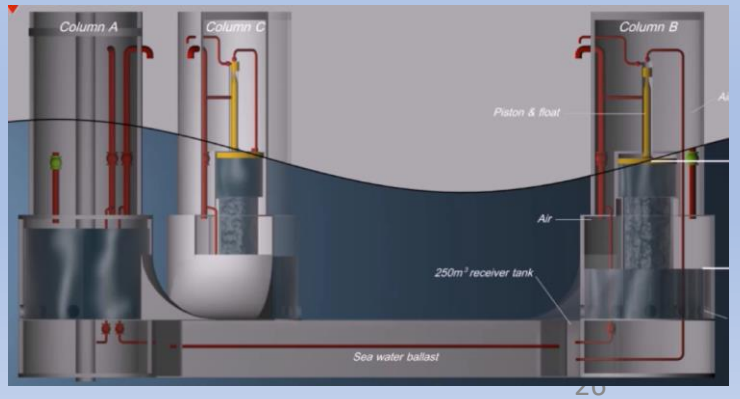
Stationmar shall be a leading global provider of technology and services within the offshore wind market. Stationmar shall continously work to improve the technology and introduce new innovative solutions to the market, and develop tailormade solutions for its clients, based on the proprietary technology.

Per Vatne, the inventor of the Stationmar technology



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Ocean Energy Parks

The Norwegian niche product within offshore renewables?

Albert Einstein:
If at first the idea is not absurd, there is no hope for it.