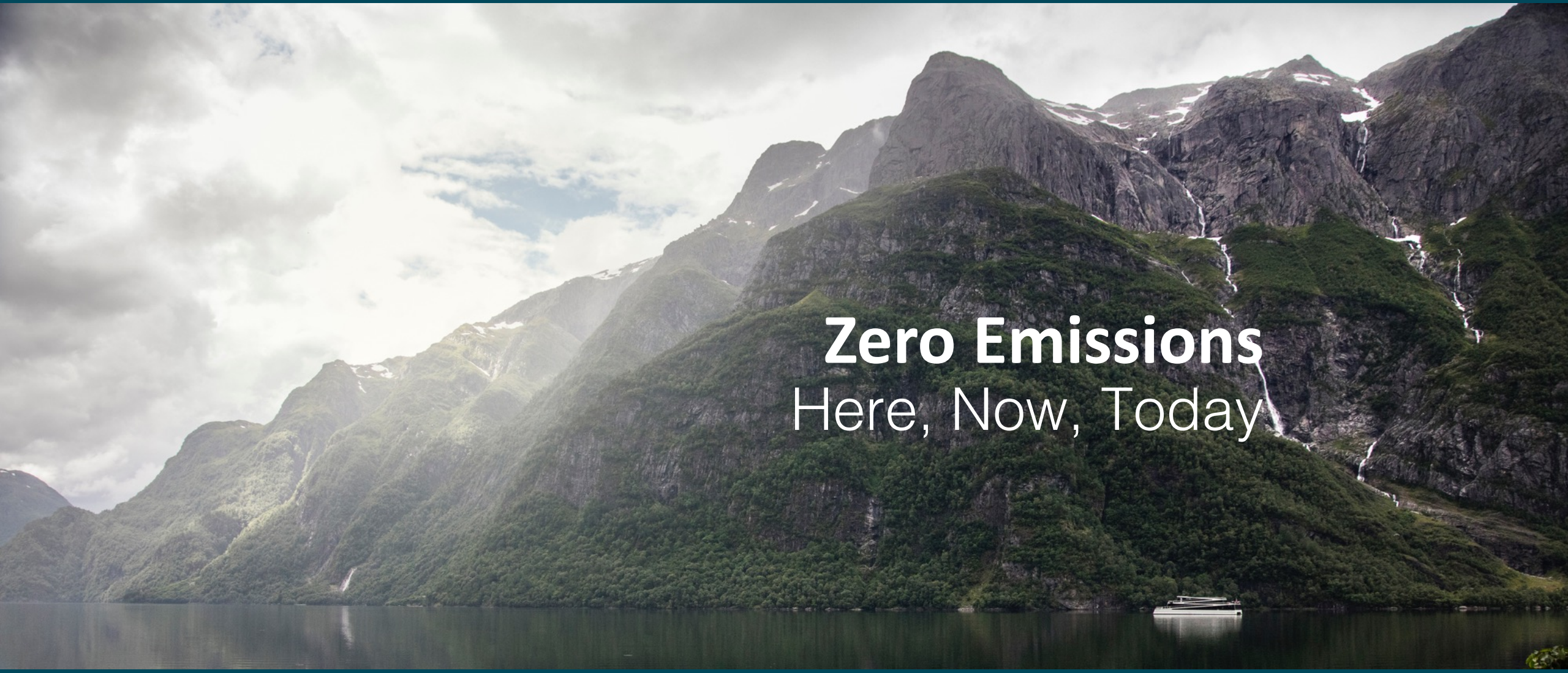

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ZESTAs.

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Zero Emission Ship Technology Association

The tide of change

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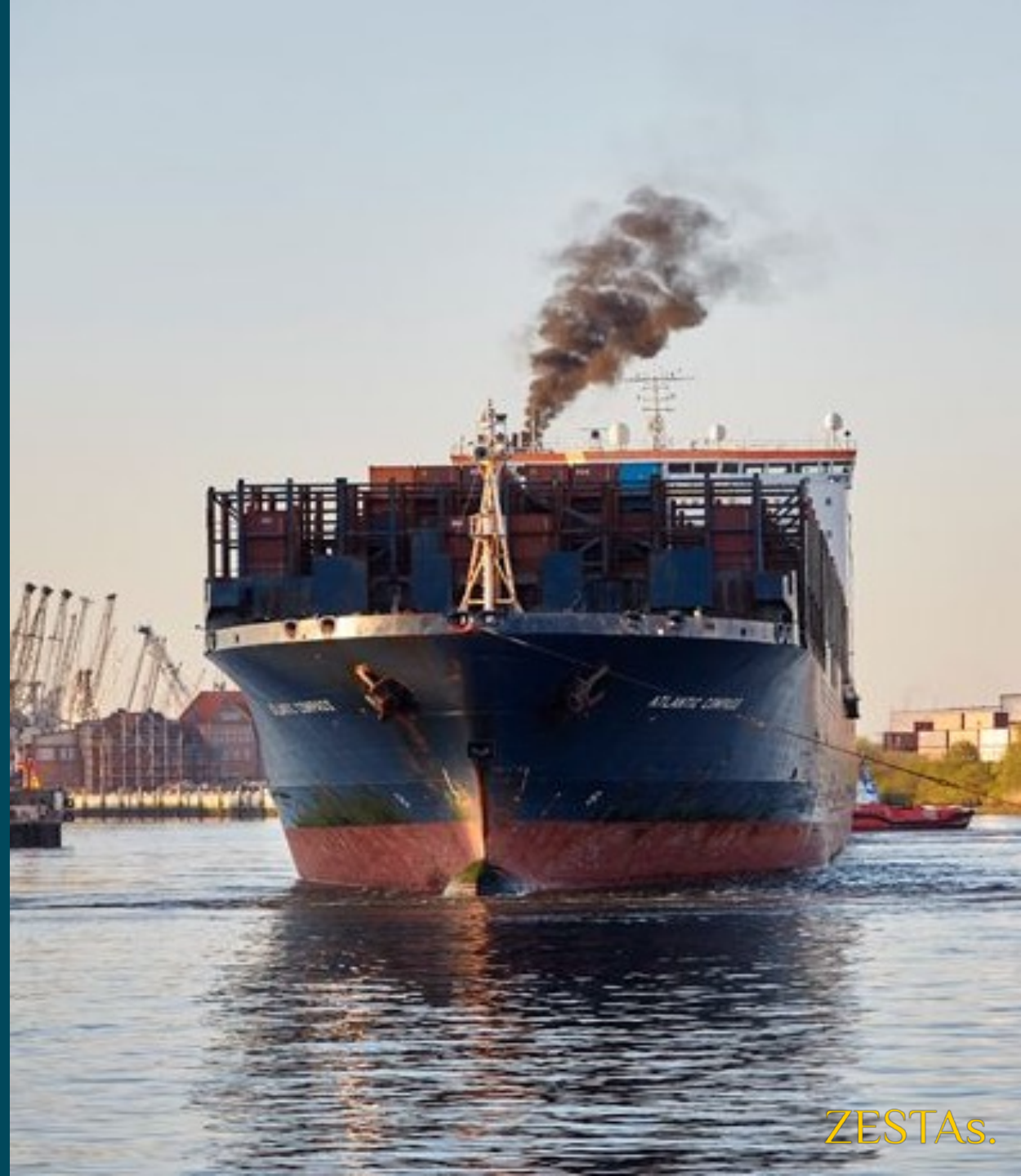
The Problem

11 years to prevent climate change catastrophe

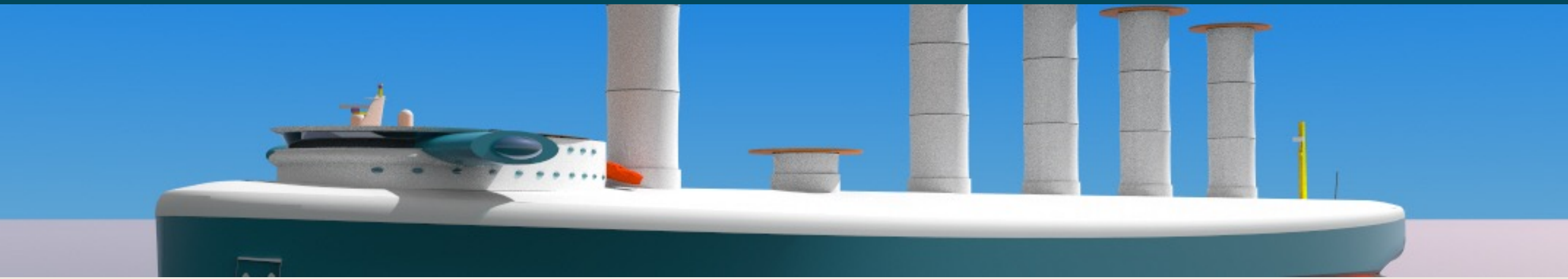
The Solution

Combining cutting edge innovation to achieve zero emissions vessels



The RESULT - ZES-1

A Zero Fuel Ship - Concept to Reality



- There is no one silver bullet to the emissions problems facing the shipping
- ZES1 is a holistic systems solution
- We have taken all the appropriate technologies
- Assuring non-conflict

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Design Goals

- Economically advanced Vessel where the fuel cost is added directly to the bottom line as profit.
- Zero Pollution, to air or ocean.
- Ultra low noise profile
- Healthy working environment
- Safe and secure vessel
- No ballast water or invasive species
- No disadvantage when compared to conventional vessels
- High resale and market value in the future green economy
- Multiple use systems

Design features and their origin

A holistic approach to design is critical.

- GEPS roll damping energy device
- Active routing for weather and current
- Regenerative propulsors/ generator turbines
- Aluminum Ballast and fueling
- High efficiency steering
- Air Cavity Hull
- Refined Hull design
- Low dynamic drag
- Photo Voltaic power generation
- Hydrogen Fuel Cells
- Hydrogen generation
- Wave propulsion
- Passive fin propulsion
- Wind power

Photo Voltaic
Solar Generation

Solar power for Navigational and house loads

ZEZ 1 will have a large raised weather deck covered in photo voltaic panals

Platform for the solar cells and ductwork for the cabling beneath.

Solar power is fed to the Lithium Ion batteries forward and aft to power all emergency systems, backups for steering navigation and lights, house loads and motive power to the Flettner rotors.


Multiple Use Systems are Clever and Key
Two, three and four use systems are best
MULTISYS√

Hydrogen is generated in two ways on ZES1

- Aluminum pellets crushed under water by Colloidal Mill
- electrolysis of sea water using energy from trailed prop and roll damping tank turbines.

Hydrogen will be used

- when the ship is approaching port
- periods of light, unstable winds or unsuitable wind direction

Aluminum pellets will be stored in “ballast” tanks throughout the hull.

*Aluminum fuel system would only activated in a sustained windless period or maintenance being carried out on the electrolyzers which prevented normal hydrogen production

MULTISYS√

Hydrogen is Key to ZES1 power regime

ZES1 fuel cell system:

- Serialized system of Marinized 3MW units.
- timeline for 20MW HFC's is 2022.

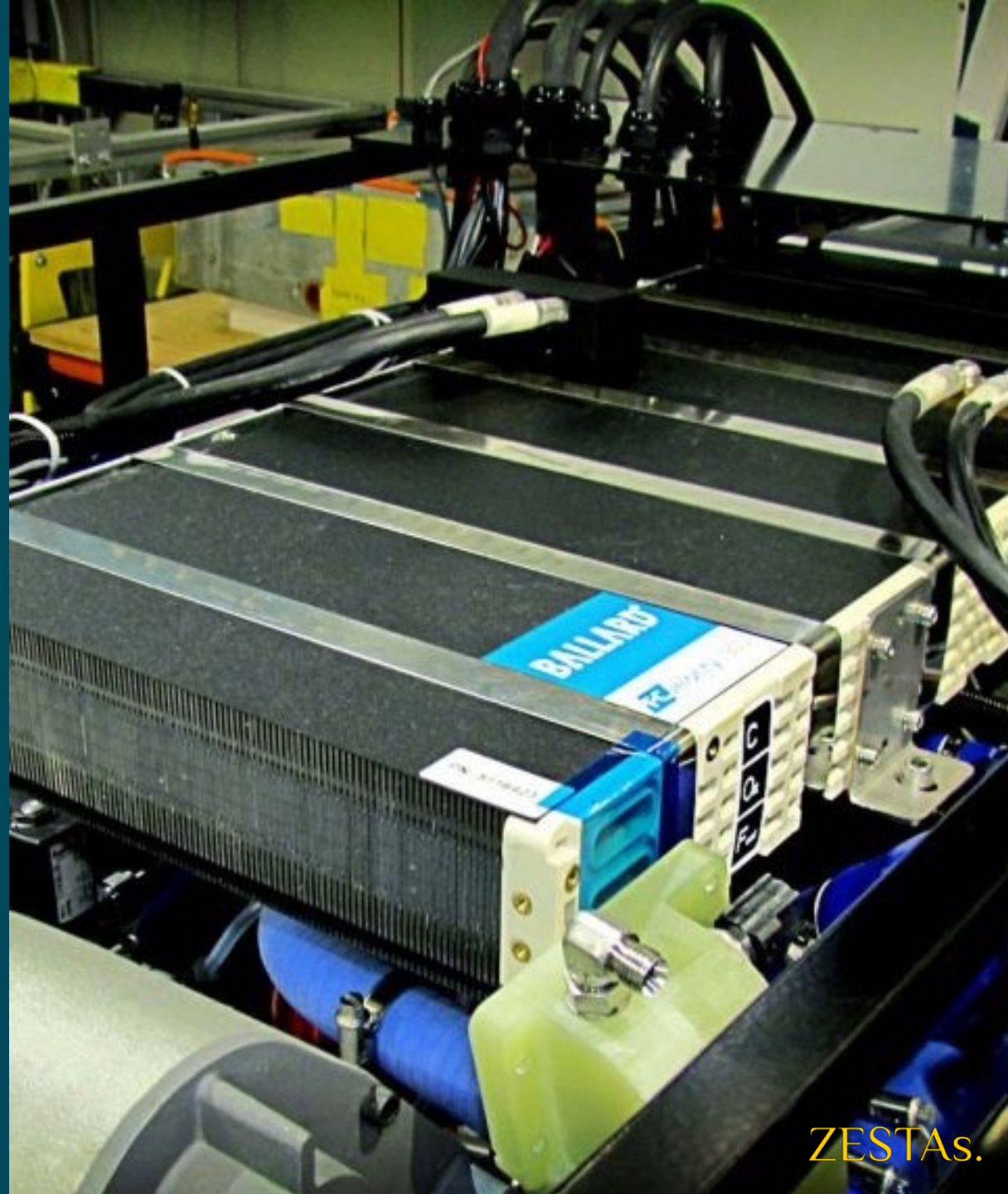
Hydrogen Storage:

- under weather deck if gaseous
- bottom of the hull if LOHC or Hydride

Added benefit Water from fuel cells:

- used for cleaning salt solar panels
- reused for hydrogen production

MULTISYS√



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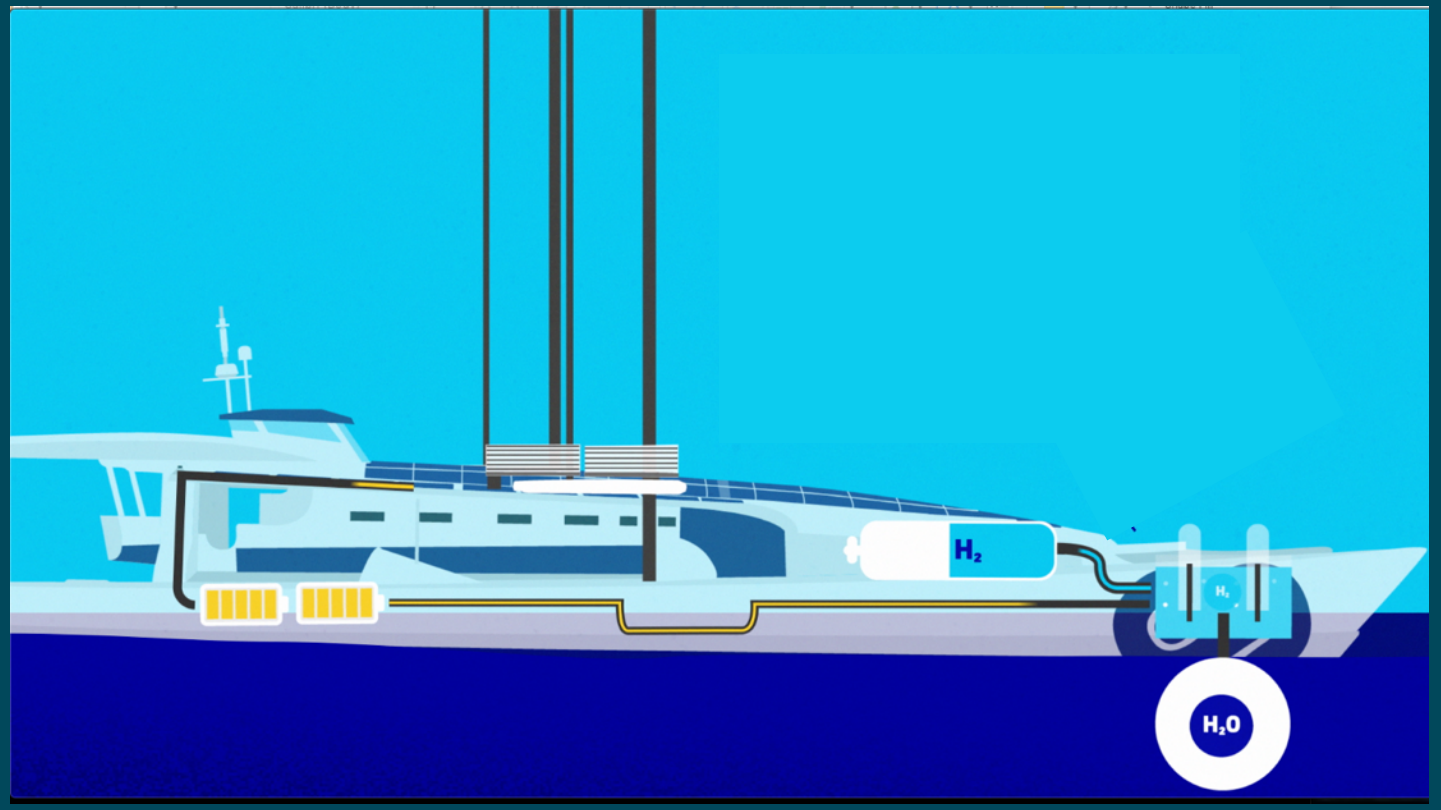
Energy Observer Has Cut the Bow Wave

Energy Observer uses solar and wind energy to produce hydrogen from sea water

- 42% efficiency
- 8 x less mass than battery



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Wave Propulsion System

Active propulsion from passive foils built into the ZES1's bows.

Systems commercially available; fixed, retractable

Demonstrations; fishing vessels, offshore vessels, commercial ships

- CFD analysis to support the real world experience.

ZES1 -

- 3 Permanent wave foils fitted below the bows
- 2 degree Rocker designed into keel to promote vertical motion and increase power extracted from waves

https://www.youtube.com/watch?v=UWpxtfmpVD4

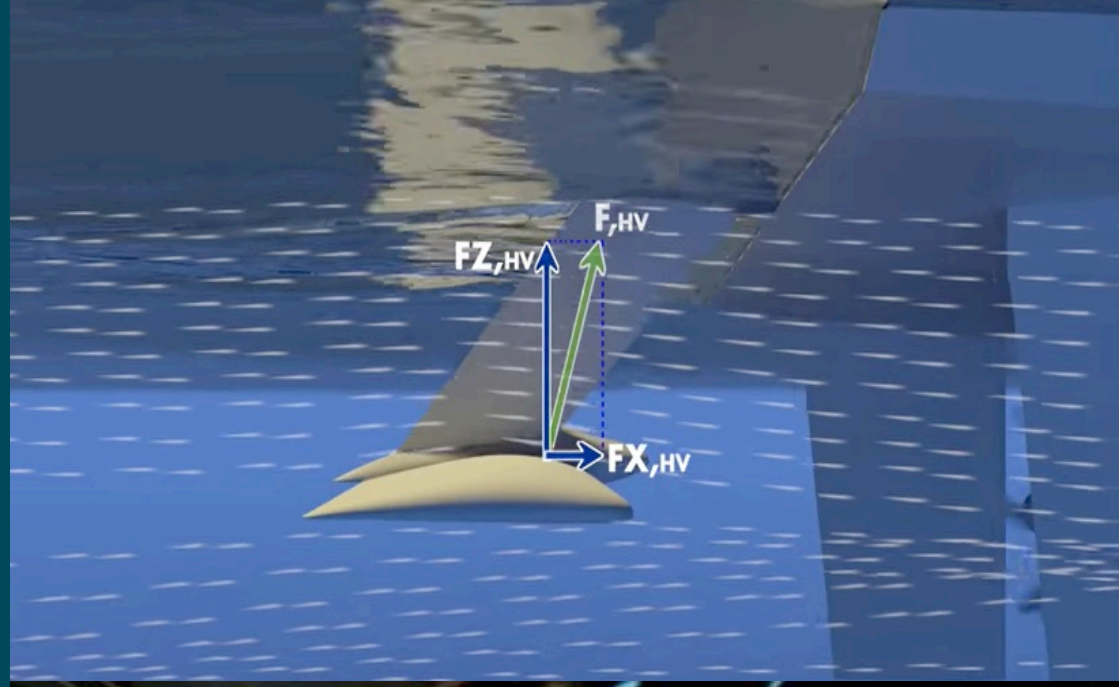
ZESTAs.

Passive Foil Propulsion

Capturing forward thrust from lift at the stern

A Passive foil positioned behind the propeller and rudders takes advantage of aft and upward direction of the water flow to generate a forward thrust vector, making use of energy which has already passed the vessel and would therefore be lost reducing power requirement on medium speed vessels by up to 15%.

Added benefit -Reduces stern waves preventing damaging wash.



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Wind Propulsion

Retractable Flettner Rotor Sail

The regenerative power sail system is key to;

- Operational capacity
- Mission duration
- Range at sea
- Power take in
- Hydrogen production
- Zero fuel in the ZES 1 bottom line

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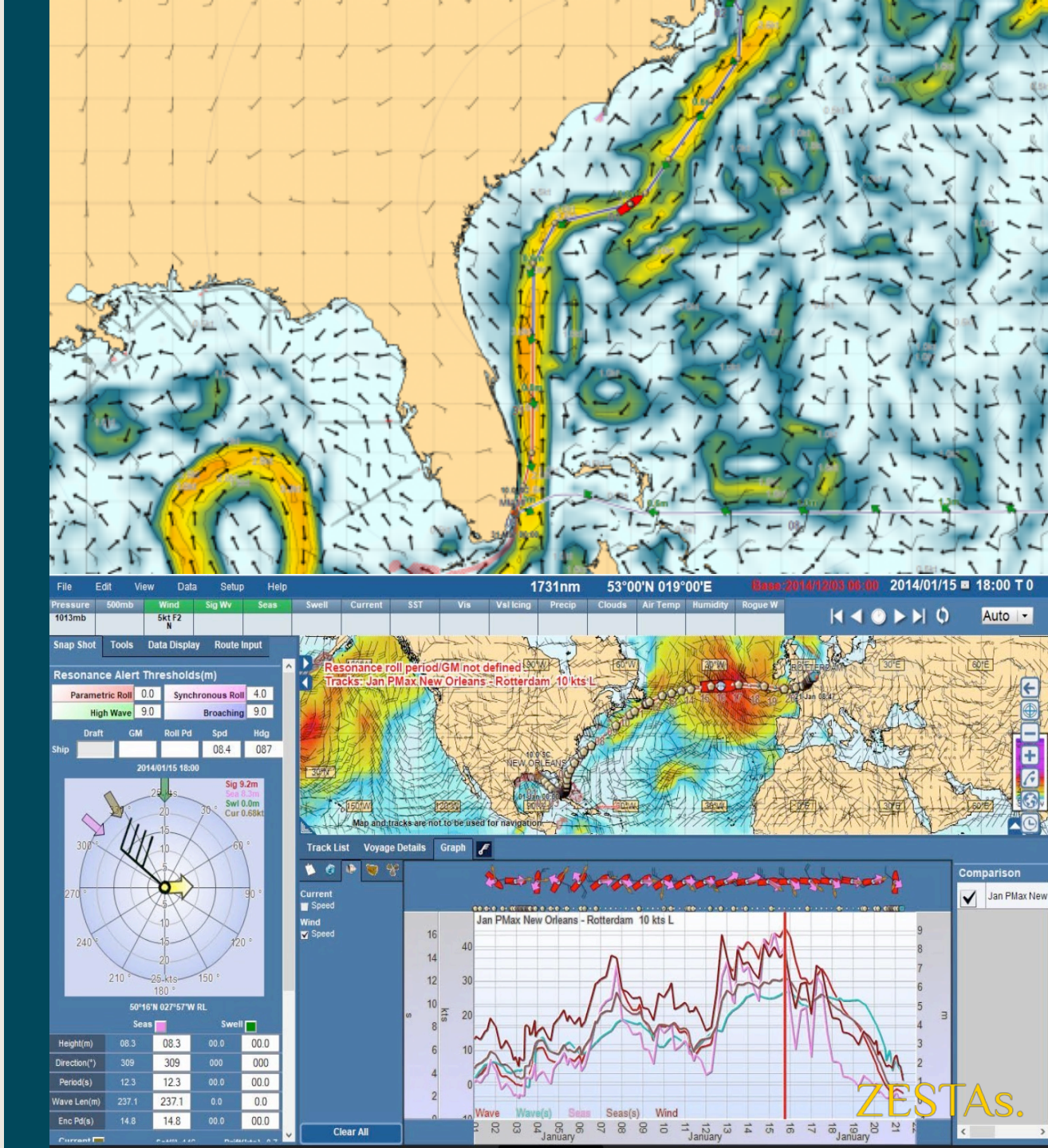
Weather and Current Routing

Smart routing

- optimise time of arrival and speed on route
- find the most advantageous winds and currents for
- Propulsion
- Power Take-in

StormGeo's BVS system

- accepts inputs from Flettner rotor sail systems
- allow for active ride catching from Ocean Currents.



Regenerative Propulsion Propulsors / Turbines

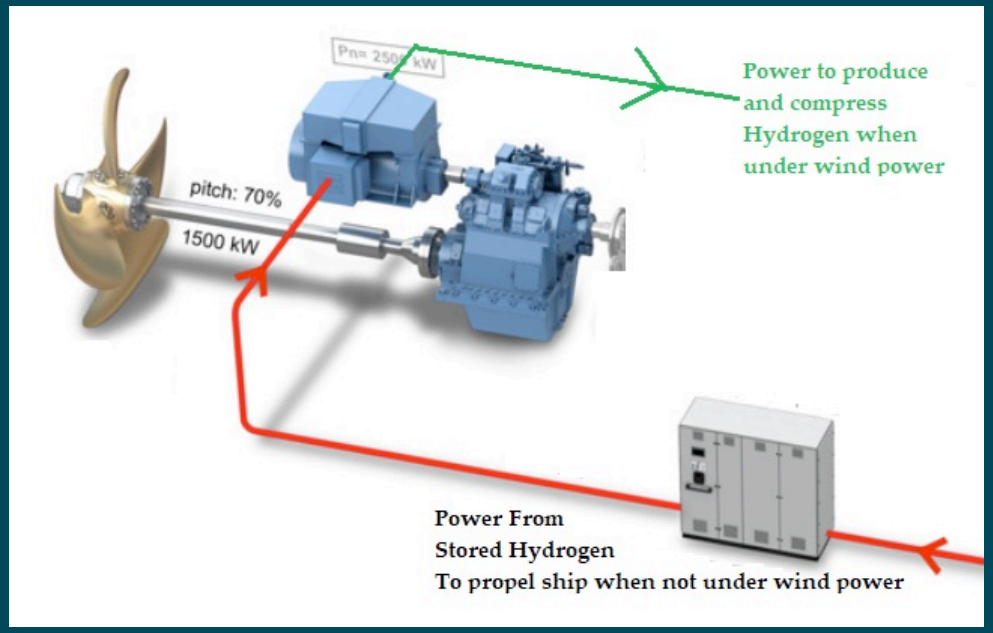
Power from sailing and power to sail

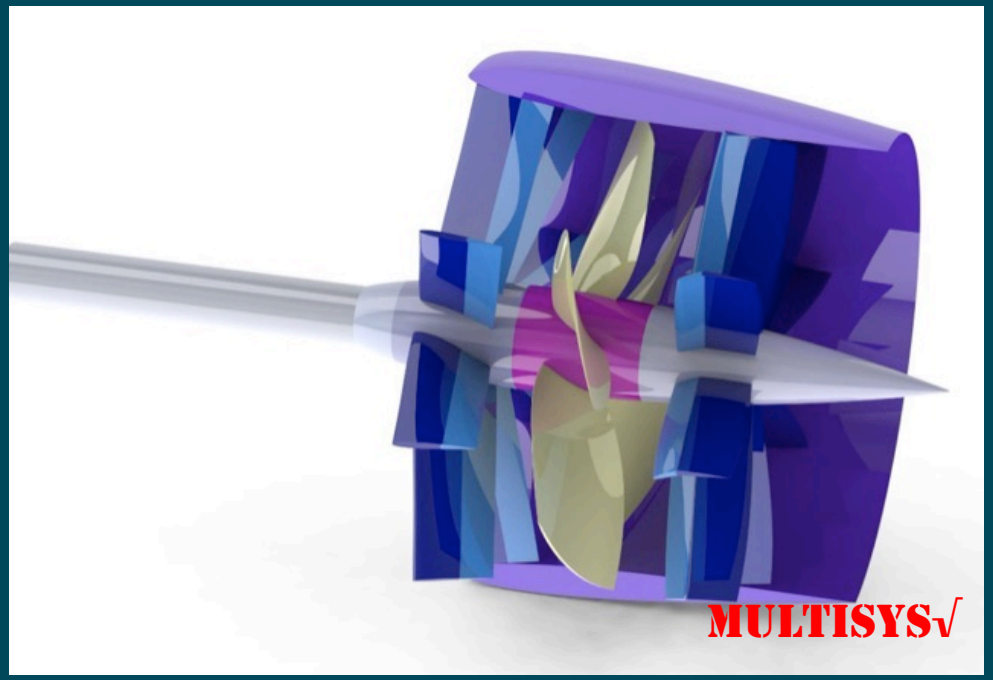
When ZES 1 is under sail, enhanced propulsers with pre and post rotor blades maximise efficiently of power take-in to electrical power generation for hydrogen generation.

ZES 1 will use this hydrogen when wind is inadequate for full propulsion.

The propulsors are 20% more efficient than the best conventional props

Permitted on commercial vessels since Oct 2018 as they now have the reverse thrust required by SOLAS regulations for emergency stop.





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Aluminum Ballast & Fuel

Aluminum dual purpose;

- 1st - ballast
- 2nd - fuel

Advantages

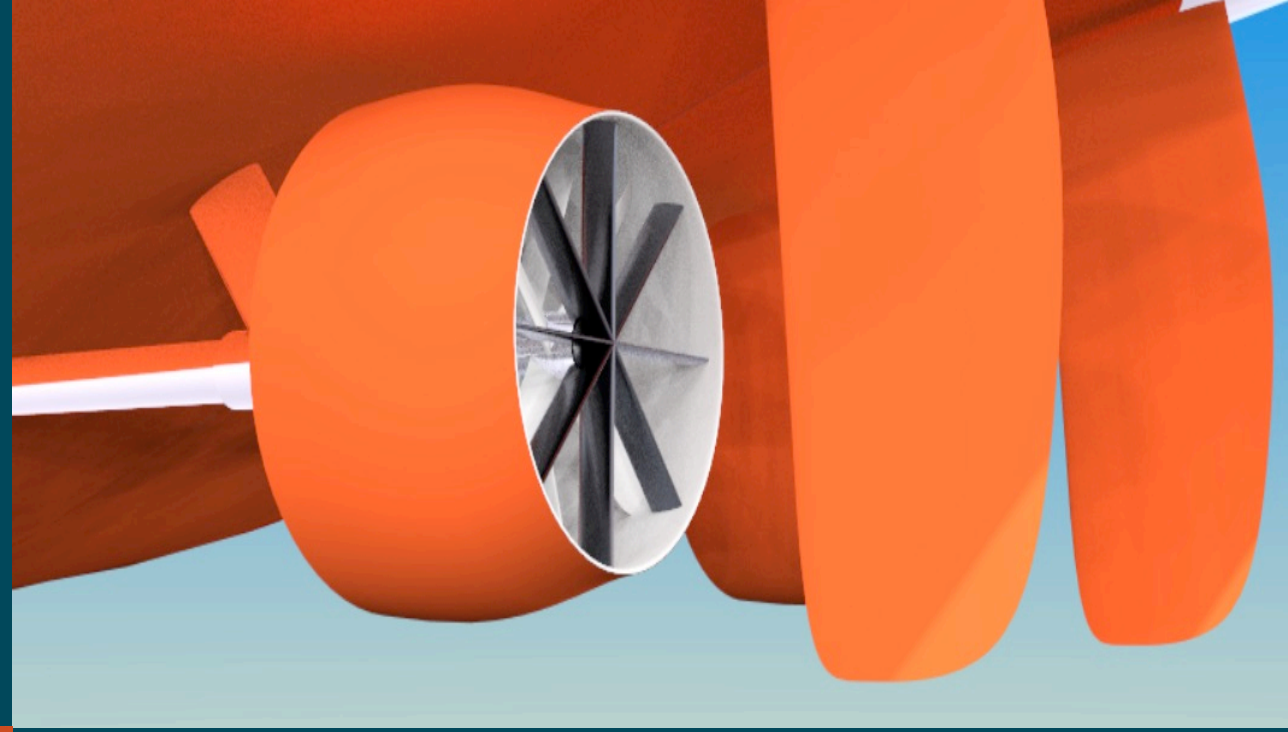
- no invasive species
- 2.5 times the weight of water as a ballasting material (leaner hull)
- one of the most abundant substances on earth.
- material left from fuel is completely none toxic

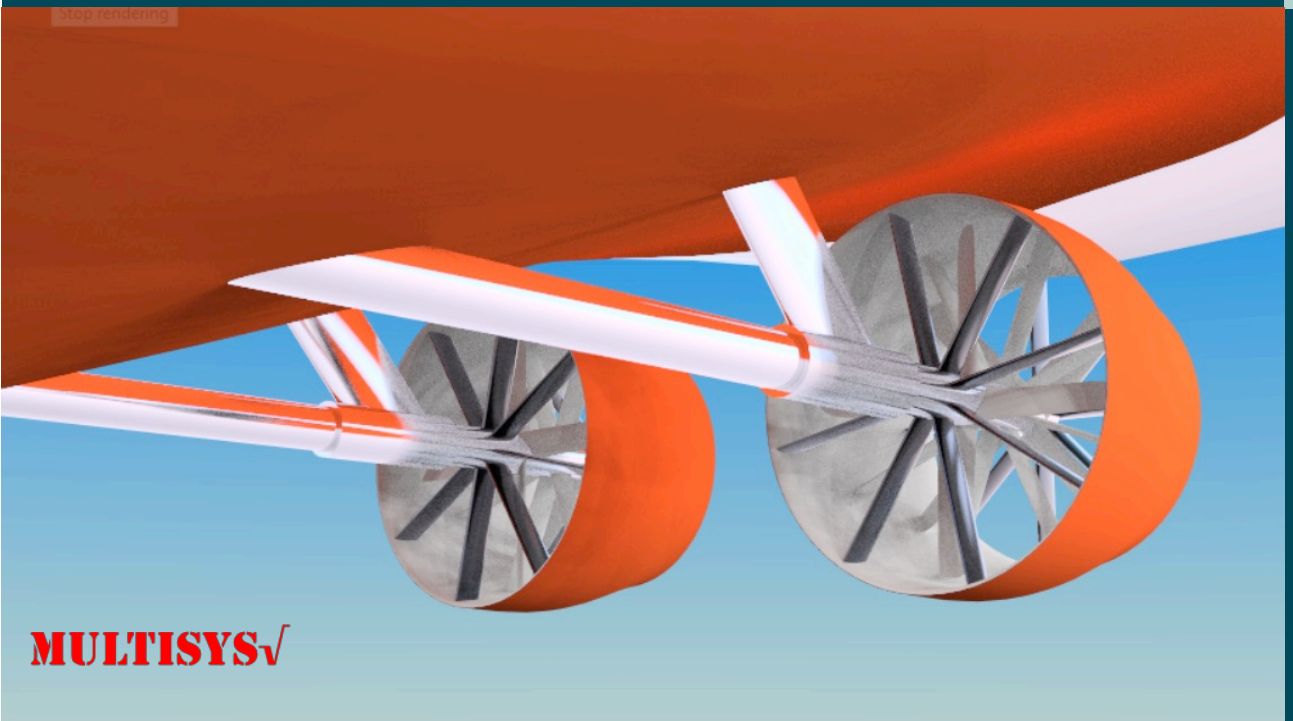
*It is envisioned that the aluminium would be stored ashore in silos and pumped like a liquid to sand from ships.

ZESTAs.

High efficiency Steering

- Retractable rudders for sailing
- Propulser Steering when under power





Balancing sail forces on the hull -

Trim tabbed rudders balance sail forces on the hull and keep the corrective rudder of lee or weather helm to an absolute minimum.

ZES1 uses high efficiency propulsors to make course corrections. Balance of thrust reduces need for additional rudder planes to maintain course.

Retracting rudders when the ship is under sail increases efficiency and reduces power demand.

ZESTAs.

Air Cavity Friction Reduction

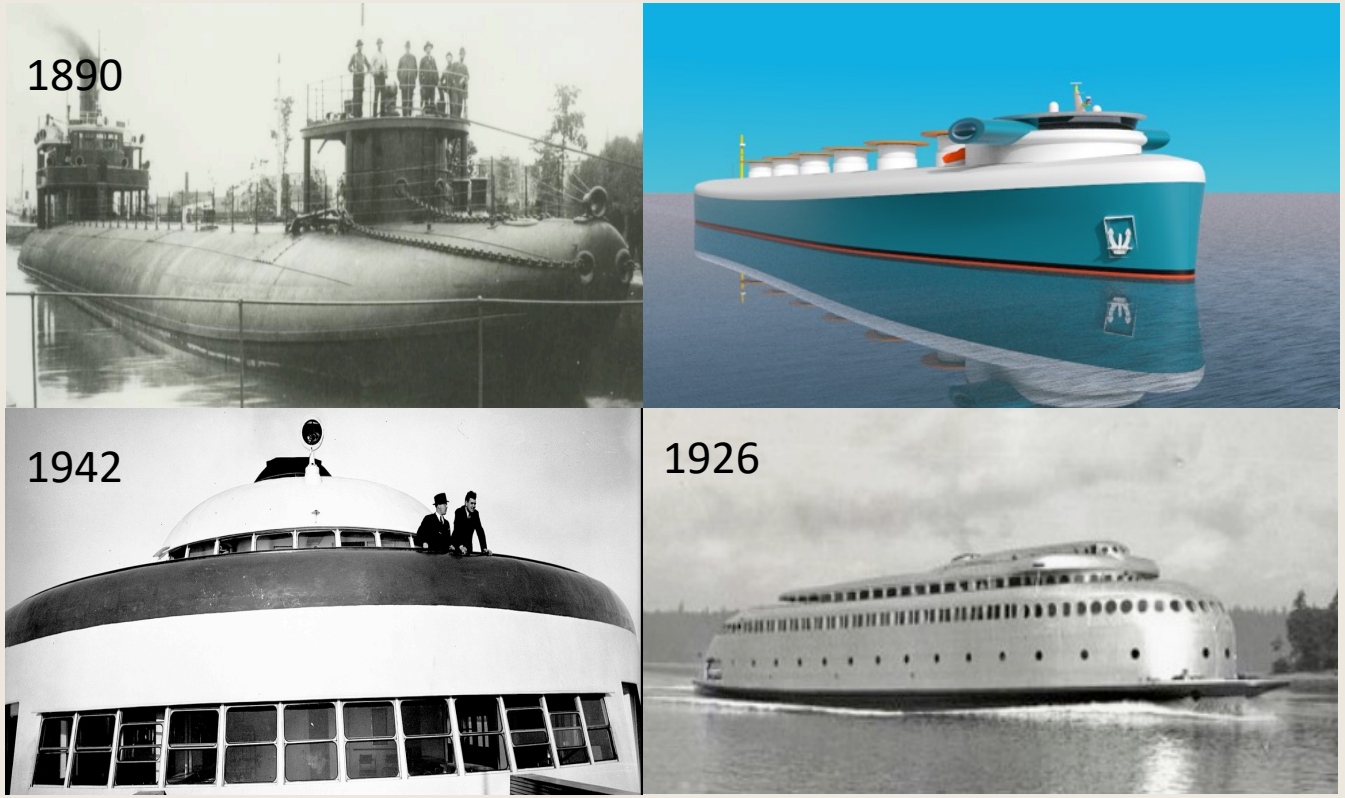
Contact between the hull and the ocean is reduced with the inverted swimming pool

ZES1the hull shape is not that of a conventional VLCC and so rather than a simple flat surface to apply an air cavity system , a set of long channels is used for the same effect.

Secondary advantage of contact reduction in hull
- The air that is trapped below the hull adds buoyancy when the vessel is laden
when in ballast air can be released
vessel will sit lower in the water reducing required ballast. Result - ships hull design has a slimmer less resistant shape increasing efficiency

Dynamic Friction Reduction by design

Concentrating on the drag inducing surfaces and apendiges to produce a low friction system for the overall ship design

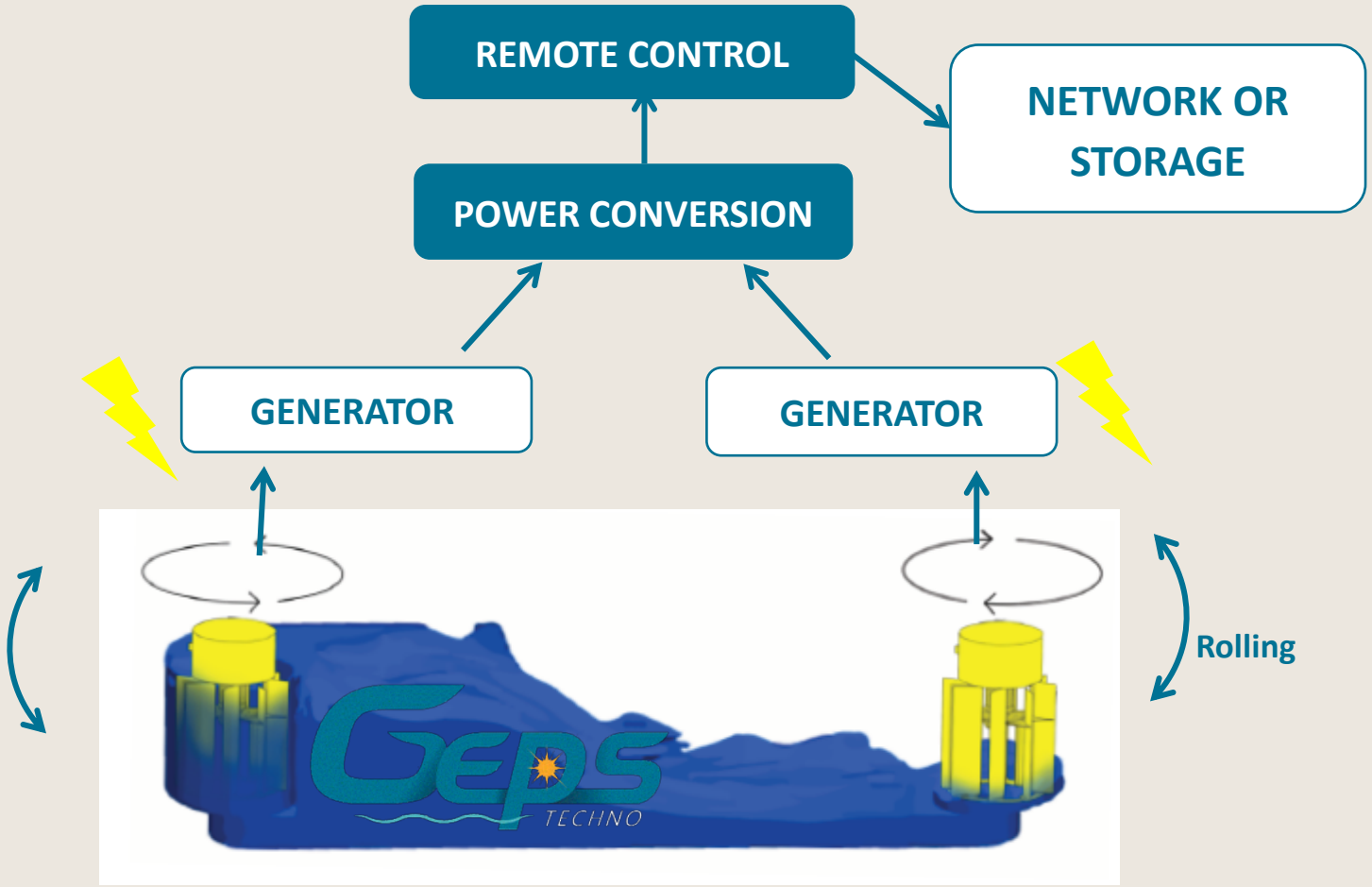


Fairing of Hull and superstructure as well as optimization of the deck and superstructure in order to yield the lowest friction coefficients both from air and water.

ZESTAs.

GSIRE®: Power Producing Roll Damping Tank

How it Works:



CASE STUDY FPSO 300m LOA / 60m B

- Around 1% of total displacement
- Dimension : full beam

- Improving stabilization
- Power estimated -

  >300 KW per tank

ZESTAs.

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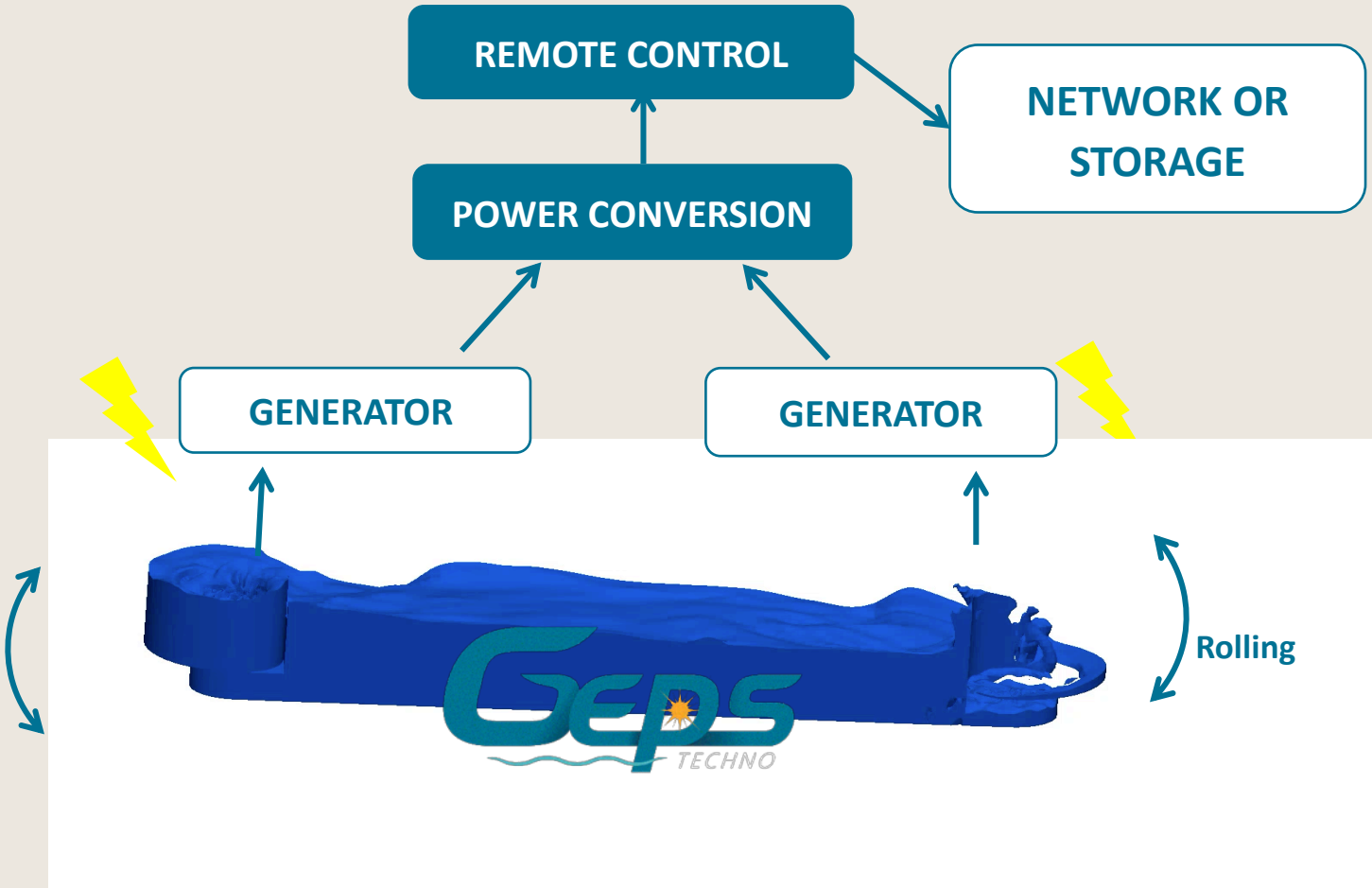

CASE STUDY FPSO 300m LOA / 60m B

- Around 1% of total displacement
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ZESTAs.

Technologies and Development

Technology	Conventional Vessel Use	Marinized	ZES1	Note	Developed
Solar power	NO	Yes	Yes	Power for Navigation, Hotel etc	Yes Fully
Lithium ion batteries	Yes	Yes	Yes	Power Storage	Yes Fully
Hydrogen Fuel Cells	NO	Not to scale	Yes	Main power propulsion	Yes
Wind Propulsion	No	NO	Yes	Primary propulsion source	Yes Fully
Passive Foil	Yes	Yes	Yes	Standard Model	Yes
Wave Propulsion	No	Yes	Much larger Array of Foils	Yes	Wave Propulsion

Technologies and Development

Technology	Conventional vessel use	Marinized	ZES1	Note	Developed
Re-gen Propulsion	No	Yes	Yes	Wind to Hydrogen power	Yes
Roll damping energy take-in	No	Yes	Yes		Yes
H2 Electrolysis	No	Yes	yes	20MW land based. Has not been marinized to scale	Yes
Al Hydrogen Generation	NO	Yes	Yes	Al reaction	Yes
Aluminum Ballast		NO	Yes	Shore installations Required	NO

Technologies and Development

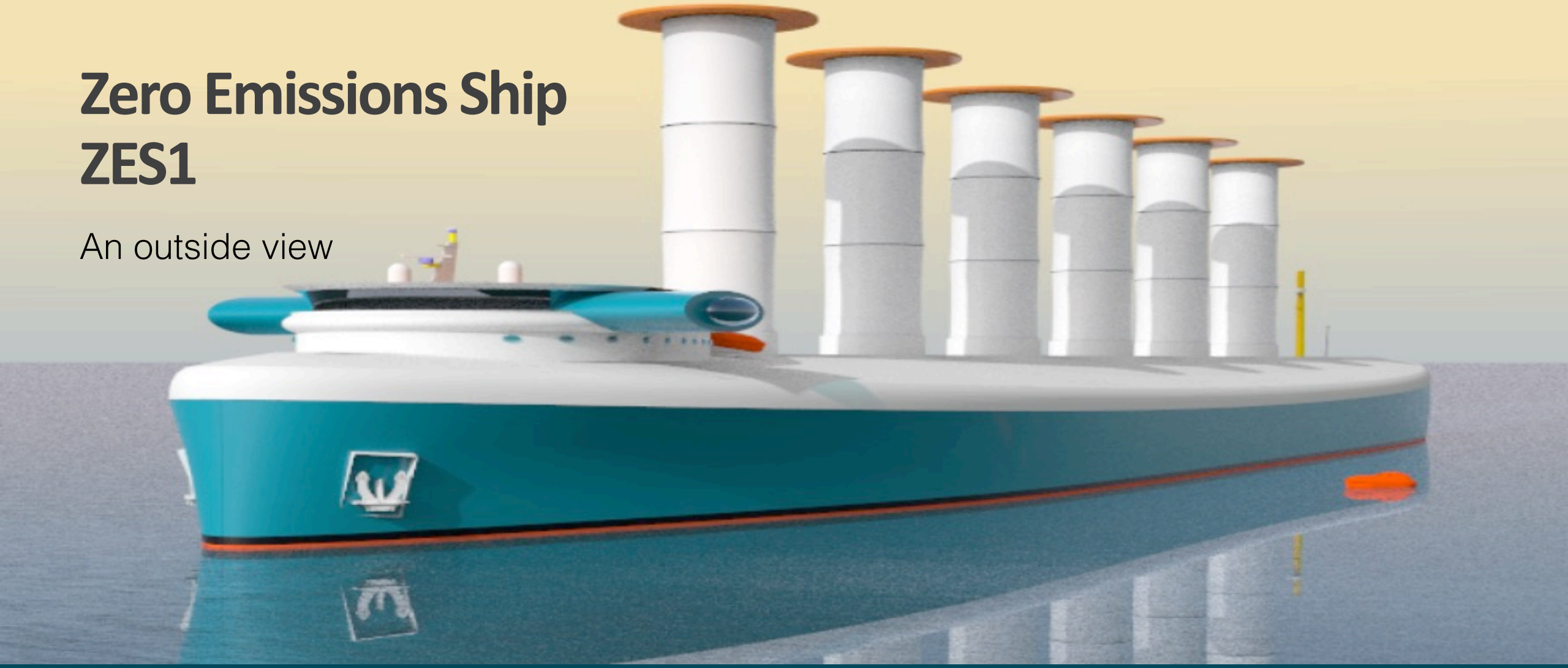
Technology	Conventional vessel use	ZES1	Note	Developed
Air Cavity hull	NO	Yes	Marin trial ship	Yes
Refined Hull design	NO	Yes	Multi aspect integration	Yes
Aero Drag Reduction	NO	Yes	Wind tunnel testing	Yes
3D Bio Mimicking Coating	NO	Yes	Shark skin antifoul	NO
Holistic Zero emissions design	NO	Yes	Complete ship system design	Yes

Technologies and Development

Technology	Conventional vessel use	ZES1	Note	Developed
Direct Salt water electrolysis	No	?	Proof of concept	No
Metal hydrides	No	?	Proof of concept pending	No
LOHC	NO	?	Toxicity issues	Yes

Zero Emissions Ship
ZES1

An outside view



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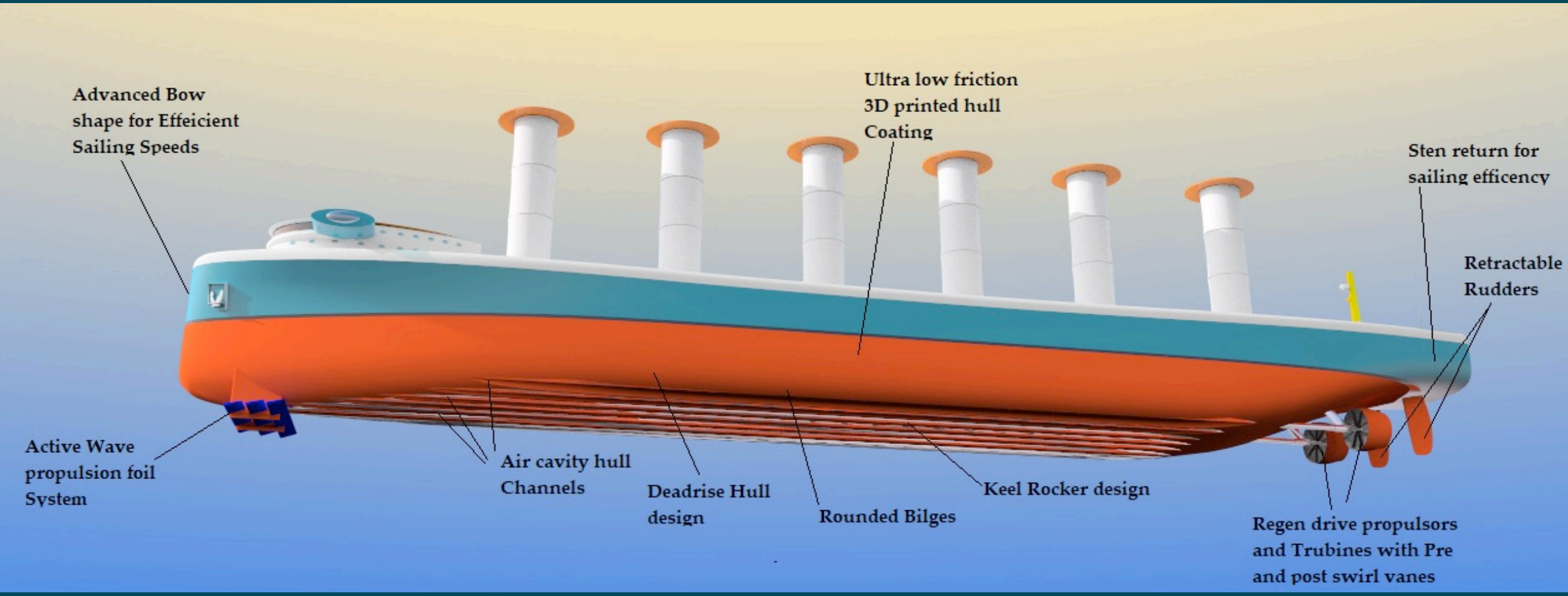
Below the Waterline



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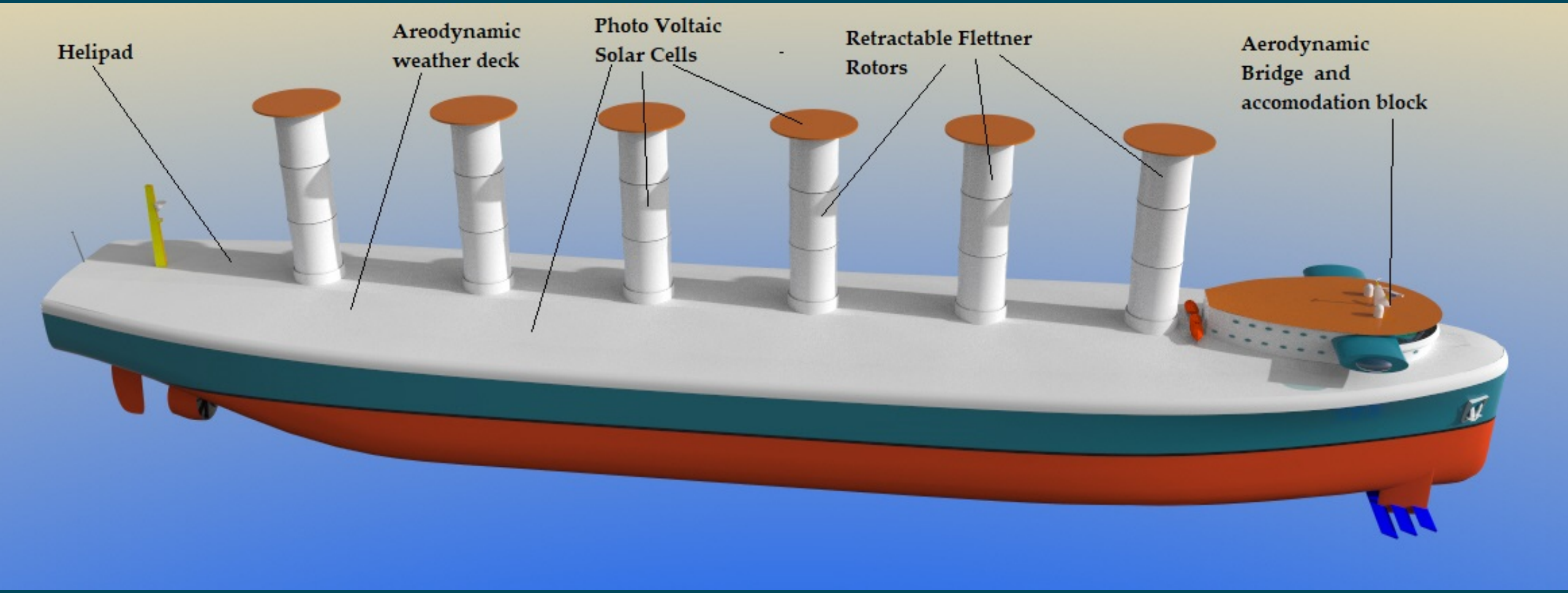
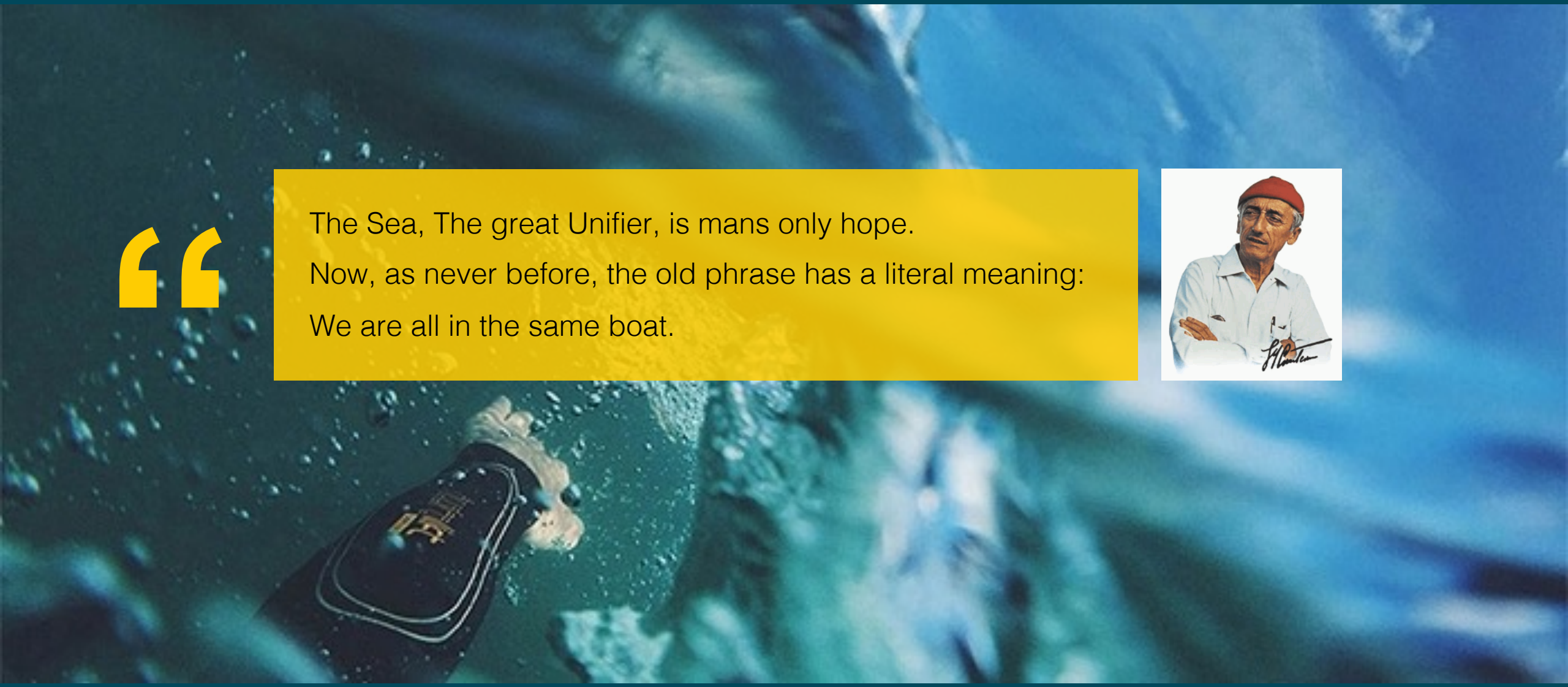
Above the Waterline





> The Sea, The great Unifier, is mans only hope.
>
> Now, as never before, the old phrase has a literal meaning:
>
> We are all in the same boat.

ZESTAs.

It is your decision how far into the Future Your Zero Emissions ship will travel

Thank you for your attention

http://zestas.org/

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