



MADADH MACLAINE

SECRETARY GENERAL

ZERO EMISSIONS SHIP TECHNOLOGY ASSOCIATION



THE SUSTAINABLE MARITIME TRANSITION & INVESTMENT CONFERENCE



1.5 DEGREES – SHIPPING'S ROLE IN PREVENTING CLIMATE CATASTROPHE
THROUGH SUSTAINABILITY AND THE ENERGY TRANSITION

ZESTAs.

Zero Emissions Ship Technology Association

International Trade Association
Founded March 2019

MEMBERSHIP

Full members:

- Project or technology that is Absolute Zero GHG Emissions at a ship level with minimal upstream impacts.
- One vote per organization.
- Access to board of directors

Associate members:

- Committed to achieving True Zero through collaboration with ZESTAs membership.
- Membership organizations / trade associations that comply with ZESTAs objectives.
- No voting rights or access to board.



Our Planet in Crisis

Ocean health's impact on climate

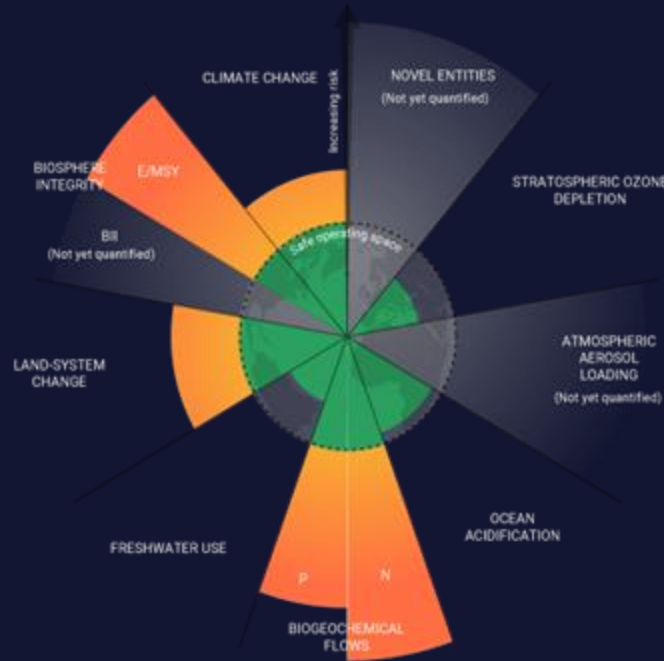
Shipping's impact on ocean health

2009



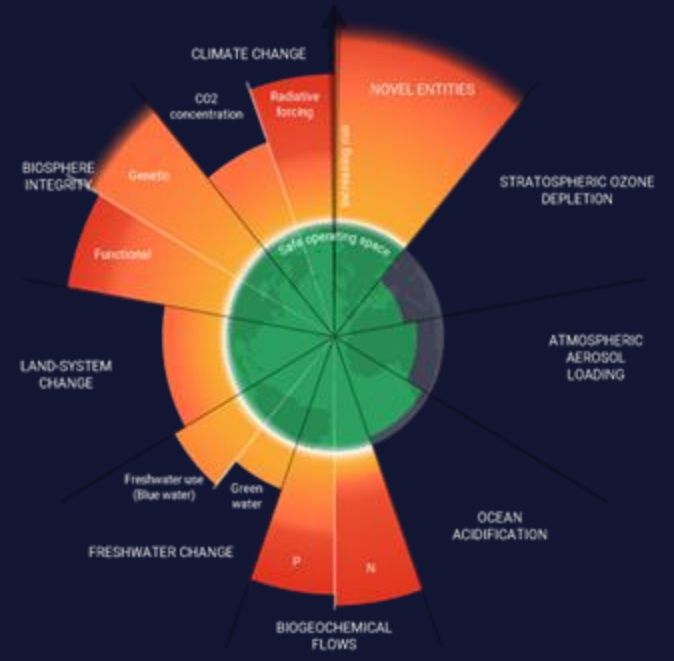
7 boundaries assessed,
3 crossed

2015



7 boundaries assessed,
4 crossed

2023



9 boundaries assessed,
6 crossed

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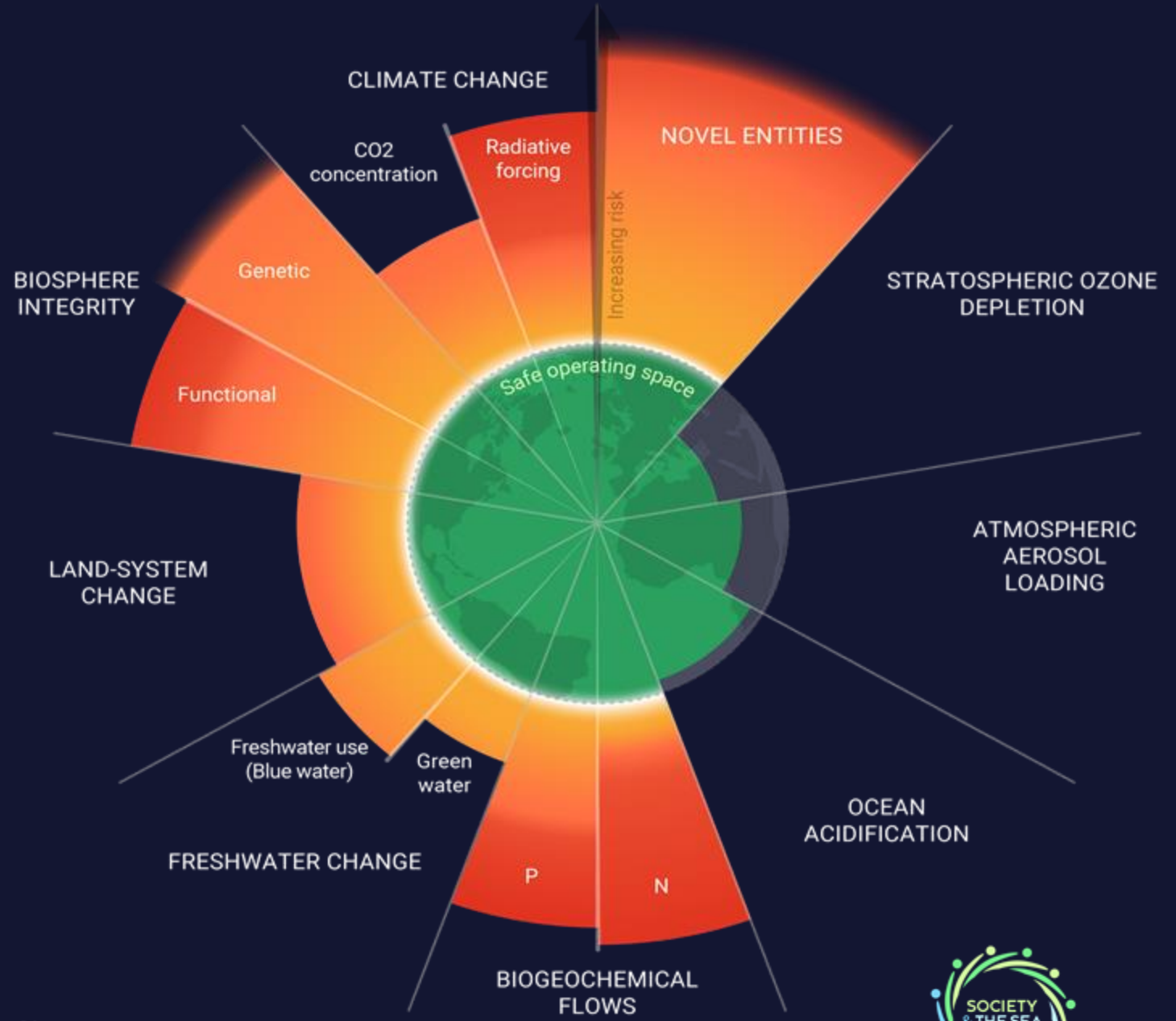
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Humanity is waging war on nature, says UN secretary general

António Guterres lists human-inflicted wounds on natural world in stark message

● [World is 'doubling down' on fossil fuels despite climate crisis - UN report](#)



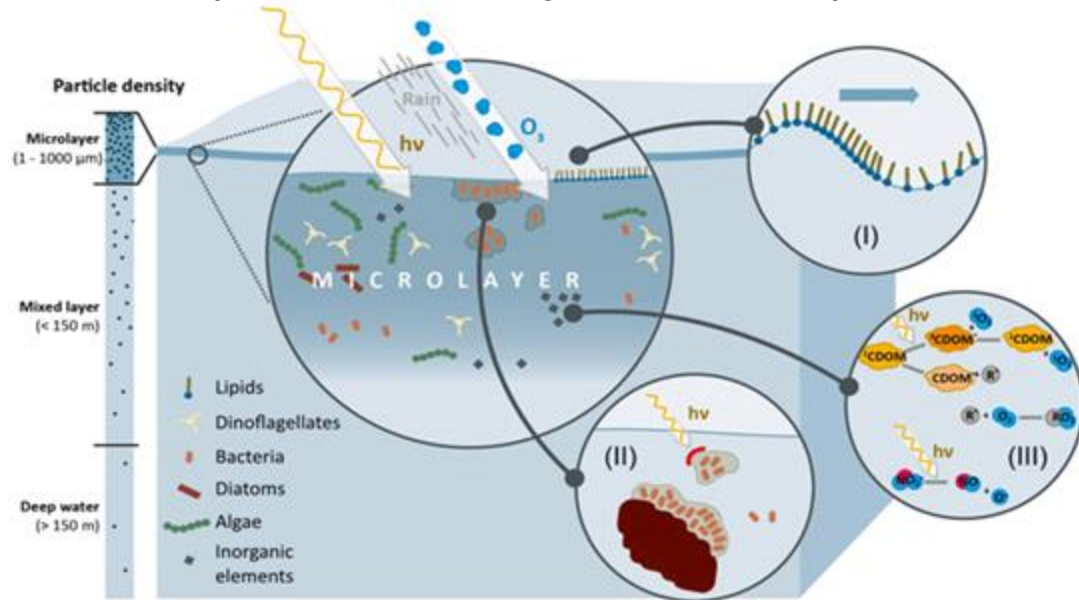
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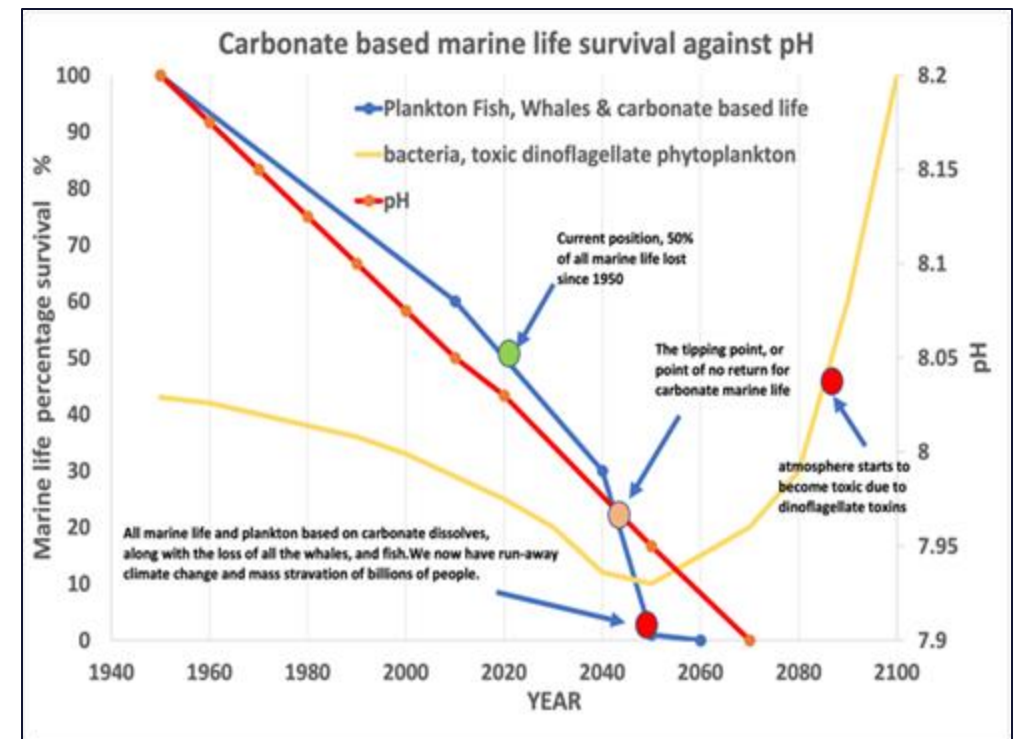
Ocean Health is key climate stability

- Main GHG – Water
- Emissions -> +Temp -> + Water evaporation & vapor -> higher temps = Feedback loop
- Surface microlayer (SML) – as important as Carbon
- SML – formation of aerosols and clouds, reduces water molecule escape & slows transfer thermal energy
- Pollution is killing SML
- -50% decline in marine plankton since 1950
- marine plankton declining at 1% decline p.a.



ANTHROPOGENIC CO₂ + POLLUTION = OCEAN ACIDIFICATION

- 1950 – pH 8.2
- Currently – pH 8.05
- 2045 – pH 7.95 -> Marine Ecosystem Collapse



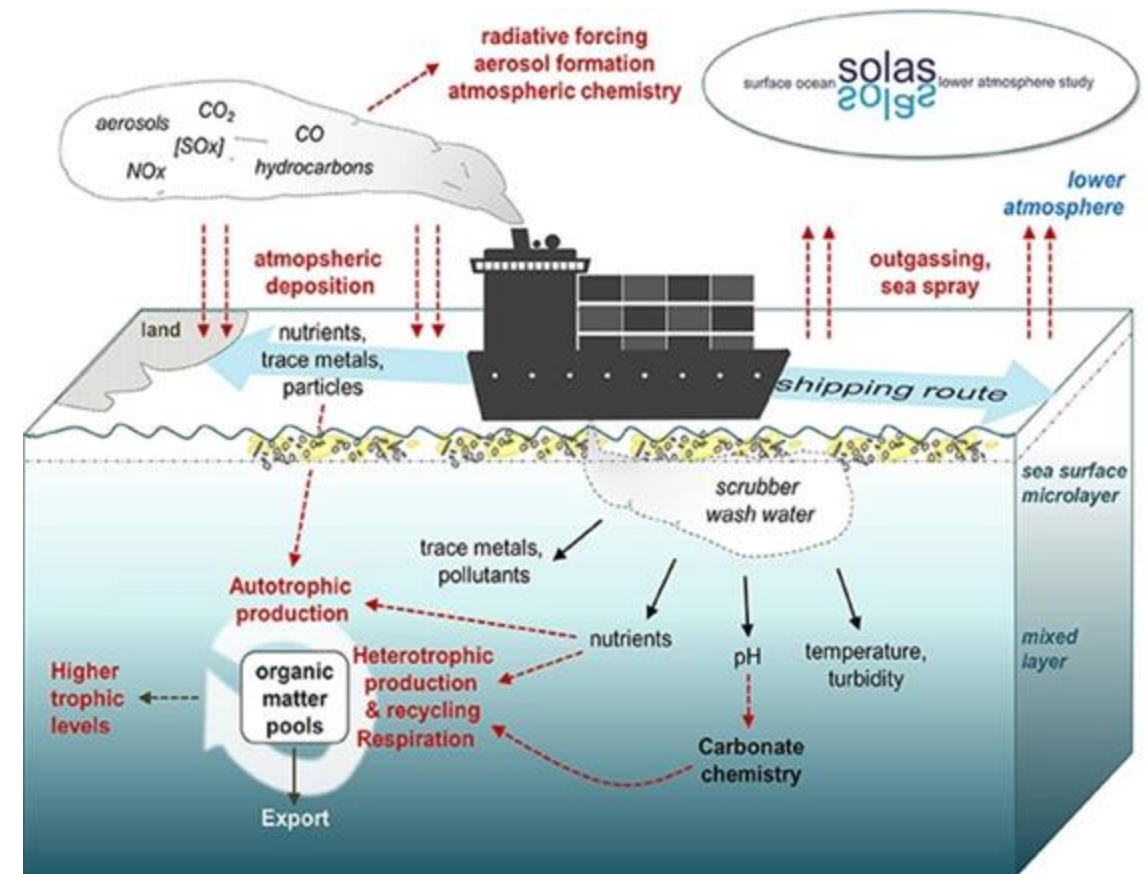
Maritime sector impact on ocean health grossly underestimated



www.GoesProject.com

GLOBAL OCEANIC ENVIRONMENTAL SURVEY

- The maritime sector - 20% of the world's pollution
- Pollution and Black Carbon (All PM) must be eliminated
- Climate Model Needs Re-evaluation to include pollution
- Net Zero will not “save the planet” without healthy marine ecosystem
- ZERO Emissions + ZERO Pollution is crucial
- Climate Change is Bad
- Ocean Acidification is Catastrophic



CAUTION! – Unintended Consequences fuels

Most “alternative fuels” produce GHGs and pollutants in FC or ICE.

Green Hydrogen in
PEM FC –
Only Absolute Zero
fuel solution

Fuel	<u>ICE</u>	<u>Fuel cell</u>
LNG	CO ₂ , methane, NO _x , SO _x , PM	Not used
Biofuels	CO ₂ , NO _x , SO _x , PM, black carbon	Not used
E-methanol	CO ₂ , NO _x , SO _x , PM	CO ₂
E-ammonia	N ₂ O, NO _x	N ₂ O (300 CO _{2e})
E-hydrogen	NO _x	Absolute Zero



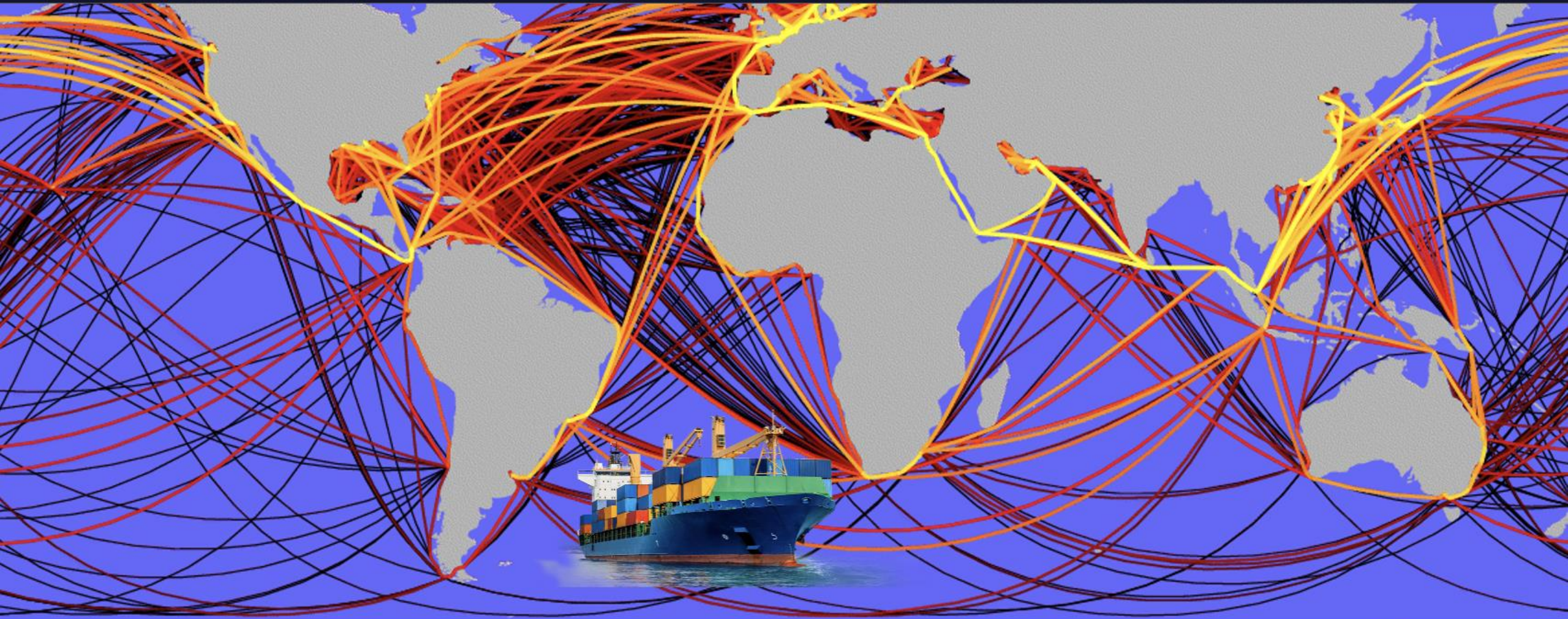
Shipping's opportunity to shine!

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Shipping's reach is global and touches all sectors



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AZE Technology is market Ready!

PEM H₂ Fuel cells T/CRL9, - 6.5MW



LH₂ and GH₂ storage is T/CRL9

- **Absolute zero** = ISWG-GHG 13/3/9 –
- “...an energy source that produces **no GHG emissions**”
- **ZESTAs** = only absolute zero emissions technologies
- **ZEST** = Ocean Health

ZESTAs IMO Submission - MEPC81/INF.5

**“Commercial
Readiness of
Absolute Zero
Emission
Technologies”**



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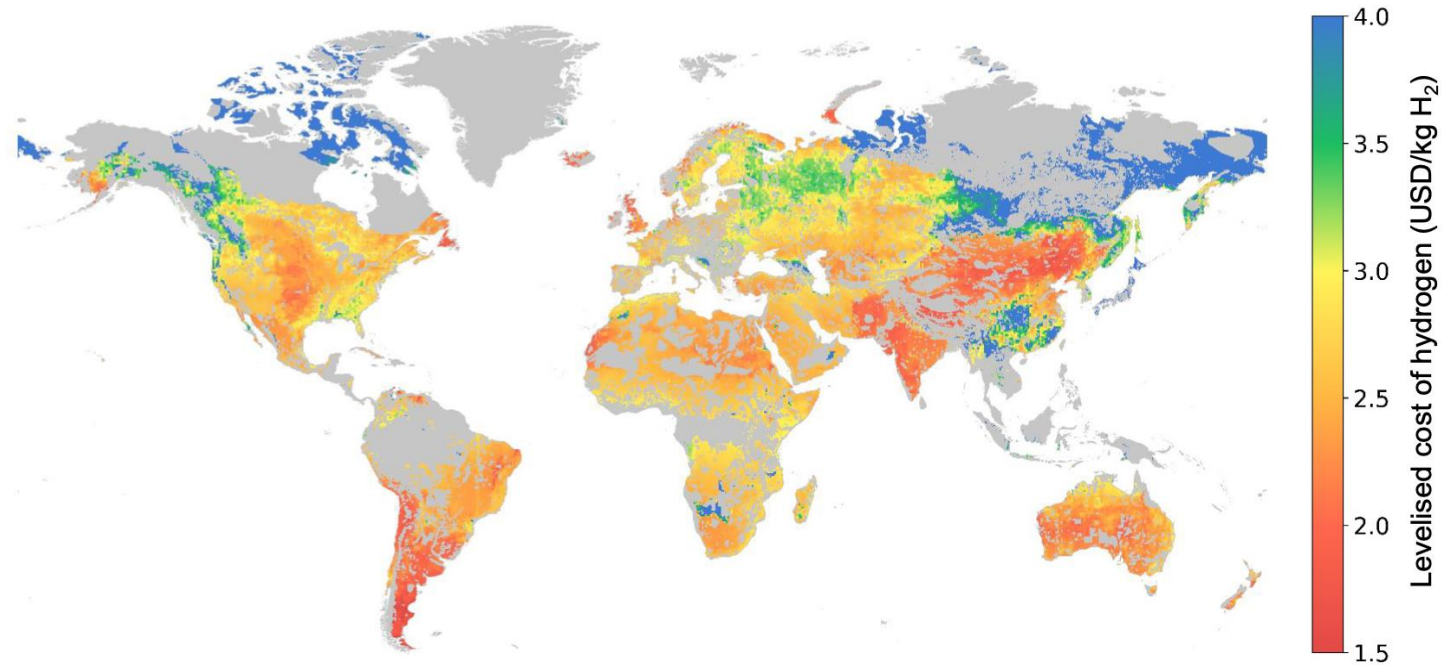
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Its all about the ENERGY!

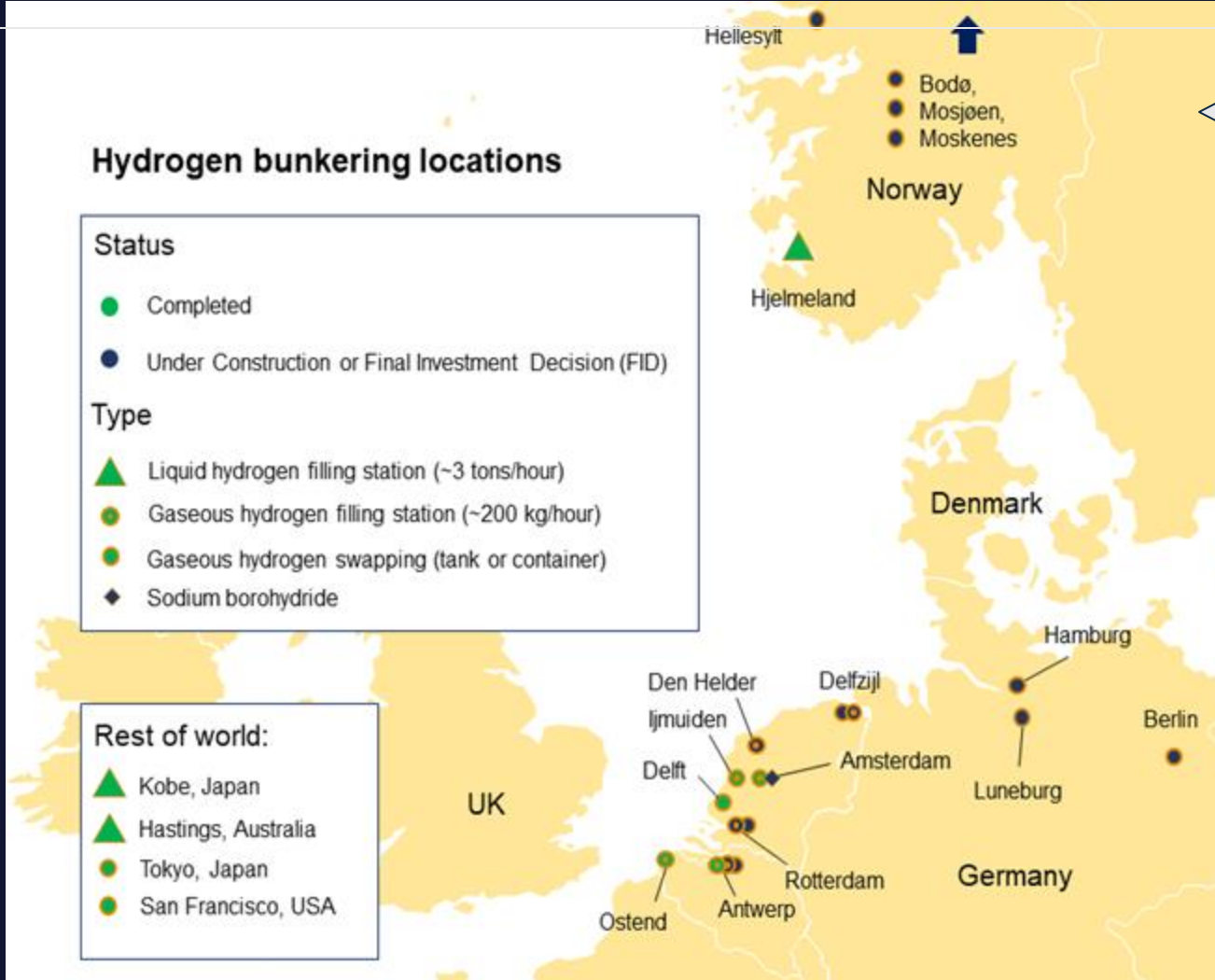
Scaling up deployment will bring down costs for renewable hydrogen

Hydrogen production costs from hybrid solar PV and onshore wind systems in the NZE Scenario in 2030



**Various regions around the world have excellent renewable resources for low-cost hydrogen production.
Costs could approach USD 1.5 kg H₂ by 2030.**

Green hydrogen refuelling infrastructure and projects



Hydrogen Bunkering - EU, Japan, US, Australia



Norled Hydra LH2 bunkering - 3 tonnes/hour

Commercial hydrogen vessels in operation



Sea Change H2 ferry

- HFC 360kW
- 250 kg CGH2 storage
- 2 days autonomy



Hydra H2 ferry

- HFC 400 kW
- 3.0 t LH2 : 80 m3 storage
- 3 weeks operation :1 hour to refuel

Commercial hydrogen vessels in operation

Future Proof Shipping



H2 Barge 1



Cochin Shipyard
H2 passenger ship, India



H2 Barge 2

- HFC 825kW
- 900 kg CGH2 containerised swappable storage
- 400 km range

Nedstack & Boskalis
H2 Dredger
Port of Rotterdam



- HFC 600kW
- GH2 containerised swappable storage

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Commercial hydrogen Vessels – Under Construction



HyEkoTank



Samskip - 2 container ships, NO



Aqua Ocean



Flagships – *Hidle*, NO



HeidelbergCement & Felleskjøpet
With Orca, NO



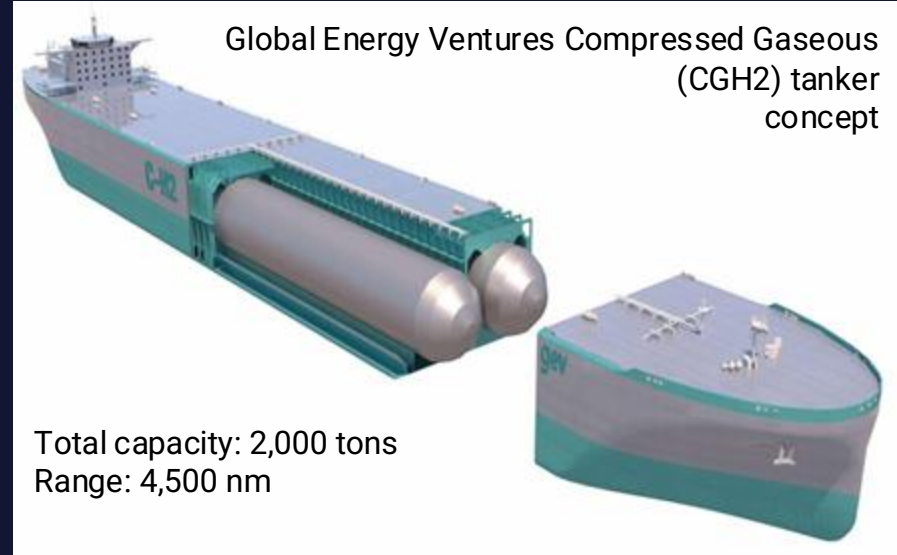
CFT – *Zulu 06*,
FR



Hydrogen Transporters

World's 1st LH₂ tanker launched in 2019

Kawasaki - Suiso Frontier



Global Energy Ventures Compressed Gaseous (CGH2) tanker concept

Total capacity: 2,000 tons
Range: 4,500 nm



Moss Maritime LH2 bunkering vessel concept
500 tons capacity
Loading rate: 500 m³/hour
Unloading rate: 300 m³/hour

Next step – Scale up to Short Sea Shipping

- **Scale up** to short sea shipping;
- 10-20 tons LH2, 1.5-2.5 MW FCs, 2-4 MWh batteries, 2-week range
- **Large shipowners** are learning from existing vessels
- **Large owners and brokers** are working together to secure long-term vessel contracts
- Sole barrier - hydrogen supply



“Scale up is not a problem”, Ivan Ostvik, Founder & CEO LH2 Shipping – Hydrdra, Project Manager

Electric Vessels and Charging Infrastructure



Charging stations:
CRL10 up to 10.5 MW



Battery swapping CRL9-
10



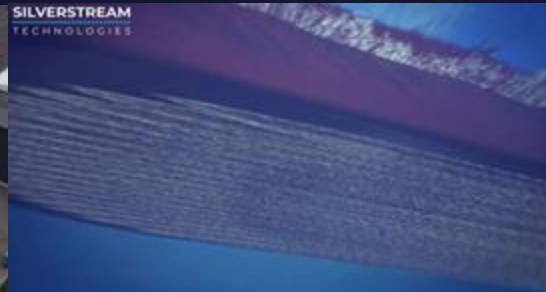
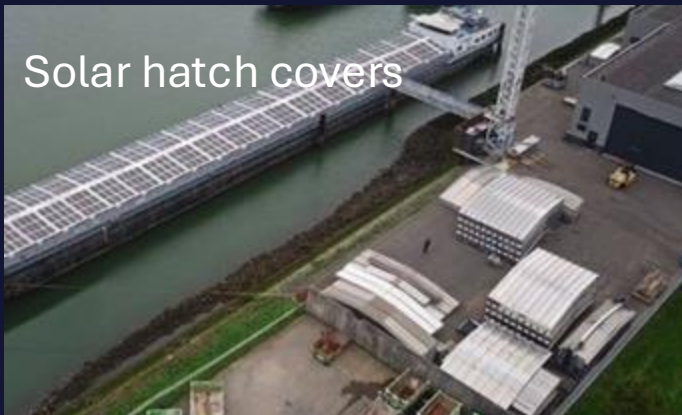
Energy Storage Systems (ESS),
Battery Management Systems
(BMS), Safety
CRL11



Offshore charging
TRL8

Energy Efficiency + Wind + Renewables = Absolute Zero Now!

- Combining technologies can reduce energy requirements 5-20% each
- Wind propulsion 5 - 20% fuel reduction CRL9
- Air lubrication (~5%) roll damping (~2%) CRL10
- Hull Vane (10-20%), Bow wind deflector (~2%),
- Onboard solar (12%), Bow foils (5-15% -) all CRL9



Air Lubrication

Wind propulsion technology

- Flettner rotors
- Suction sails
- DynaRig
- Wing sails
- kite sails

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Absolute Zero Ship Technologies = Zero GHG Emissions + Zero Pollutants

Wind + Hydrogen-electric Propulsion

Multi-MW hydrogen fuel cells

Liquid hydrogen storage



Battery ESS

Onboard renewable
energy generation

Efficiency technologies and designs

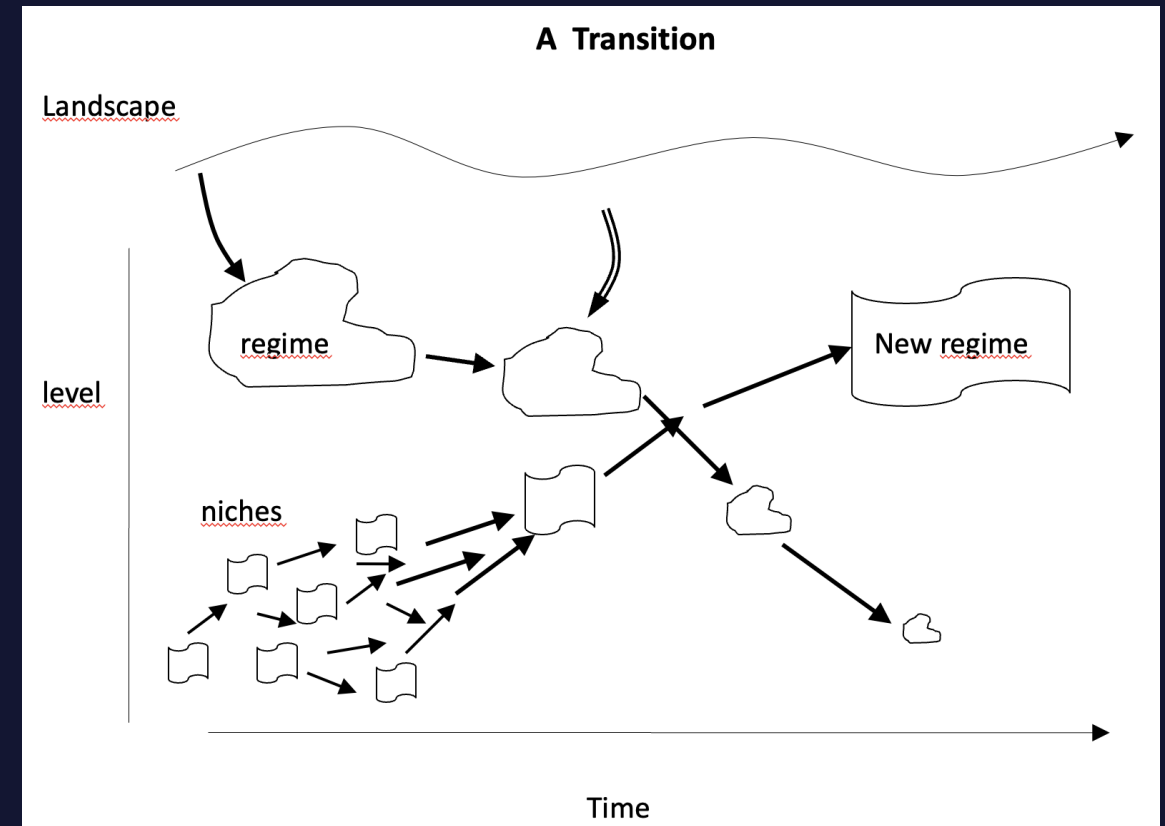
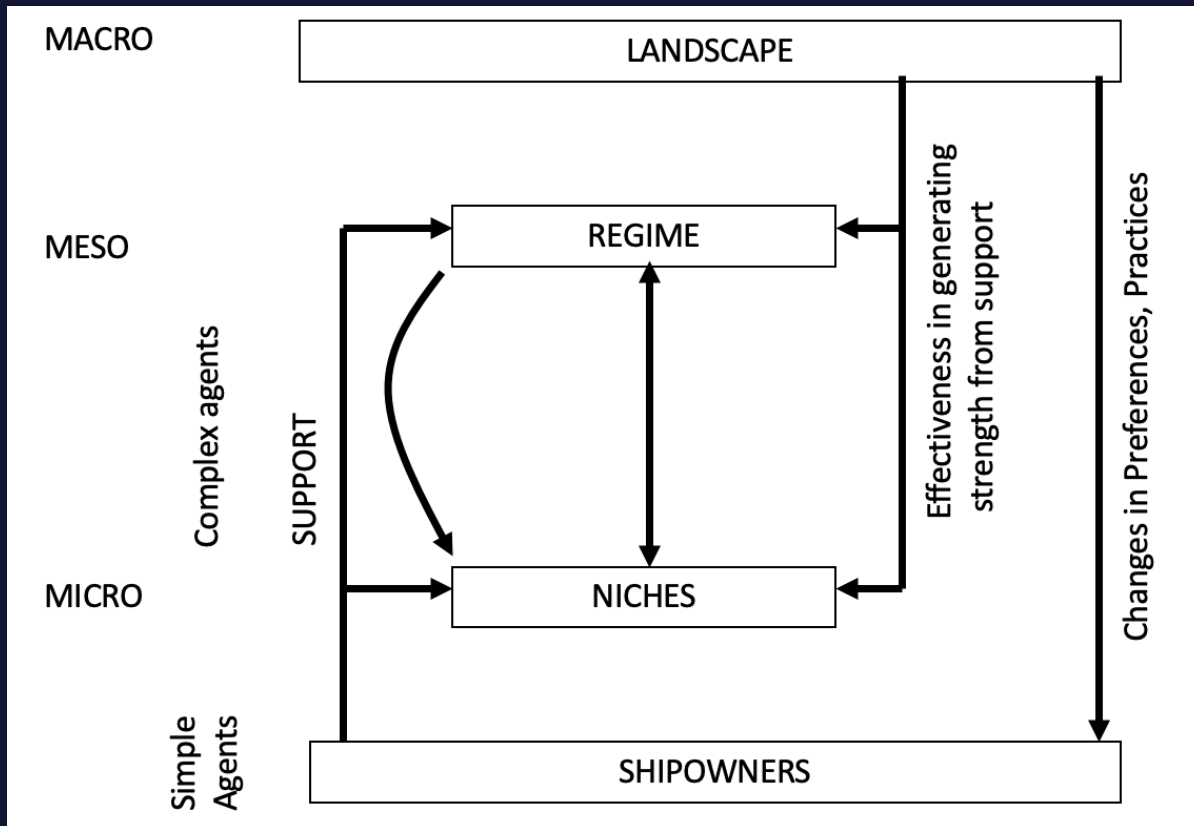
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Enabling AZE Market Transformation



AZE Ecosystem

Electric container vessel



Shore charging



Electric Ferry



LH2 Bunkering



Offshore charging



LH2 Ferry



LH2 Container ship



ShipZERO AZE Ecosystem Workshops



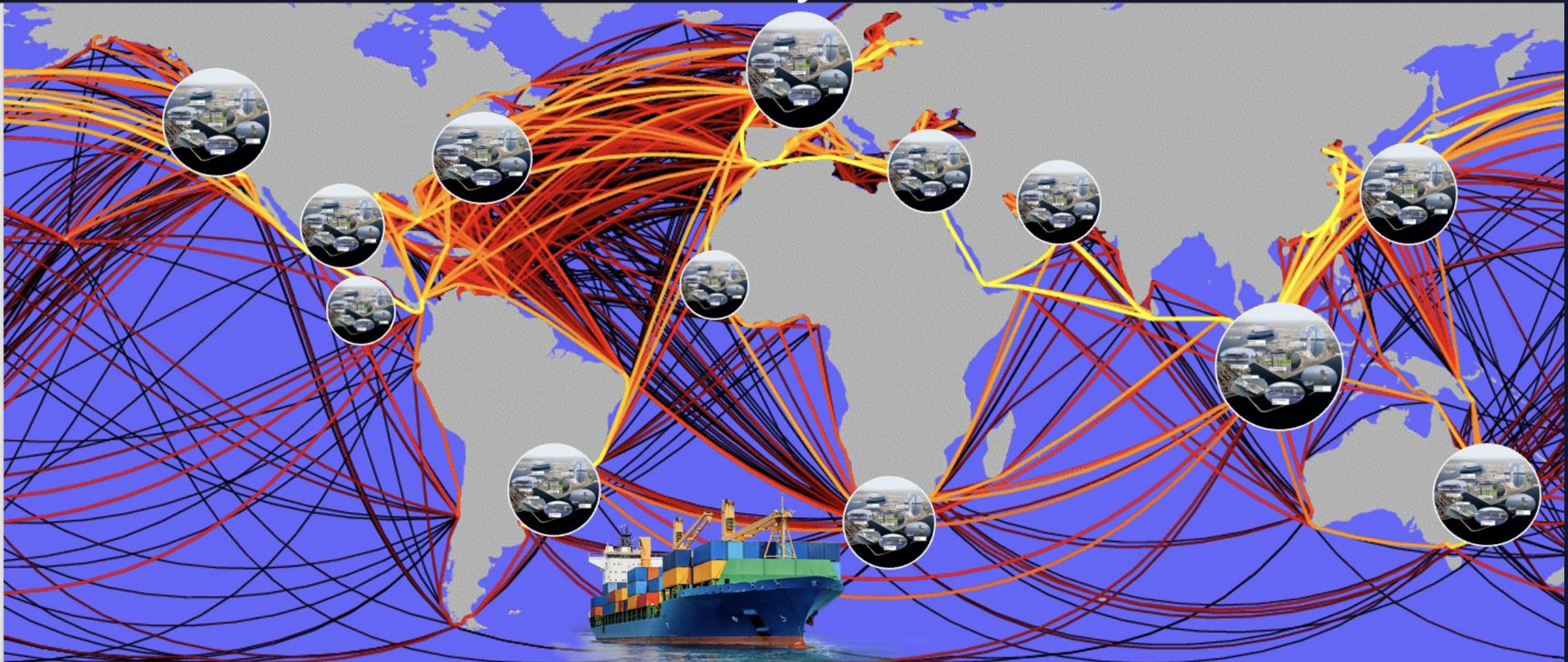
Building on existing projects

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Global AZE Ecosystems Network



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Questions?



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- Join the ZESTAs community of innovators committed to Absolute Zero
- Exchange ideas and build the AZE sector together
- Show investors and stakeholders that your company is committed to leading the energy transition in shipping

