

The 2020s – A decade of Technology Revolution in the Marine Industry

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Introduction

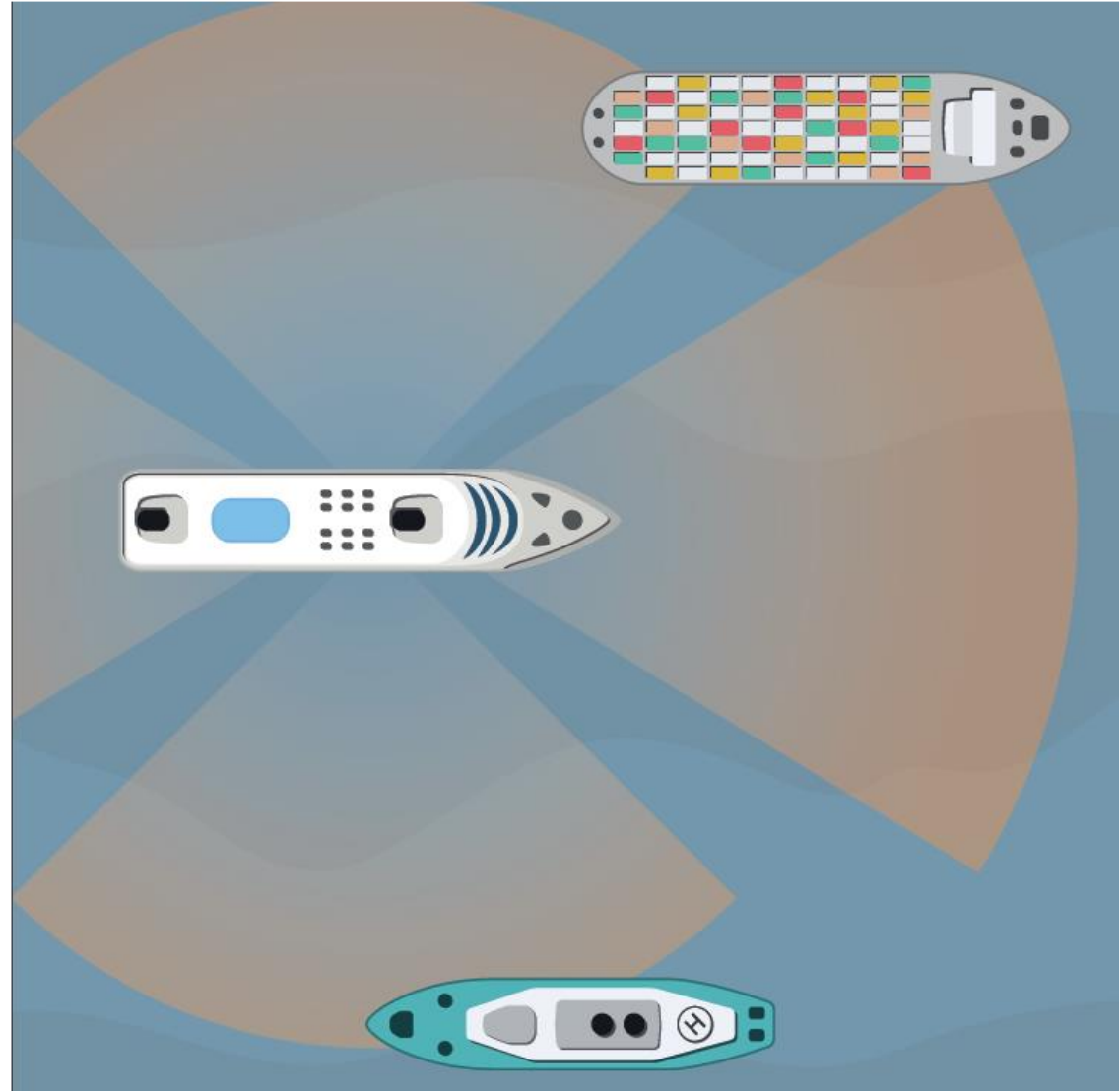
- The next 10 years will be revolutionary for Marine
 - Remote Operations and autonomous functions
 - Shipping & Greenhouse Gases Reduction
 - Future Marine Fuels
 - Artificial Intelligence
 - Robots and Maintenance
 - People & Skills

A conceptual image of a container ship at sunset. The ship is on the left, with its white superstructure and stacks of colorful containers (green, blue, red, and grey) visible. The sun is a bright yellow circle on the horizon, casting a pinkish glow across the sky and water. The water is dark blue with whitecaps. Overlaid on the water in the foreground are several lines of glowing blue binary code (0s and 1s) that recede into the distance, creating a sense of depth and digital connectivity.

Remote Operations and Autonomous Functions

What do we mean

- Move roles from the ship to the shore.
- Remove humans from risky scenarios.
- Design ships differently and gain more degrees of freedom.
- Capture and automate best operational practice.
- Remove some human element risks.
- Opportunity to exploit knowledge, technology, best practice and human factors from other sectors.



Situational Awareness

- Height of laden containers limited by minimum visibility requirements in SOLAS
 - 2 ship lengths or 500m
 - Situational awareness package and augmented reality package
 - All for less than \$1m
-
- 10-20% more containers
 - Payback is measured in a couple of voyages.
 - Better utilization of container vessel – lower emissions per container shipped.

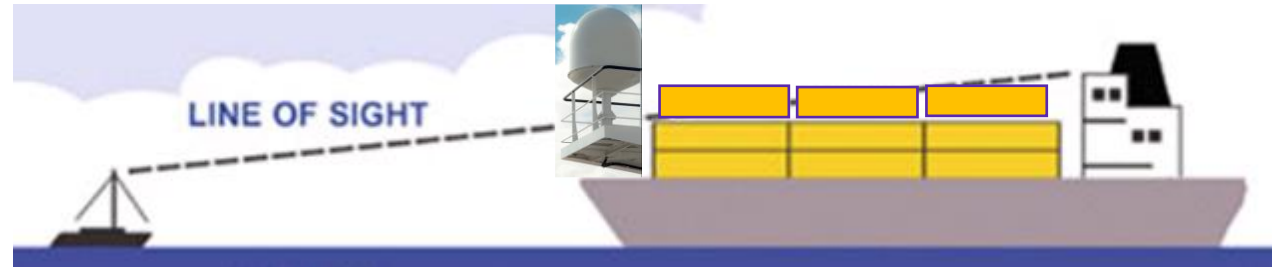


Image credits: Mermaid Consultants and Rolls-Royce plc

Remote Controlled Tugs

- Svitzer Hermod, Copenhagen
 - PSA Marine, Singapore
 - Keppel, Singapore
 - ST Engineering, POSH, Singapore
 - Robert Allan Ltd., Abu Dhabi Ports
-
- Why remote for Tugs?
 - Enhances safety.
 - Crew flexibility (less crew or no crew onboard).
 - Close to shore operation means excellent and diverse communications.
 - Makes operational costs lower, but capex higher?



Recent Project Announced in last 3 months

Norway : ASKO Maritime AS, Norway (2 x ferries)

Japan: Mitsui OSK Lines (containerships / RoRo)

Japan: Designing the Future of Full Autonomous Ship Project (DFFAS Project)

Japan: Mitsubishi Shipbuilding / Shin Nihonkai Ferry (Ferries)

South Korea : (Oceangoing remote con. ships)

EU: AUTOSHIP (short sea shipping / Inland waterways)

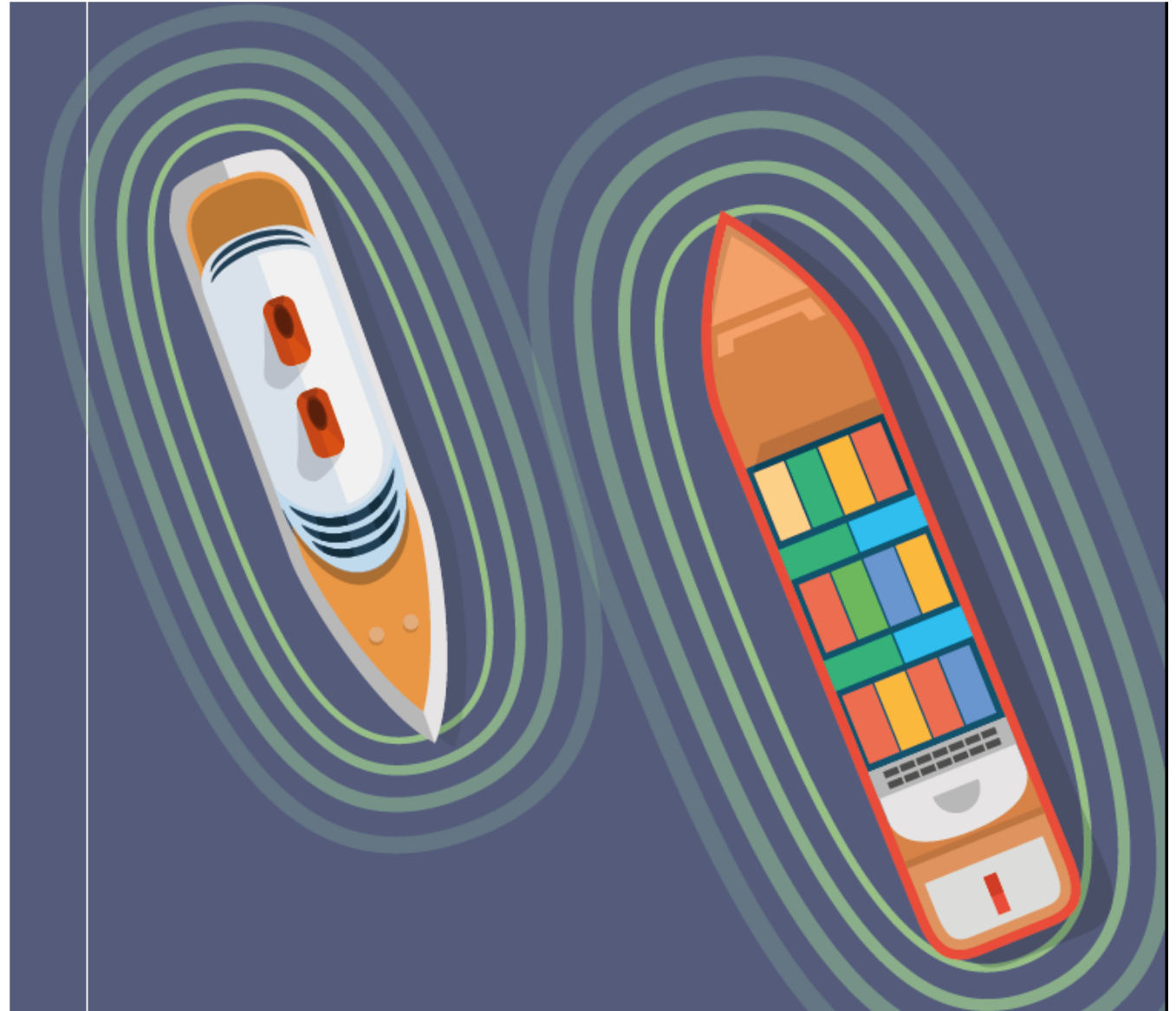
EU: AEGIS (autonomous shipping lanes)

EU: Autonomous Guard Vessel (AGV)

France: SeaOwl, VN Rebel Trials

Netherlands: Kotug, Rotortug & Captain AI to navigation tests on RT Borkum training tug in Rotterdam

USA: Sea Machines, Metal Shark Boats, U.S. Coast Guard R&D Centre, test vessel for evaluating autonomous tech



...and China?

- Thetius research analysts predict China would be the leader in Autonomous Ships within five years. Thetius researchers unearthed almost 3,000 patents relating to autonomous shipping technology worldwide, of which 96% were registered in China
- Established 770 km² autonomous shipping testbed in Guangdong.
- Yunzhou Tech
- Navigation Brilliance



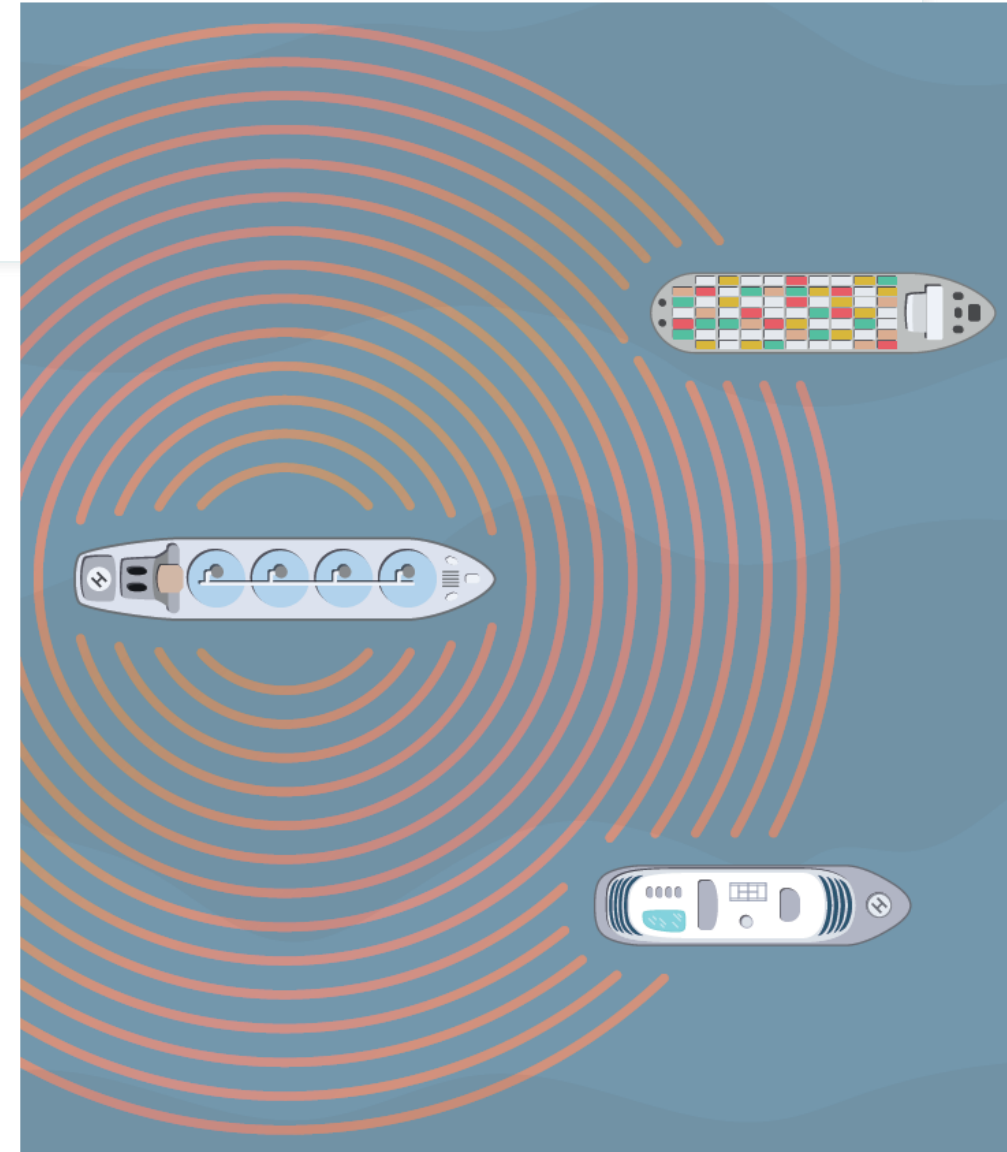


Future Autonomous Ships Market

Analyst	Year	Market Estimate \$Bn
Reportlinker.com	2025	15.2
BlueWeave Consulting	2026	14.7
Data Bridge Market Research	2027	11.5
Fiormarkets	2027	11.2
Nextmsc	2030	132.0
Allied Market Research	2030	130.0

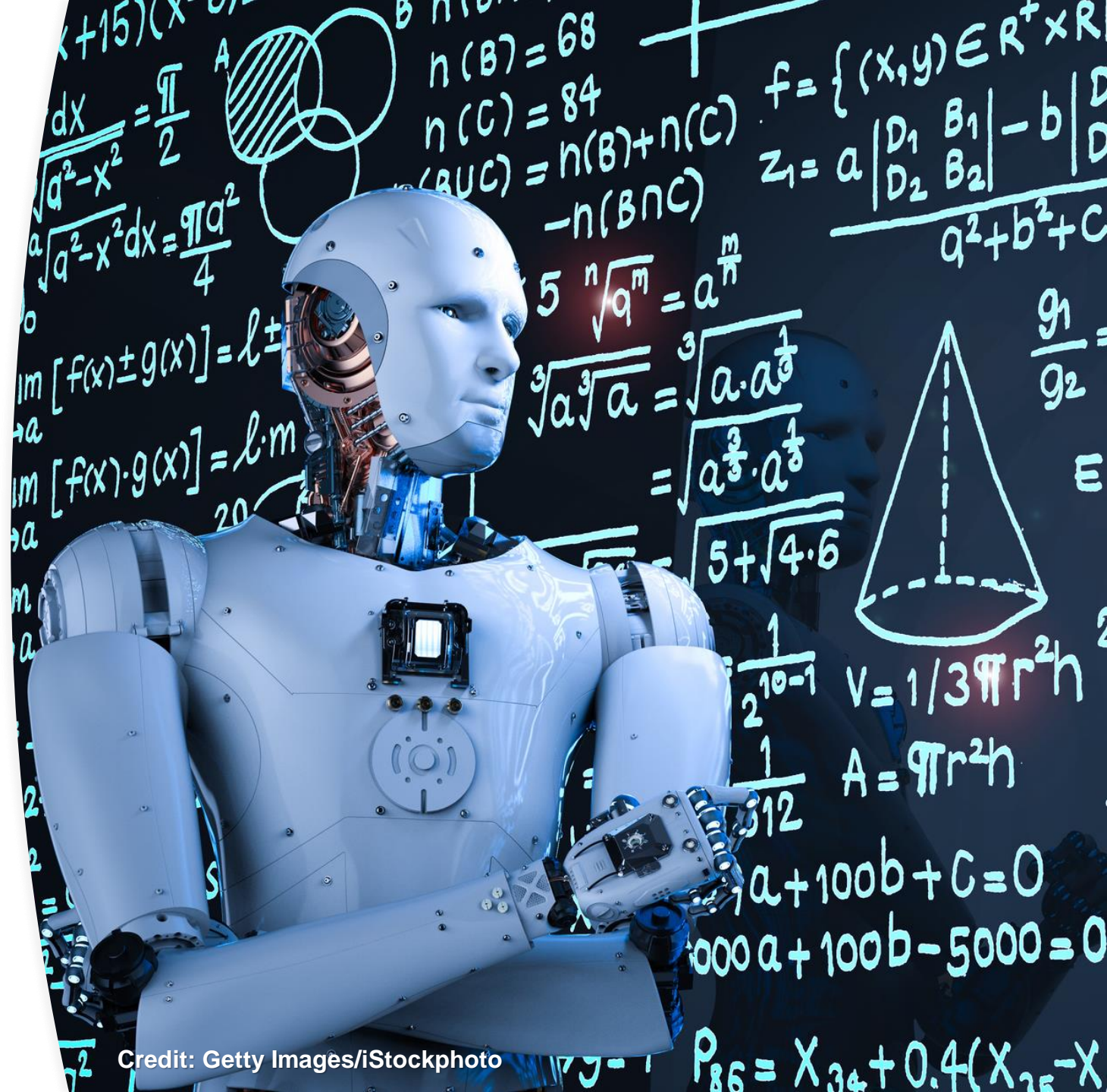
Pathway to autonomy over next 10 years

- High Probability
 - Inland waterways
 - Coastal cargo
 - Tugs
 - Ferries
 - Workboats
 - Ro-Ro
 - Naval
- Low Probability
 - Containerships
 - Bulkers
 - Cruise
 - Oil Tankers
 - Chemical tanker
 - Gas Carriers



Autonomy Challenges

- Remote operations – human v machine
- Trust in autonomy
- New emergent hazards
- Costs (R&D investment, CAPEX)
- Who has access to the technology

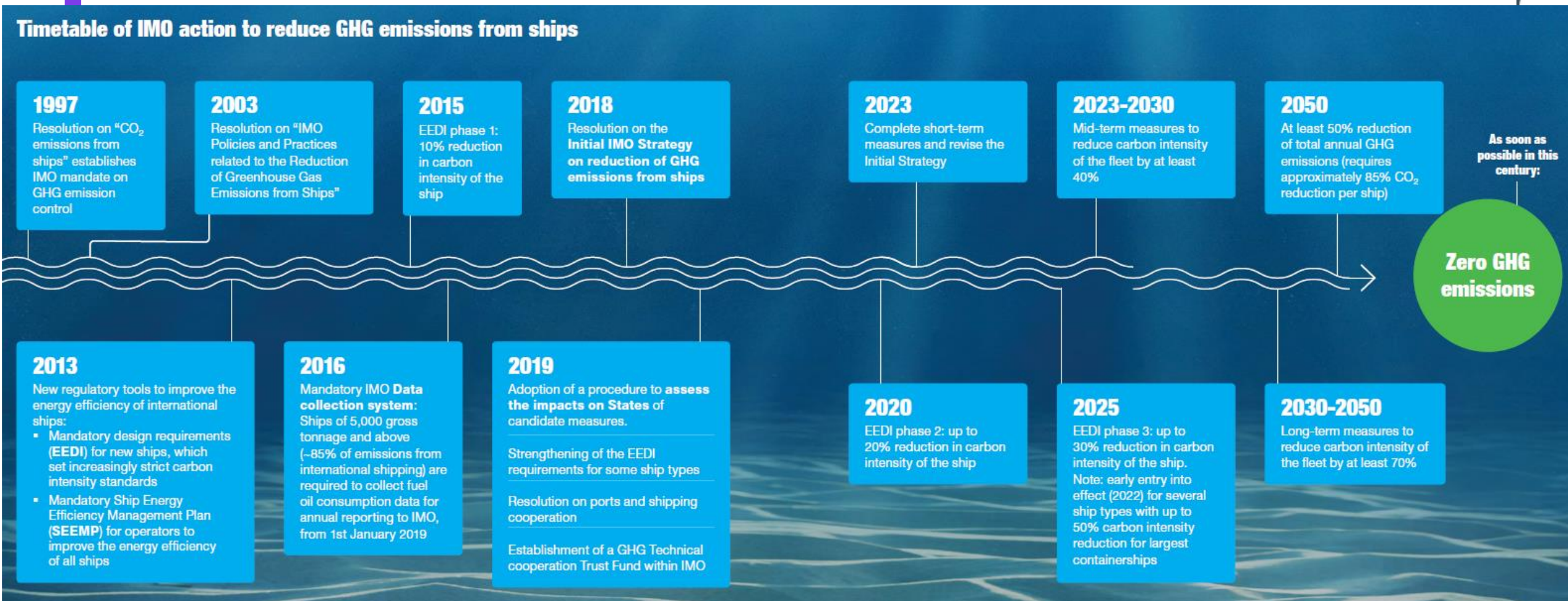


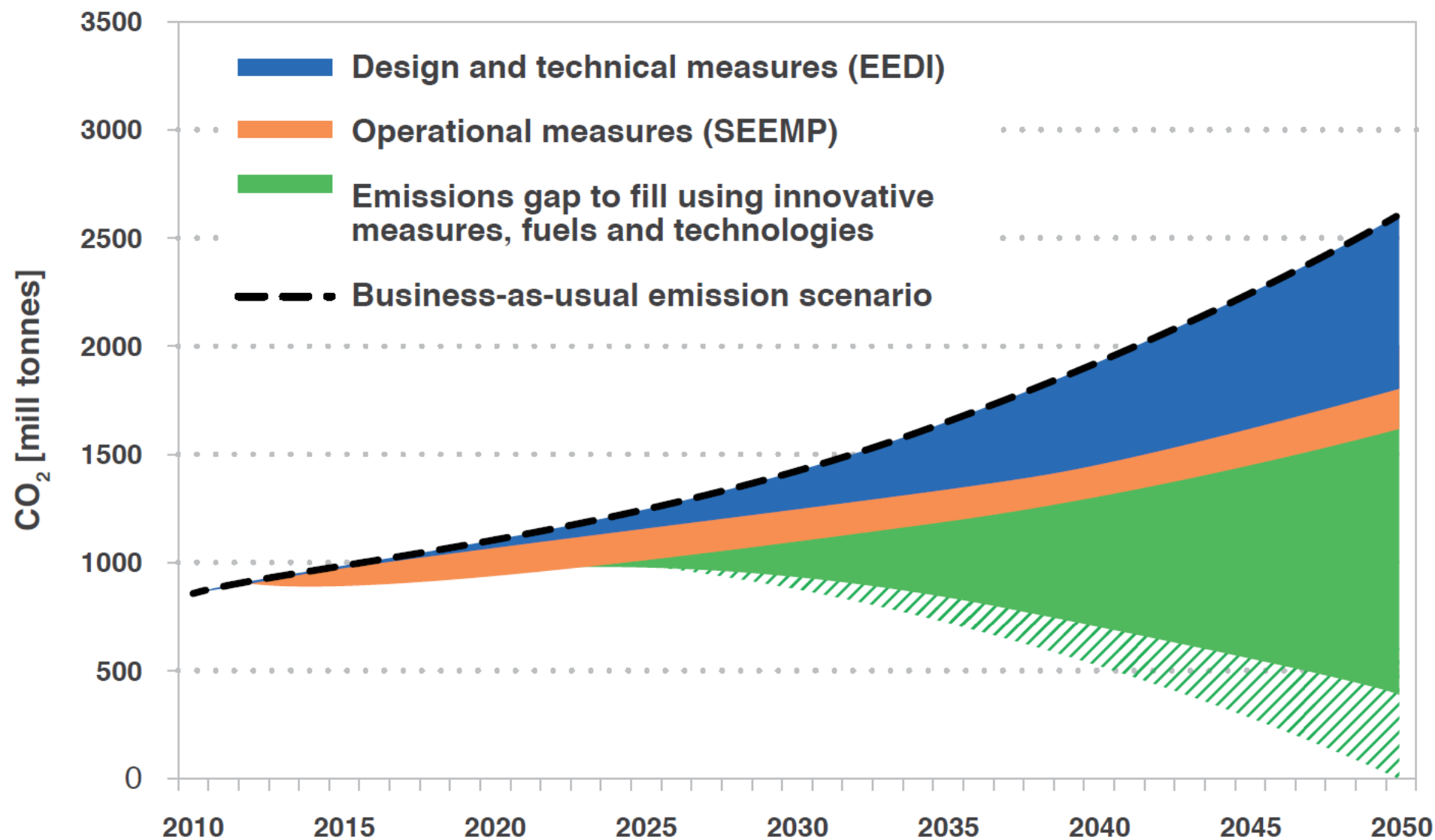
Credit: Getty Images/iStockphoto

Shipping & Greenhouse Gases Reduction



IMO Timetable

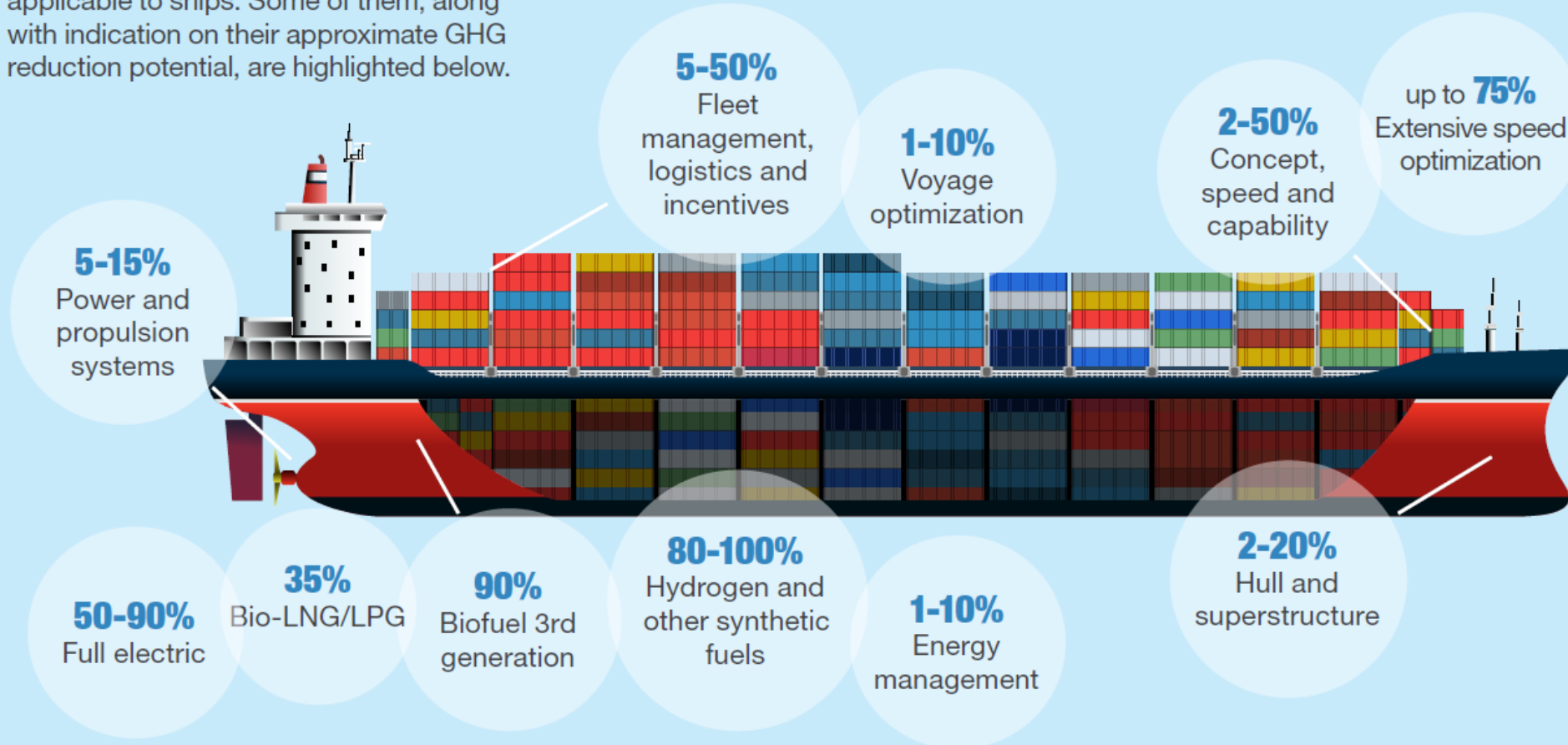




Source: IMO

A wide variety of design, operational and economic solutions

Achieving the goals of the Initial IMO GHG Strategy will require a mix of technical, operational and innovative solutions applicable to ships. Some of them, along with indication on their approximate GHG reduction potential, are highlighted below.



Technologies & Development

Technology	In Use	Marinized	
Solar power	No	Yes	TRL 9
Lithium ion batteries	Yes	Yes	TRL 9
Hydrogen Fuel Cells	No	Yes	TRL 9
Wind Propulsion	No	Yes	TRL 9
Passive Foil	Yes	Yes	TRL 9
Wave Propulsion	No	Yes	TRL 9
Re-gen Props	No	Yes	TRL 9
Roll damping energy take-in	No	Yes	TRL 7
Water Electrolysis	No	Yes	TRL 9



IMAREST Annual Conference 10th July
**Absolute Zero - From Marine
Renewables to Zero Emissions Ship
Design**
Madadh MacLaine

zoom
Tech



23:01

-38:41



1.5x
Speed



Future Marine Fuels

FUTURE MARINE FUELS

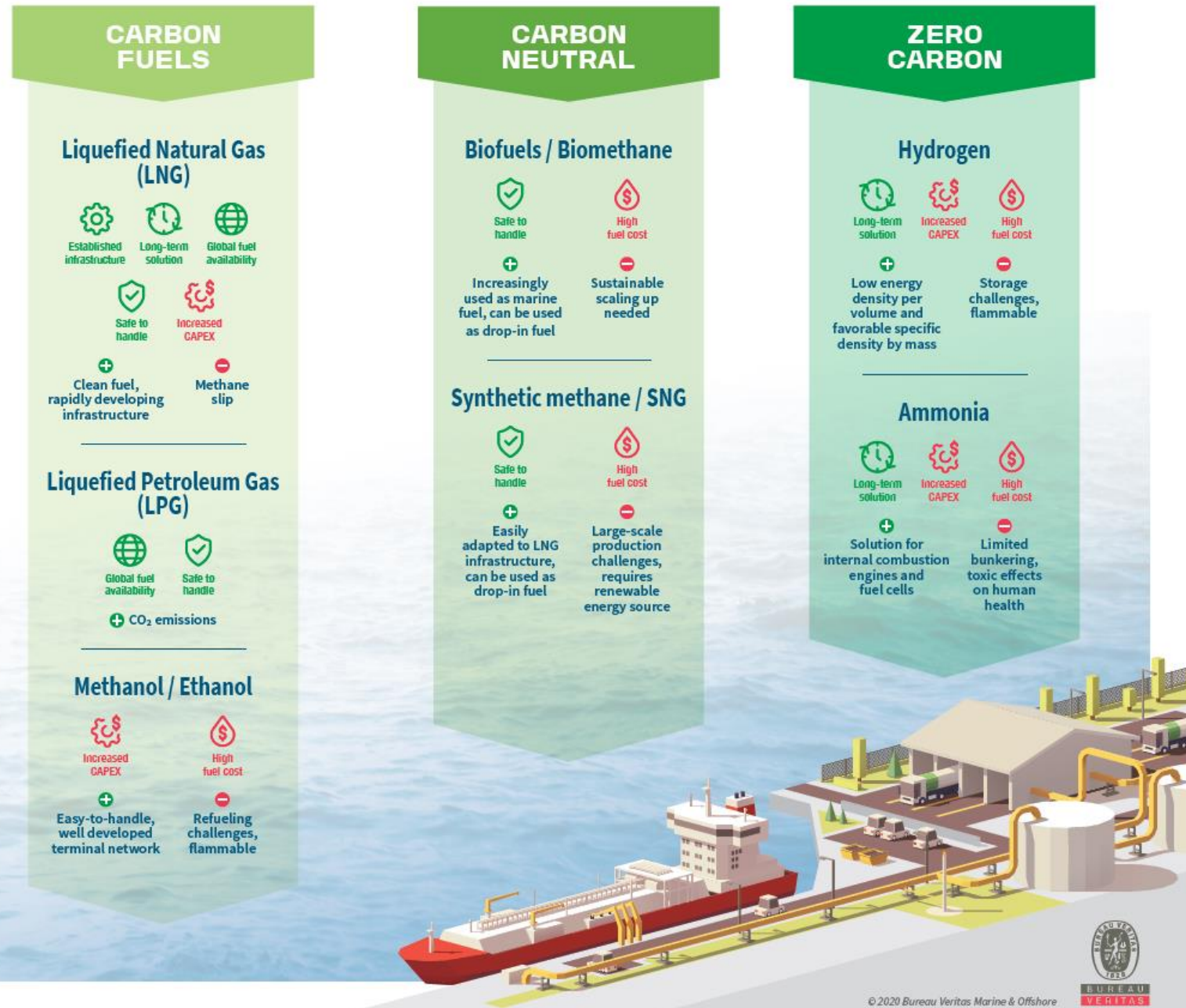
PATHWAYS TO DECARBONIZATION

IMO has developed the ambitious target of a minimum **50% reduction** in greenhouse gas (GHG) emissions **by 2050**.

Shipowners have **alternative fuel options** to help them meet IMO's ambitions, each with its own advantages and challenges.

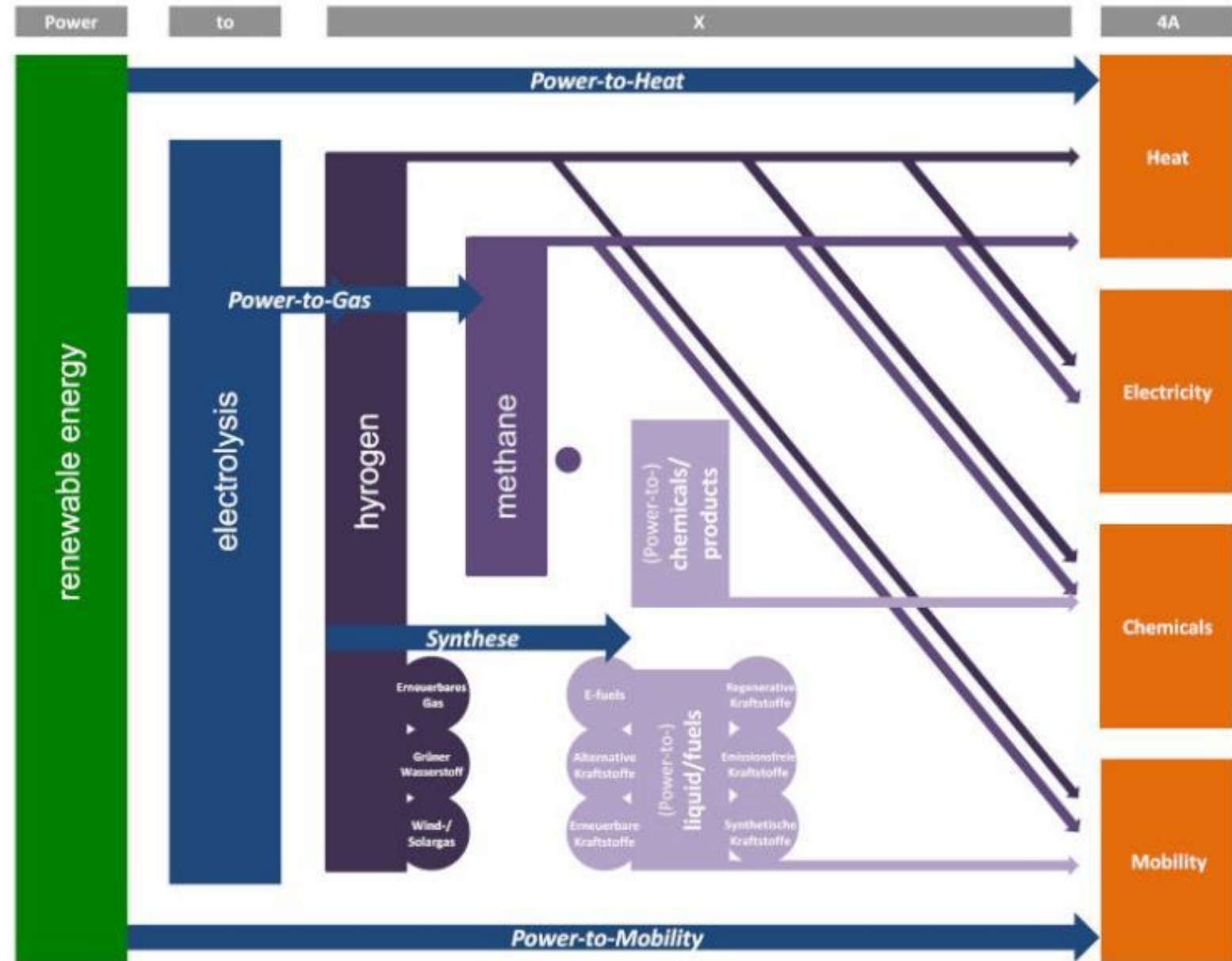
○ Advantages

○ Challenges



Power to "X"

- power-to-ammonia
- power-to-chemicals
- power-to-fuel
- power-to-gas
- power-to-heat
- power-to-hydrogen,
- power-to-liquid
- power-to-methane
- power-to-mobility
- power to food
- power-to-power
- power-to-syngas





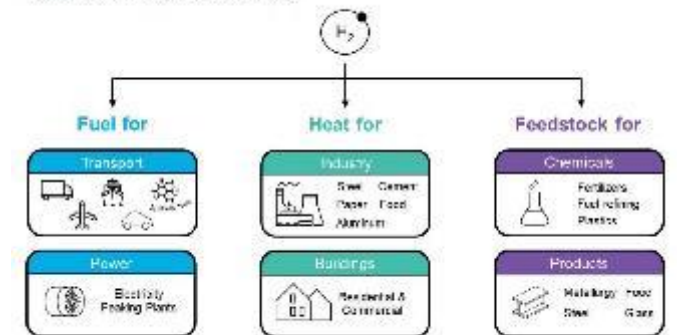
World's Largest Green Ammonia Plant Planned

- Plans to construct a \$5bn world-scale green hydrogen-based ammonia production facility in Saudi Arabia.
- Unveiled 7th July 2020 and on stream by 2025.
- 650 tonnes/day of green hydrogen from sun, wind and water.
- Hydrogen is extracted from water, nitrogen from air and combined into NH₃ Ammonia.
- Ammonia is used for export and converting back to hydrogen on import. Ammonia is easier to transport than hydrogen.
- Ammonia can be used as a fuel, generate fertiliser and manufacture cleaning products.

Hydrogen - Nation State Initiatives

- Nation state strategies that have been produced include Germany Netherlands, Norway, Portugal, Japan, South Korea, Australia and New Zealand
 - Western Australia - solar to hydrogen
 - EU - Clean hydrogen economy strategy over next 10 years
 - Scotland - hydrogen strategy - take advantage of renewables
 - Germany - national hydrogen strategy (green hydrogen with Fossil-based hydrogen with carbon capture as a transition).

Figure 2: The many uses of hydrogen



Source: BloombergNEF

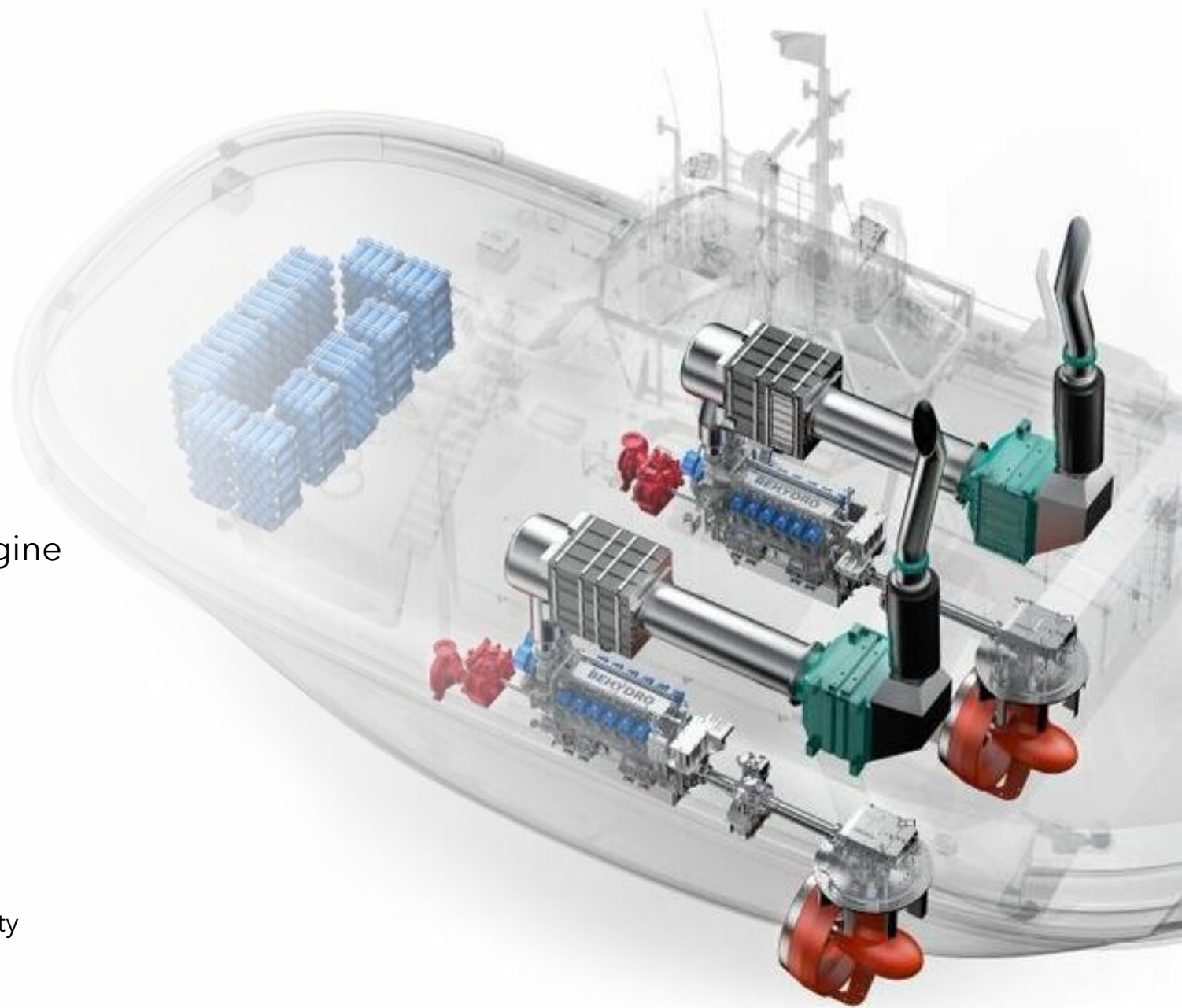


Fuel Cells


- **Not new** but wait.....!
- Multi-megawatt?
- Seriously suitable for large scale series production?
- Learning from other sectors?
- Manage the hydrogen fuel risk?

Hydrotug, the world's first hydrogen fueled tug

- The Port of Antwerp
- Behydro Hydrogen medium speed recip engine
- Delivery 2021?
- Challenges to overcome
 - LH2 boils at 20°K
 - 350-700bar storage pressure
 - Material embrittlement
 - Ventilation and gas detection too slow
 - Wide flammability, low ignition energy, high reactivity



100



Artificial Intelligence –
the use of intelligent
machines to work and
react like humans – it
is already part of our
daily lives!



WHEN JOB\TASKS WILL BE TAKEN OVER BY MACHINES

2016

2026

2036

2046

2056

2066

2076



Beat humans in new levels of Angry Birds



Master poker enough to win World Series of Poker



Fold laundry



Transcribe speech



Assemble any LEGO



Outperform Atari game testers on all games



Read text aloud



Write a high school essay



Drive a truck



Generate a Top 40 pop song



Beat the fastest human in a 5K race



Translate a new language with Rosetta Stone



Retail salesperson

The New York Times

Write a NYTimes Best Seller



Perform surgery



Research math

All human tasks



Inspired by BusinessInsider

AI in Marine

- Vessel design
- Fleet optimisation
- Machinery asset management
- Navigation
- Autonomous ships
- Deep Sea Mining Robots
- Situational Awareness
- Tracking marine mammals
- Mapping marine environments
- Demand forecasting
- Dynamic pricing
- Knowledge capture and decision making
- Cyber-security
- Port optimization
- Climate modelling
- Weather forecasting
- Tide and current prediction
- Wave modelling
- Species identification
- Ecosystem interactions
- Enforcement of fisheries and protection
- Pollution tracking
- Sub-surface flows, air-sea currents, and energy transport
- Oil spill mapping and detection
- Habitat modelling
- Coastal water quality



AI Challenges

- IT and communications infrastructure
- Certification
- Trust (bias, explainability, testing.....)
- Data quality
- Developing new expertise and methods
- Software tools and frameworks
- Investment
- Legal concerns, privacy, compliance and regulations

A controversial photo editing app slammed for AI-enabled 'blackface' feature

Clearview AI to stop selling controversial facial recognition app to private companies

Artificial Intelligence Makes Bad Medicine Even Worse
A new study out from Google seems to show the promise of AI-assisted health care. Actually, it shows the threat.

Uber case highlights risks of automated decisions about employees

Bias detectives: the researchers striving to make algorithms fair as machine learning infiltrates society, scientists are trying to help ward off injustice.

Police agencies, software firms and the public must ensure that crime-forecasting software improves public safety and officer accountability

Let's avoid these types of Headlines




Robots and Maintenance





A **robot** called "Spot"! Cognite & Aker BP.

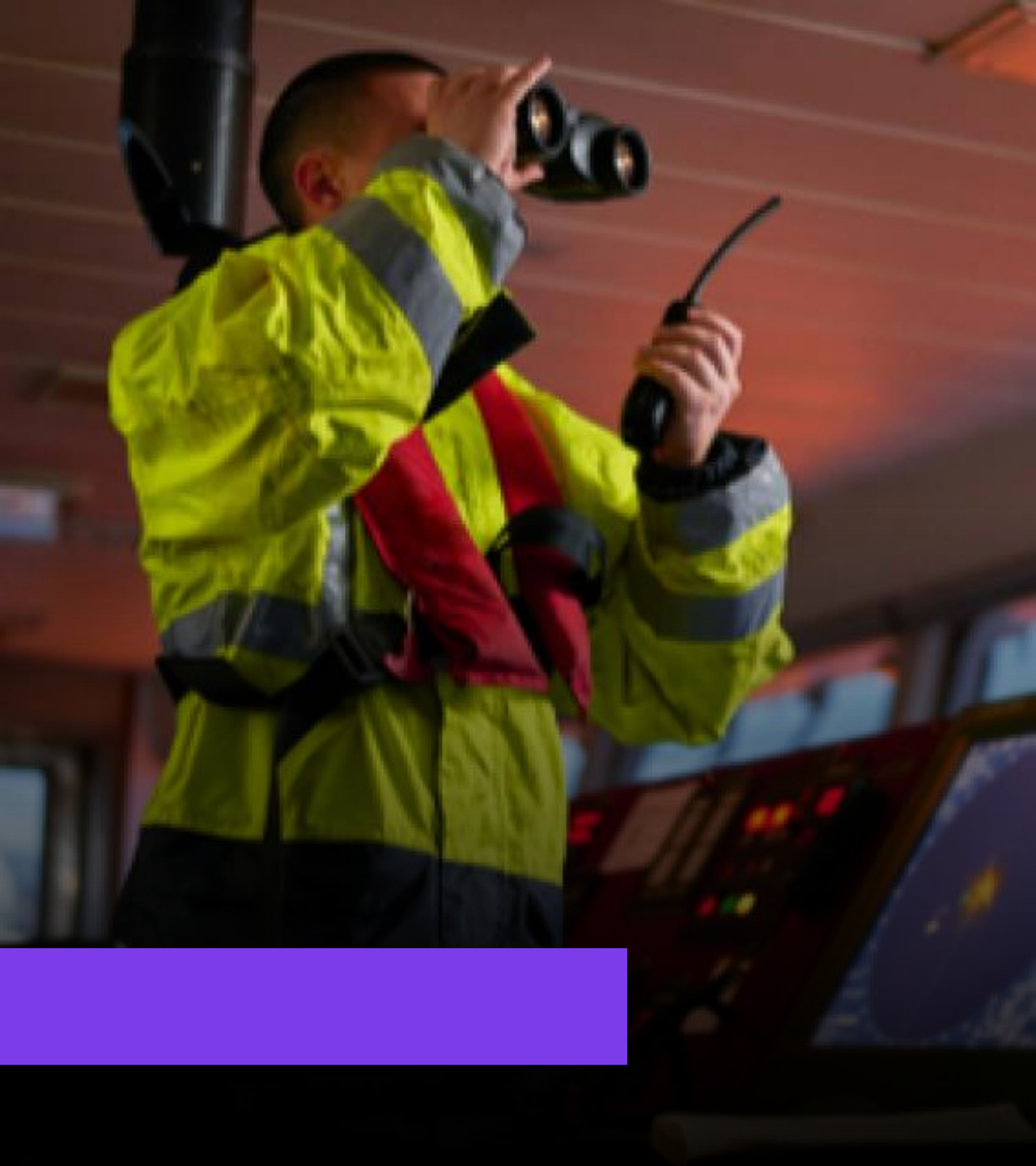
A large yellow industrial robotic arm is shown in a factory setting, with its articulated joints and various cables visible. The background is slightly blurred, showing other industrial equipment and a bright light source.

Maintainers replaced by robots?

Once trained no mistakes.
24/7 hour on call.
Never tires or complains.



People



Skills

- Maritime needs to attract innovators
- Remote Operating Centres allow more access to talent and diversity
- Multi-sector approaches – share talent air, land and sea.
- Capture knowledge and concentrate talent.



The Nautical Institute provides 10 terrific facts about the future of maritime technology*



1. Stay current
2. Plan ahead
3. SWOT up on your tech
4. Be critical...but not cynical
5. Don't get lost in the data
6. Garbage collection
7. Feedback matters
8. Need and want
9. Mentoring: Learn from everyone
10. Version control

**The Navigator June 2020 Edition*





Dealing with Change

Thank you

