WHEN TRUST MATTERS

Tackling Fuel Transition Barriers with Smart Efficiency Strategies

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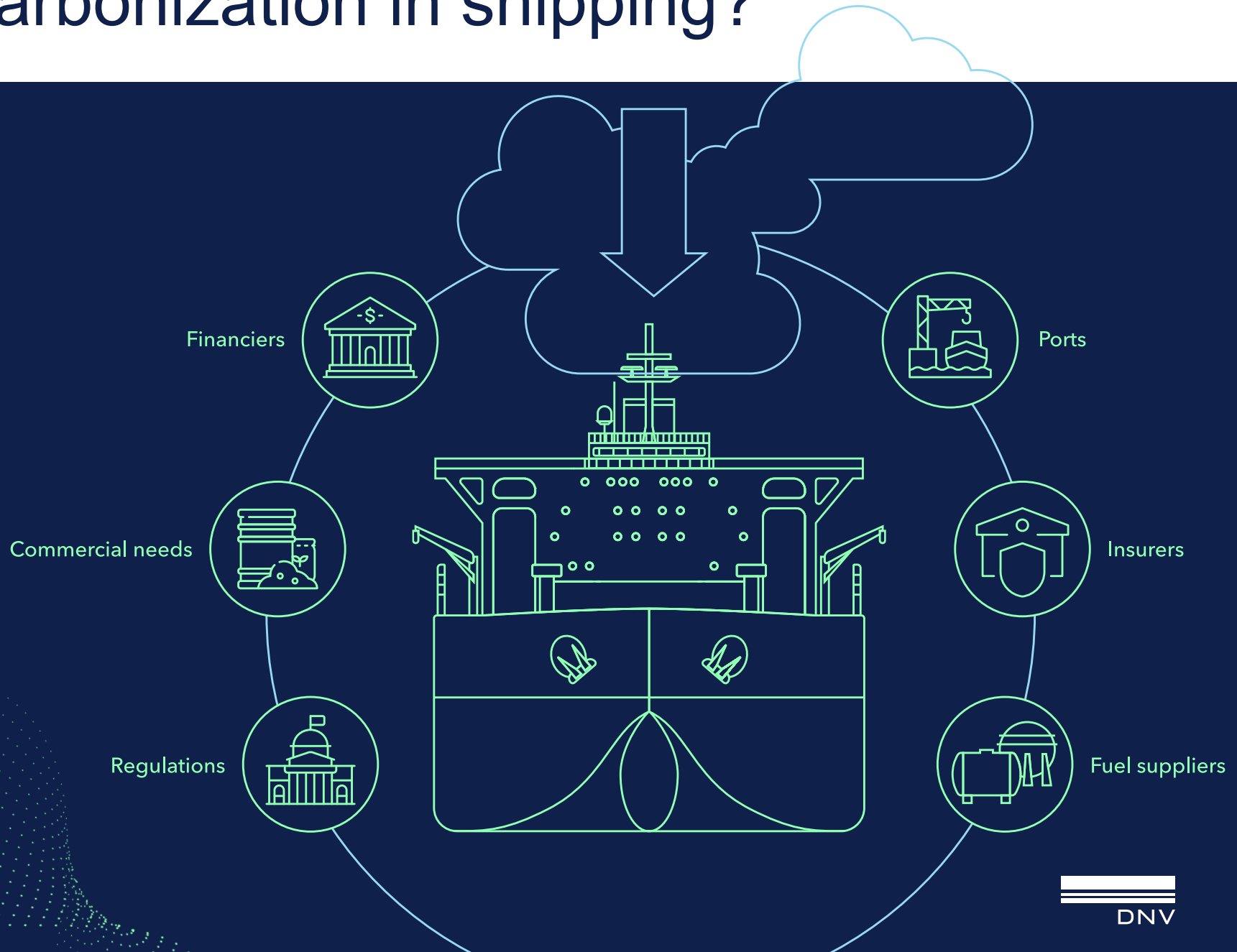
What drives decarbonization in shipping?

- **Regulatory requirements**: IMO, EU, first time CO_2 tax
- **Commercial demands**: Cargo owners and charterers push ESG agenda and emission reduction
- **Financiers**: Lending connected to emissions

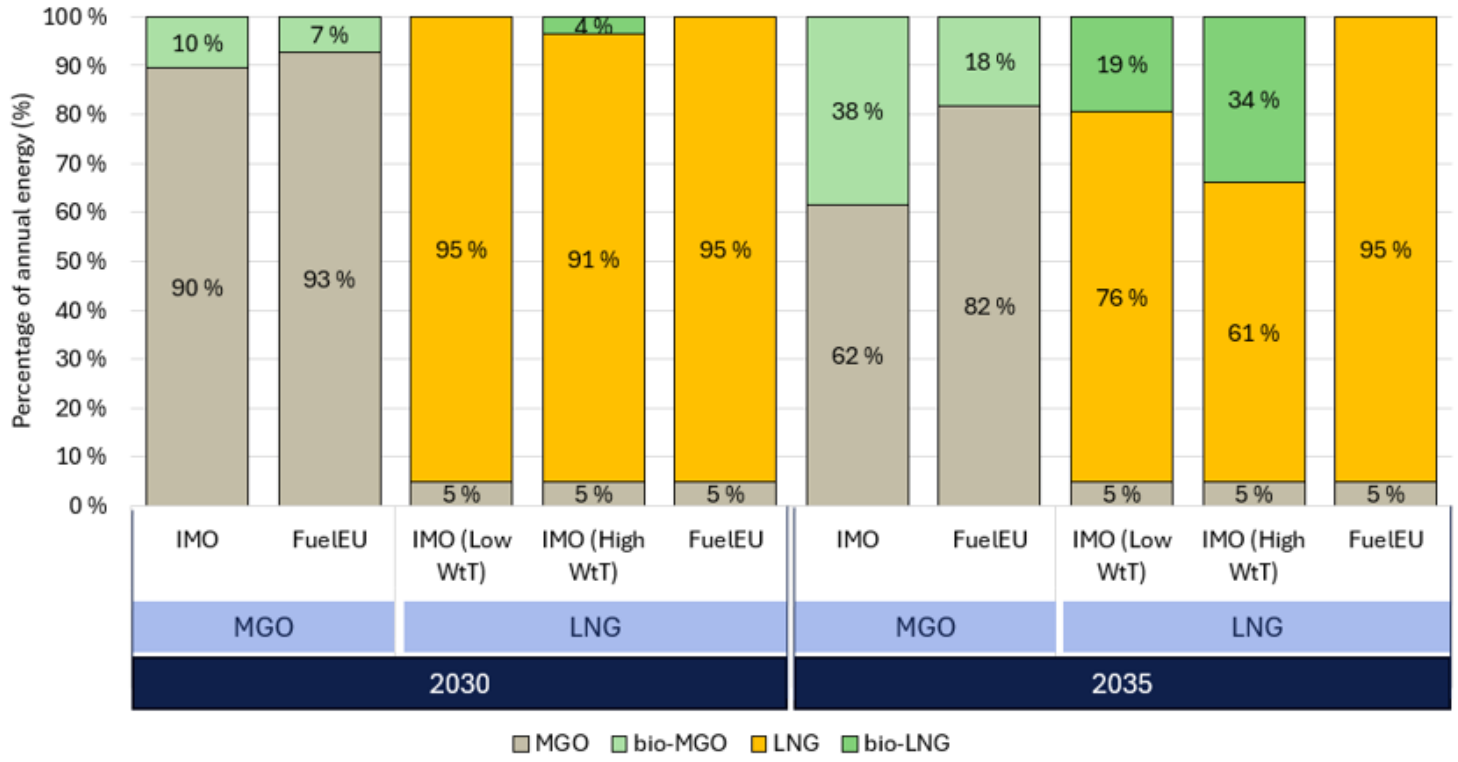


IMO Net-Zero Framework approved at MEPC83

Increasing regulatory complexity and overlap, and compliance will become tougher

A case study for comparison between NZF and FuelEU Maritimem

Percentage of low GHG emission fuels to meet the IMO NZF Base target or FuelEU Maritime requirement in 2030 and 2035 for an MGO fuelled and an LNG fuelled vessel



EU ETS from 2024

FuelEU Maritime from 2025

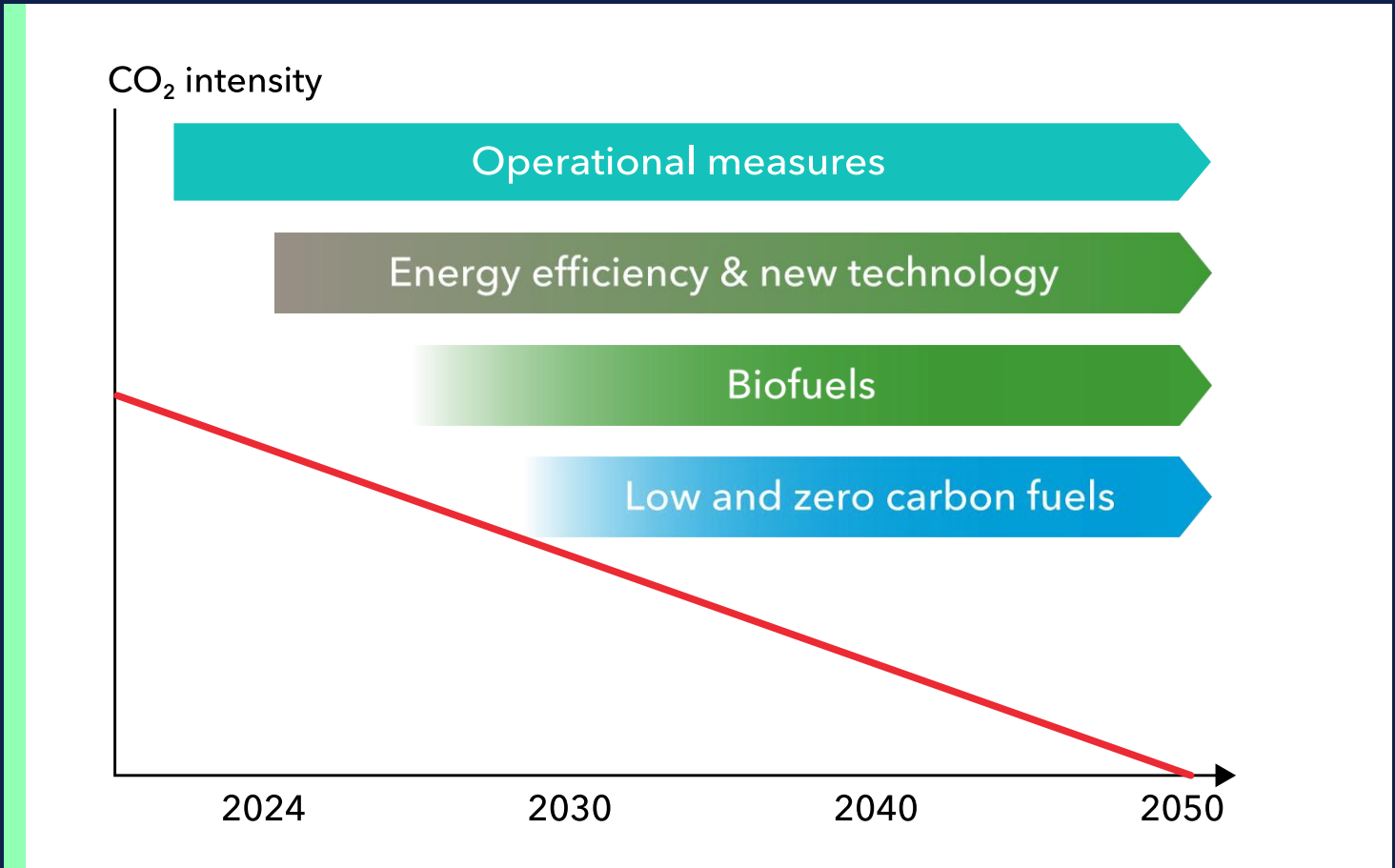
- GHG fuel intensity requirement
- Pooling of compliance

IMO Net-Zero Framework*

- Technical element:
  mandate on reduced GHG fuel intensity (GFI)
- Economic element:
  GHG pricing mechanism and reward

- Due for adoption in 2025.10
- With adoption, enter into force in 2027.3, and take effect from 2028.1.1
- Guidelines detailing the requirements will be developed

Key elements of maritime decarbonization



- **Low-/zero- carbon fuels**: End solution that requires industry transition
- **Biofuels**: Drop-in fuels
- **Energy efficiency and technology**: Considerable industry experience, ongoing innovation, need for performance validation
- **Operational measures**: Low hanging fruit not always within operators reach

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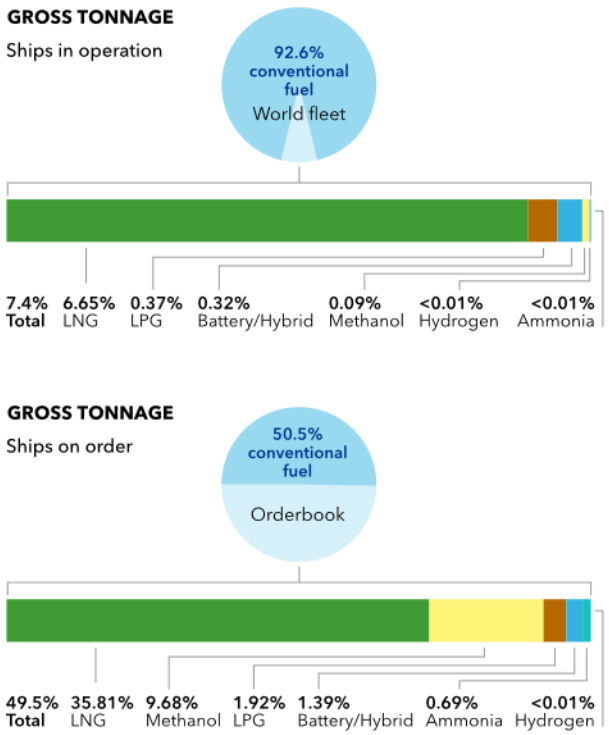
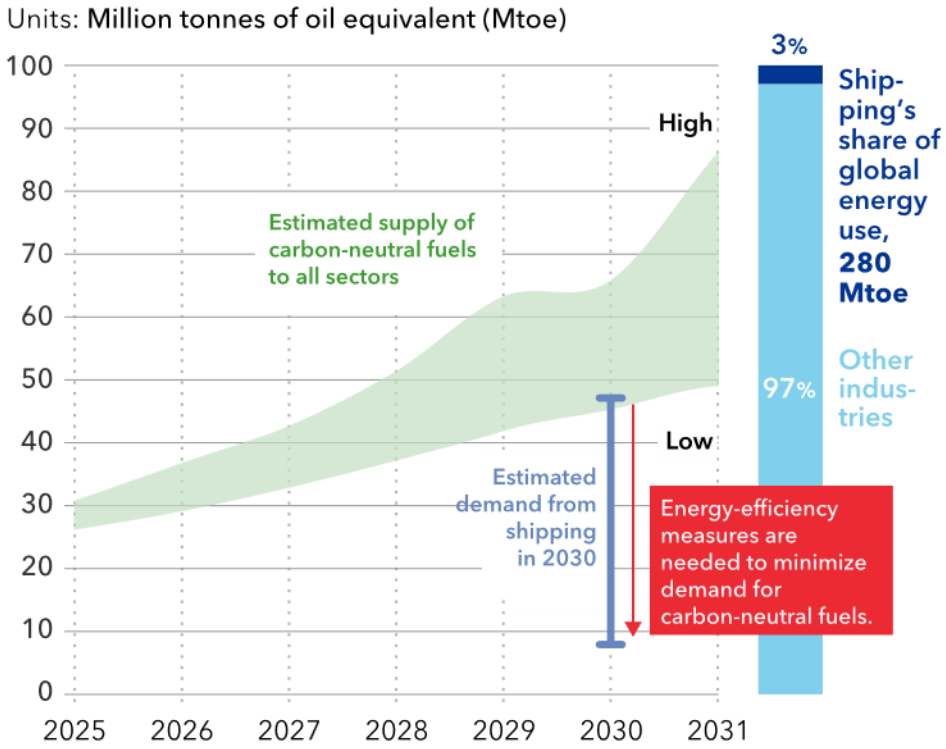
How is the fuel picture developing?

Alternative fuel uptake as per 06/2024



Expected cross-sector supply of carbon-neutral fuels vs.total shipping demand

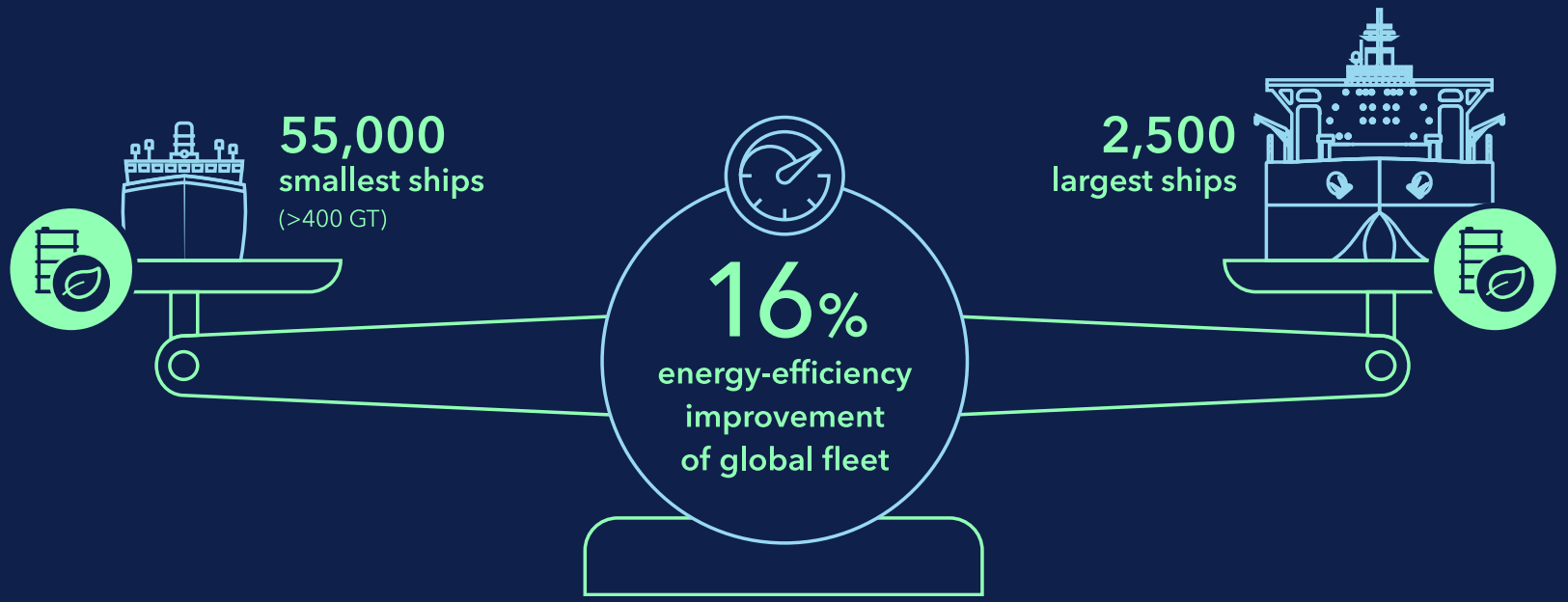


- **Fuels technology uptake**:
  - High uptake in NBs – half go for dual fuel
  - Existing fleet growing but remains low overall
- **Fuel supply**:
  - High activity and projects planned
  - Uncertainty for marine usage
- **Fuel demand**:
  - Growing but uncertainty around future needs
  - Can be reduced through EE measures

Why is energy-efficiency important in the long-term?

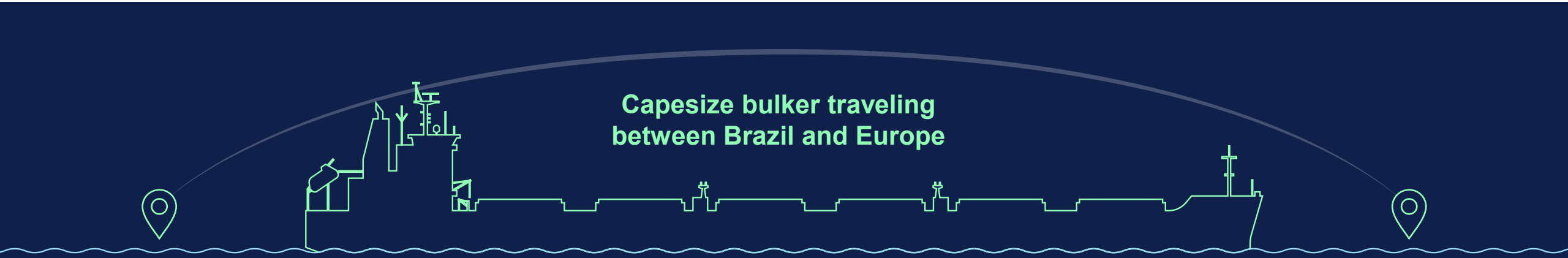
Reduced global fleet demand for carbon neutral fuels:

- Improved EE means lower fuel consumption and demand



The 2024 edition of DNV's Maritime Forecast to 2050 estimates that energy efficiency can deliver fuel savings and emissions reductions of up to 16%.
This is equivalent to the emissions of the 2,500 largest vessels or the 55,000 smallest ones.

EE as enabler for faster adoption of alternative fuels



TODAY

MGO
600 t
300,000 $

MGO + EE
480 t
240,000 $

Savings: 60,000 $

FUTURE

Methanol
1,220 t
1,500,000 $

Methanol + EE
980 t
1,200,000 $

Savings: 300,000 $

FuelEU and ETS
cost decrease

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What is energy efficiency in maritime?

OPERATIONAL

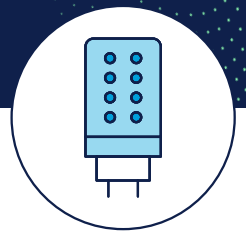
Measures related to how the vessel is **maintained** and **operated**, and the **cargo is handled**.

PROPULSION AND HULL

Measures that improve the **hydrodynamical performance** of the vessel.

MACHINERY

Measures related to the machinery onboard the vessel, including **main engines, auxiliary engines, and associated systems**.



ENERGY CONSUMERS

Improvement in energy efficiency of onboard consumers such as **lighting equipment** and **cargo handling systems**.

ENERGY HARVESTING

Measures that capture energy from the surroundings, converting it to propulsion power or electricity (e.g., **sails** and **solar panels**).

Industry experience:
The industry has been working with EE measures for decades

New developments:
High level of activity driving new technology and solution development

Assessment:
Need to verify savings claims

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High potential for industry uptake on EE measures

Vessel type		Containership	MPV	Bulk carrier	Tanker	Gas carrier	OSV	Pass./Ferry	RoRo	Total
Category	Technology	Energy Saving Technologies (EST) share								
Energy harvesting	**Total**	**0.1%**	**0.3%**	**0.3%**	**0.3%**	**0.2%**	**0.1%**	**0.4%**	4.6%	**0.2%**
	Flettner rotor		0.0%	0.1%	0.1%	0.2%		0.0%	0.3%	0.0%
	Inflatable sail								0.1%	0.0%
	Rigid sail			0.0%	0.1%			0.0%	0.2%	0.0%
	Solar	0.1%	0.0%	0.0%	0.0%		0.1%	0.3%	3.9%	0.1%
	Suction wing	0.0%	0.2%	0.0%	0.1%				0.2%	0.0%
	Wind kite		0.0%	0.0%						0.0%
Machinery	Waste heat recovery system	0.8%	0.1%	0.1%	0.1%		0.1%	0.4%		0.1%
Hull	**Total**	**11.4%**	**2.0%**	**10.1%**	**2.1%**	**12.8%**	**1.5%**	**1.0%**	**12.8%**	**2.6%**
	Air lubrication system	2.4%	0.0%	0.1%	0.1%	6.9%		0.6%	3.3%	0.4%
	Bow enhancement	8.8%	1.9%	7.6%	1.6%	6.4%	1.4%	0.3%	8.9%	2.0%
	Bow foil							0.0%		0.0%
	Hull fin	1.0%	0.5%	4.2%	1.0%	0.1%	0.0%	0.1%	0.6%	0.7%
	Stern enhancement						0.2%	0.0%		0.0%
Propeller	**Total**	**31.9%**	**2.7%**	**26.2%**	**14.2%**	**14.8%**	**0.1%**	**1.2%**	**19.6%**	**6.7%**
	Gate rudder	0.1%	0.0%	0.0%					0.6%	0.0%
	Hull vane						0.0%			0.0%
	Propeller boss cap fin	11.2%	0.4%	6.0%	2.9%	2.5%	0.0%	0.2%	8.4%	1.7%
	Propeller duct	1.8%	0.5%	10.3%	7.2%	4.3%	0.0%		0.1%	2.1%
	Rudder bulb	17.6%	0.9%	9.0%	4.3%	9.7%	0.1%	1.0%	11.3%	2.7%
	Rudder fin	0.0%	0.1%	1.9%	0.2%			0.0%		0.2%
	Stator fin – post-swirl		0.0%	0.1%		0.3%			0.7%	0.0%
	Stator fin – pre-swirl	11.3%	0.5%	10.0%	3.0%	1.6%			4.8%	2.0%
	Wake equalizing duct	1.0%	0.8%	0.8%	0.7%	0.2%	0.0%		0.1%	0.3%
Total		**33.8%**	**4.2%**	**28.4%**	**15.4%**	**24.1%**	**1.8%**	**3.3%**	**23.8%**	**7.9%**

MPV: Multi purpose vessel; OSV: Offshore supply vessels; RoRo: Roll-on Roll-off

Adoption:
Variation across segments

Parameters:
- Ship type and size
- Speed
- Route
- Operating profile

Combination:
Enhancement or incompatibilities
Interaction effects should be assessed when combining energy-efficiency measures

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Technical and economic impact of measures varies greatly

Category	Measure	METRICS					IMPACT ON INDEXES			VESSEL TYPES APPLICABILITY [1, 2]					
		Efficiency gain (%)	CAPEX (kUSD)	OPEX (% or kUSD)	Implementation time	NB / Retrofit / Both	Design Index (EEDI/EEXI)	Operational index (CII, ETS)	Fuel-based index (FuelEU, GFI)	Bulk carriers	Tankers	Gas carriers	Car carriers	Container-ships	Cruise /RoPax
Machinery	Batteries	2.5- 5	1,000–3,000	2.5–25	6 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Electronic auto-tuning	0.5–2	5–10	1–3	1–6 months	Retrofit	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Engine de-rating	5–15	50–1,000	6–20	1–12 months	Retrofit	Yes	Yes	Yes	✓	✓	✓	✓	✓	–
	Engine performance testing and tuning	1–4	50–150	1–3	0	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Exhaust-gas boilers on auxiliary engines	0.3–1	100–300	0.3–0.5	6 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	–
	Improved auxiliary engines load	1–5	–	1–5	0	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Optimized turbocharger for lower engine loads	1–3	30–100	1–3	4 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Shaft generator (PTO/PTI)	2–5	700–2,000	0.5–1	6 months	Both	Yes	Yes	Yes	✓	✓	✓	✓	✓	✓
	Shore power	25–50 on aux	20–1,000	–	6–12 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Steam plant operation improvement	0.5–1.5	50–300	0.2–1	3 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Variable engine speed	1–20 on aux	700–3,000	0.2–1	12 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Variable frequency drives	0.5–2	70–300	0.2–2	3–12 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Waste-heat recovery	5–12	1,500–9,000	2–5	18 months	Both	Yes	Yes	Yes	✓	✓	✓	✓	✓	✓
Operational	Autopilot adjustment and usage	0.2–0.5	–	5,000	0	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Deadweight/maximum draught increase	–	30–50	–	2–3 months	Retrofit	Yes	Yes	–	✓	✓	✓	–	✓	–
	Optimization of bow thruster openings	1–5	700–3,000	1–10	12 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Trim optimization	2–7	50–60	0	1–2 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Port optimization	0.2–1	–	–	–	Both	–	Yes	Yes	✓	✓	✓	✓	✓	–
	Speed optimization	5–40	–	–	0	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	Weather routing	3–10	Software-based	2–10	3 months	Both	–	Yes	Yes	✓	✓	✓	✓	✓	✓
	DP Power system upgrades	5–30	Dependent on system	5–30	1–2 months	Both	–			–	✓	–	–	–	–

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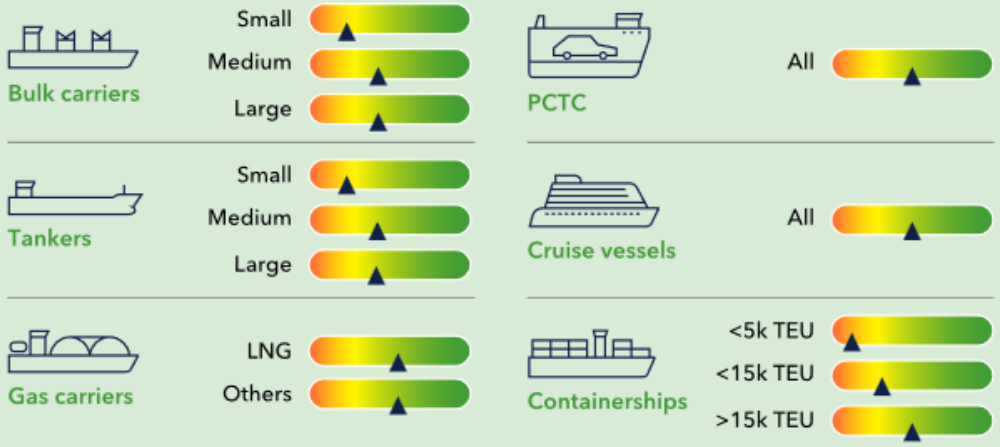
Energy Efficiency measures should be assessed case-by-case

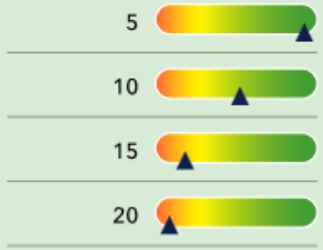
- **There are a lot of parameters** (technical and commercial) affecting the suitability of each measure for different vessels.
- To support **green design and investment decision-making**, energy efficiency measures should be assessed case-by-case.

Technology Readiness Levels

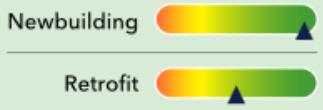
Vessel Type Suitability



Vessel Age (Years)



Applicability



Impact on

EEDI/EEXI	–
CII	✓
EU ETS	✓
FuelEU *	✓
GFI **	✓

* Does not help towards compliance, but can reduce penalty

** To be decided/adopted by IMO, based on existing proposals (MEPC 82).

CAPEX
50 – 1,000 kUSD

Efficiency gain
0.5 – 1.5%

OPEX
1 – 2%

Implementation
6 months after order

Retrofit level
In operation, or dry-docking

These figures are general estimates based on past DNV projects and industry data. Actual numbers depend on vessel specifications and technology. Efficiency gains vary by vessel type, size, conditions and should be verified on real operations.

Explainer: Vessel Type Suitability takes into consideration technical and operational constraints, techno-economic implications and past experience.
It provides general guidance, while specific study is suggested to assess suitability for specific vessel.
As this evaluation is based on DNV experts judgement and current knowledge it might change in the future as technologies and financial conditions evolve.

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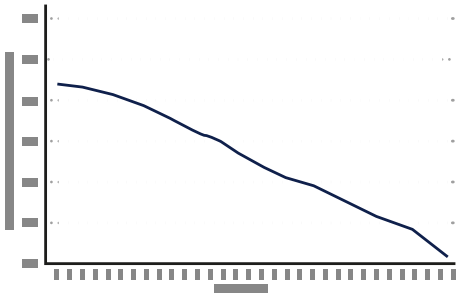
Fleet planning and implementation

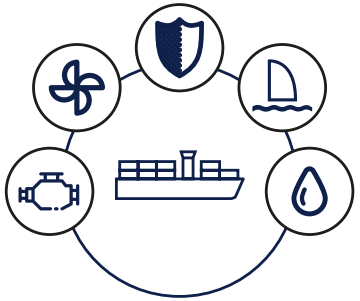
1

Define GHG trajectory and goals



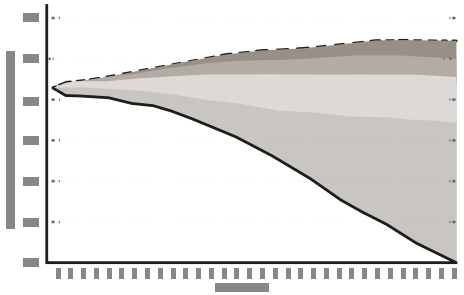
2

Assess pathways for meeting GHG trajectory and goals



3

Develop fleet decarbonization strategy and plan



Plan ahead: Identify fleet-wide implementation pathway

Parameters:

- Investment and applicability
- Dry-docking planning
- Off hire time
- Lifetime compliance

Implementation and Operation:

- KPIs
- Monitor progress
- Corrective actions

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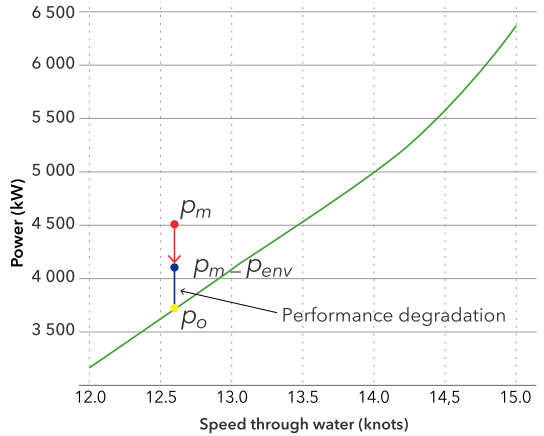
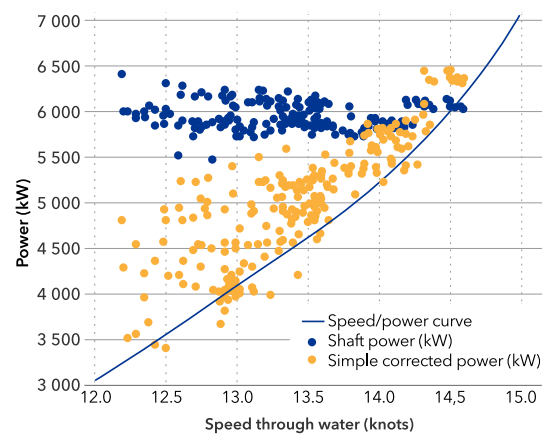
How to strengthen confidence in the business case?

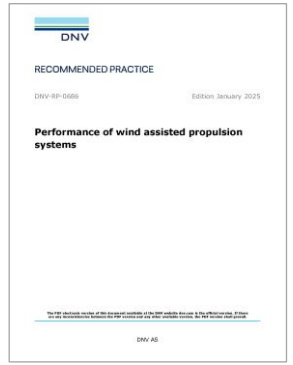
New technologies arise and verification standards are required by the industry

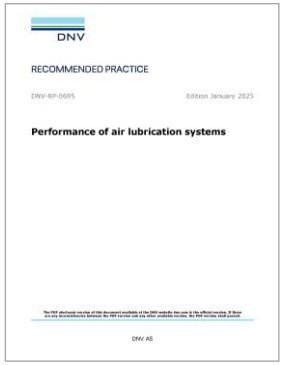
- **Data**: Standardization, quality
- **Methodology**: Accuracy, science-based, isolation of actual effect
- **Real operations**: Aggregate savings to actual operations not only one operational point

→ Recommended practices published









Recommendations

Investigate new fuels for newbuildings

Assess current status of vessel and fleet

Identify options and remaining potential

Develop a fleet plan and **implement** changes

Upgrade data infrastructure and use data to monitor and validate

EE can enable faster adoption of alternative fuels

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White papers from DNV

Energy-efficiency measures and technologies – Key solutions and strategies for Maritime's decarbonization journey

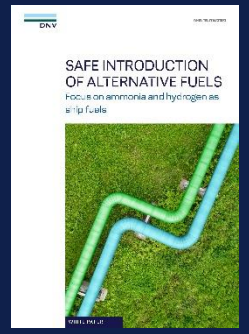
dnv.com/eereport

Wind-Assisted Propulsion Systems (WAPS) – How WAPS can help to comply with GHG regulations

dnv.com/waps

FuelEU Maritime – Requirements, compliance strategies, and commercial impacts

dnv.com/fueleu-paper

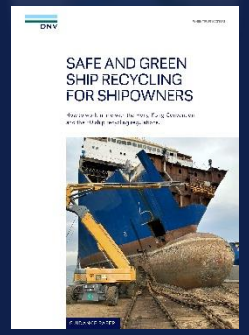


Safe introduction of alternative fuels – Focus on ammonia and hydrogen as ship fuels

dnv.com/alternativefuels

The potential of onboard carbon capture in shipping

dnv.com/occ



Safe and green ship recycling for shipowners – Compliance with HKC and EU Regulations

dnv.com/ship-recycling

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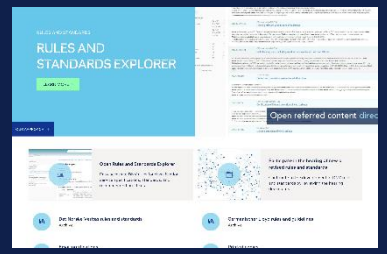
Services



Rules and Standards

dnv.com/rules-standards

Advisory services

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DNV Cyber

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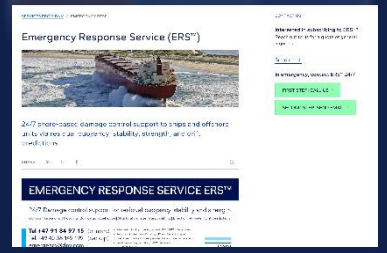

Emergency Response Service (ERS™)

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Thank you.

Rachel Gao
Business Development Manager – Innovation and Market Development
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