



GBA Sustainable Marine Fuels Webinar

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Global regulatory
framework and
policies for
international
shipping

Global regulatory framework and policies for international shipping

Marine Biofuels Webinar – 26 August 2025



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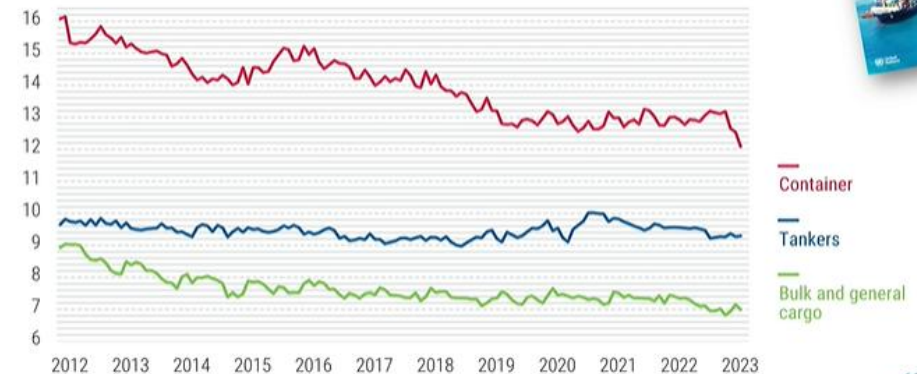
1. GHG emissions from international shipping and the role of IMO
2. Overview of the 2023 IMO GHG Strategy
3. Update on recent IMO action to implement the 2023 GHG Strategy
4. Conclusion

1. GHG emissions from international shipping and the role of IMO

GHG emissions from international shipping

- Shipping is the most energy efficient long-distance cargo transportation mode
- GHG emissions from international shipping = **2 to 3%** of total anthropogenic emissions (source: *Fourth IMO GHG Study, 2020*)
- GHG emissions from international shipping = not addressed through Nationally Determined Contributions (**NDCs**) of the UNFCCC and its Paris Agreement
- Because these emissions occur outside national territories → IMO (same with international aviation → ICAO)
- Regular update of IMO to UNFCCC's Subsidiary Body for Scientific and Technological Advice (**SBSTA**)

World fleet, main vessel types, monthly CO2 emissions per ton-mile, Jan 2012–Mar 2023
(Gram/ton*nautical mile)



Source: UNCTAD, based on Marine Benchmark

Chapter 3 Decarbonizing shipping Review of Maritime Transport 2023



The International Maritime Organization (IMO)



Created in 1948: **United Nations specialized agency** mandated to ensure safe, secure and efficient shipping on cleaner oceans



176 Member States, 3 associated members, >150 observer organizations (IGOs and NGOs)



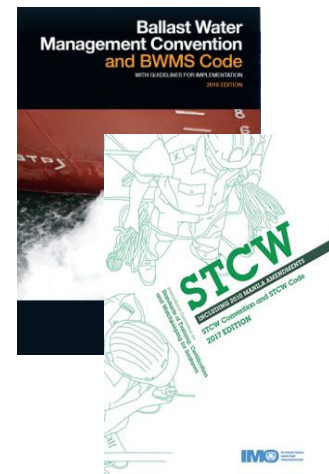
~300 permanent Secretariat staff in London and **7 regional offices** (Côte d'Ivoire, Ghana, Kenya, the Philippines, Trinidad and Tobago and the recent additions Fiji (Pacific) and Egypt (MENA Region). **45 nationalities**



IMO regulates > **50,000 ships** trading worldwide



IMO's instruments contain **binding obligations**, which are **enforced globally** by flag States and port States (incl. SOLAS, MARPOL, BWMC, etc.)



2. Overview of the 2023 IMO GHG Strategy

The Washington Post
Democracy Dies in Darkness

World shipping body votes on 'historic' emissions cuts to curb warming

BBC
NEWS

What would net-zero shipping look like?

Climat : le secteur maritime, un important pollueur, renforce ses objectifs de décarbonation

Le Monde

Forbes

World Shipping Body Toughens Their Emissions Targets

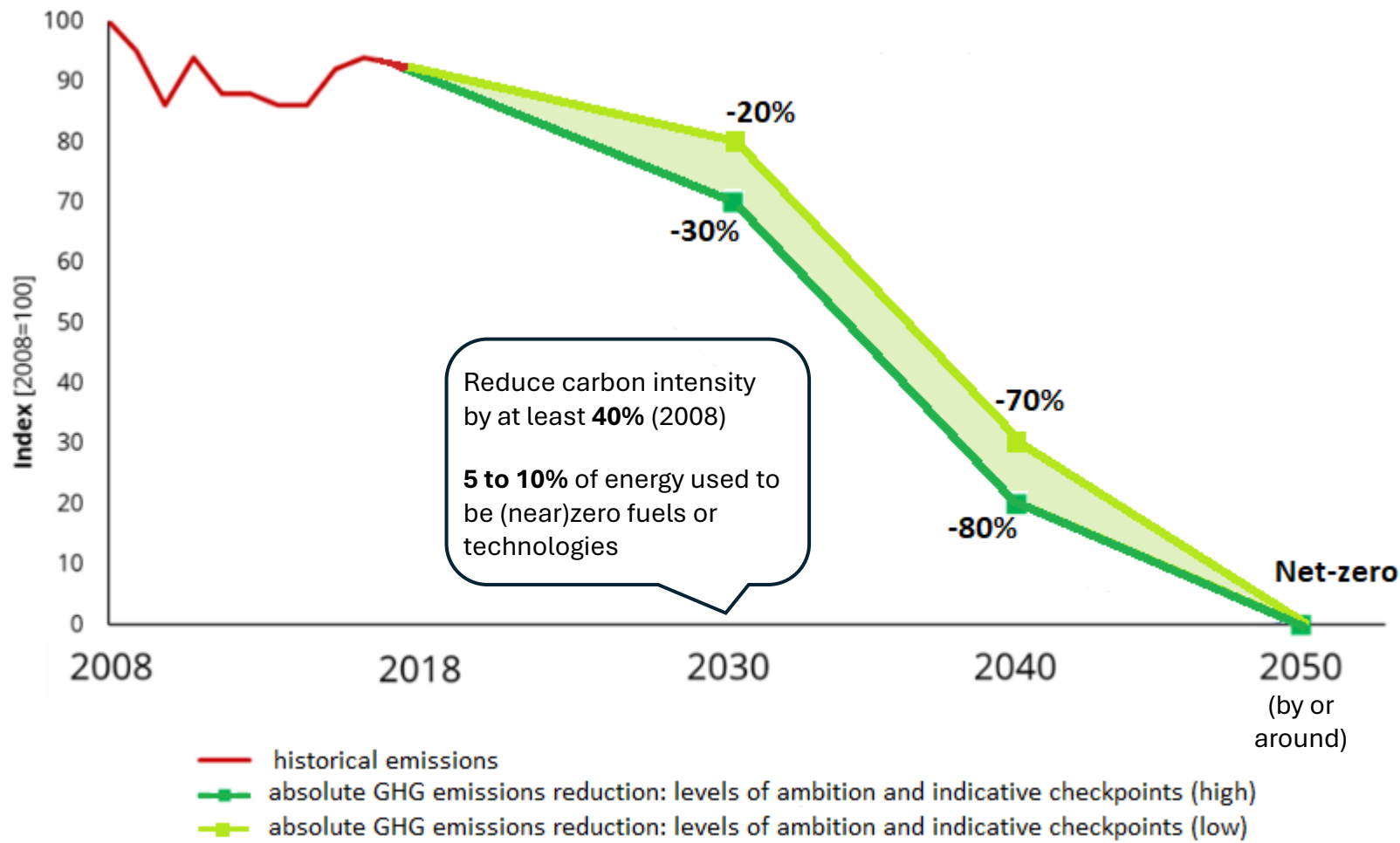
CincoDías 45

El transporte marítimo eleva su compromiso ambiental hasta las cero emisiones netas en 2050



“IMO remains committed to reducing GHG emissions from international shipping and, as a matter of urgency, aims to **phase them out as soon as possible**, while promoting, in the context of this Strategy, a **just and equitable transition**”

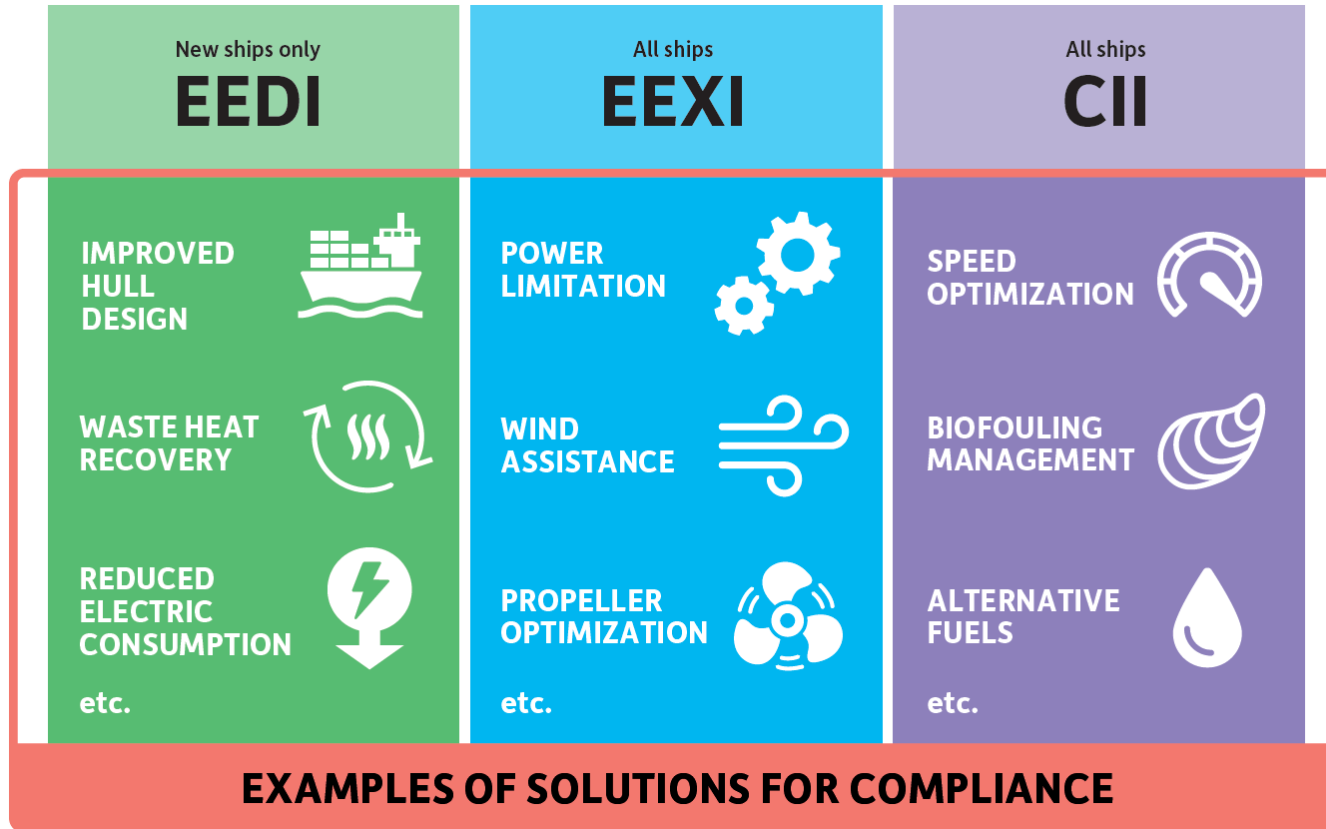
Overview of the 2023 IMO GHG Strategy



- The “Paris Agreement” for international shipping
- Sets clear timelines for finalization of **mid-term measures**: to be approved and adopted in 2025, for entry into force in 2027
- Many other elements (guiding principles, barriers, supportive measures, safety and human element, etc.): **a framework for action by IMO and the sector as a whole**
- Review in 2028
- Etc.

3. Update on recent IMO action to implement the 2023 GHG Strategy

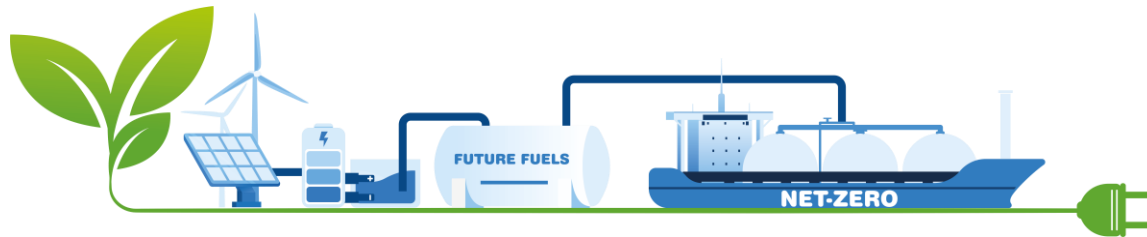
Implementing the IMO GHG Strategy: IMO energy efficiency measures



- Goal-based regulations incentivizing energy efficiency and reduced carbon intensity (e.g. biofuels for CII)
- Mandatory regulations creating a level playing field across the sector
- Addressing both new and existing ships
- Based on robust data collection system
- Mandatory energy efficiency management system (SEEMP) with associated audit regime
- Kept under IMO review

Implementing the IMO GHG Strategy: IMO incentives for low emission fuels

- The 2023 IMO GHG Strategy foresees the adoption of “a basket of candidate measure(s), delivering on the reduction targets, should be developed and finalized comprised of both:
 - a **technical element**, namely a goal-based marine fuel standard regulating the phased reduction of the marine fuel's GHG intensity; and
 - an **economic element**, on the basis of a maritime GHG emissions pricing mechanism.”
- **Timelines** for finalization of the IMO Net-Zero Framework:
 - April 2025: approval of draft amendments to MARPOL Annex VI
 - October 2025: consideration of draft amendments for formal adoption (extraordinary session of MEPC)
 - Spring 2027: expected entry into force
- **Zero and near-zero fuels** are essential. About 25 to 30 MTOE low emission fuels will be needed to comply with the requirements in 2030 (source: DNV)



Development of the IMO Net-Zero Framework

- **Key elements** of the approved IMO Net-Zero Framework:
 - **Two-tiered GFI** reduction trajectories ('base target' and 'direct compliance target')
 - GFI calculated on the basis of '**well-to-wake**' emissions (using LCA Guidelines)
 - Ability to generate/transfer '**surplus units**' (SUs) in case of overcompliance
 - Ability to use surplus units and/or to purchase '**remedial units**' (RUs) in case of compliance deficit
 - Transfers to be registered in the ship's account in the **IMO GFI Registry**
 - Ability to receive '**rewards**' for the use of zero/near-zero fuels, technologies,
 - Framework for **certification of sustainable fuels (LCA)**
- **Other elements** of the approved IMO Net-Zero Framework:
 - Establishment of the **IMO Net-Zero Fund** to provide rewards for the use of zero/near-zero fuels technologies and to support Member States with a range of other initiatives supporting the implementation of the IMO net-zero framework and the energy transition of shipping
 - Enhanced focus on assessing possible impacts on **food security**
 - Explicit support to promotion of **technical cooperation** and **transfer of technology**

World's first regulatory framework to combine mandatory emissions limits and GHG pricing across an entire industry sector

Mandatory for all ships > 5,000 tons from 2028 (~85% of emissions)

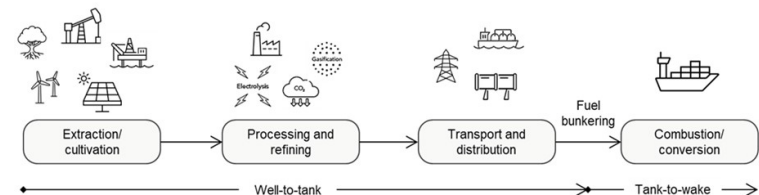
Amendments to be formally adopted in October during **MEPC extraordinary session**

Expected to provide **regulatory certainty** for industry and fuel providers

Implementing the IMO GHG Strategy: IMO fuel sustainability assessment framework



- Current IMO regulations only focus on downstream emissions (“**Tank-to-Wake**”)
- Low- and zero-carbon fuels have very different overall GHG intensities when considering only the downstream emissions and when considering also the upstream emissions (“**Well-to-Tank**”)



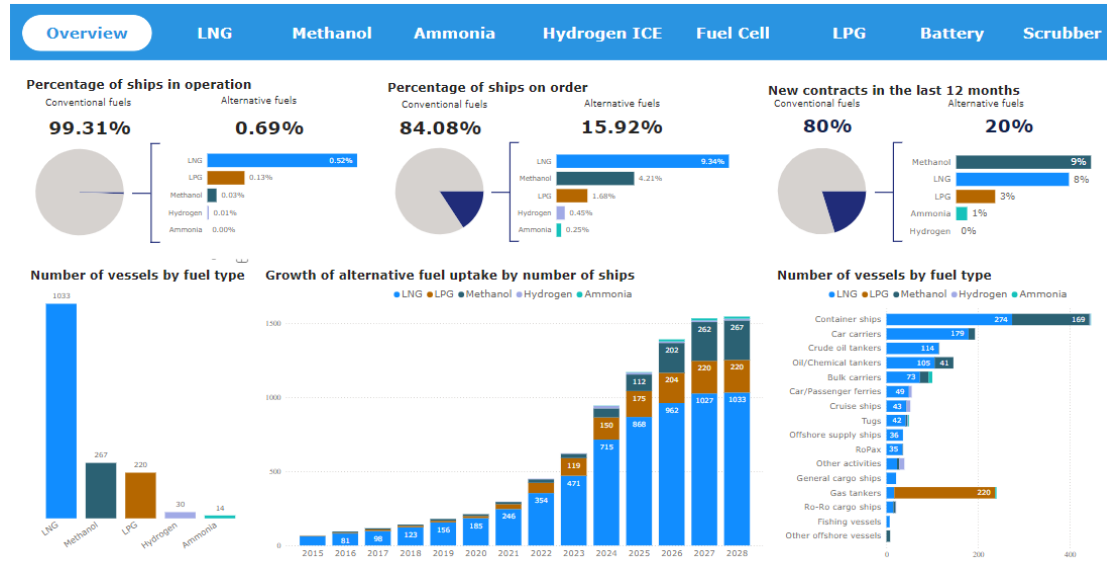
- MEPC 80 adopted the first *Guidelines on life cycle GHG intensity of marine fuels (LCA Guidelines)* providing the methodology and framework for the assessment of Well-to-Wake emissions
- Establishment of an expert group for scientific review of the LCA framework: **GESAMP-LCA**
- Development of a sustainable marine fuel **certification framework**

Sustainability themes/aspects in the IMO LCA Guidelines
1. GHGs
2. Carbon source
3. Source of electricity/energy
4. Carbon stock – DLUC
5. Carbon stock – ILUC
6. Water
7. Air
8. Soil
.9 Waste and chemicals
.10 Conservation

Implementing the IMO GHG Strategy: IMO safety regulations and training standards

- On the use of **liquid biofuels (e.g. FAME, HVO)**, there is already a wide set of safety rules applying today, including for blends
- **MSC:** new (continuous) output on "Development of a safety regulatory framework to support the reduction of GHG emissions from ships using new technologies and alternative fuels"
 - recommendations to address barriers and gaps in current IMO instruments that impede the safe use of alternative fuels or new technologies
- **MSC 109** (December 2024) approved *Interim guidelines for the safety of ships using ammonia as fuel*
- **MSC 110** (June 2025) approved *Generic interim guidelines on training for seafarers on ships using alternative fuels and new technologies*
- CCC plans to further develop and finalize interim guidelines for safety of ships using **hydrogen** as fuel, with a view to approval at MSC 111 in 2026.
- IMO participation in the Maritime Just Transition Task Force (**MJTTF**)

IMO Future Fuels and Technology project (FFT)



Future Fuels & Technology Project for Low/Zero Carbon Shipping

IMO INTERNATIONAL MARITIME ORGANIZATION

About the Project | Latest Information | Future Insight | News and Events | Training and Cooperation

Fuel Uptake | **Fuel Supply** | **Fuel Prices** | **Fuel Consumption (DCS)**

Latest Information

The most up-to-date data on alternative fuels uptake and supply, current fuel prices, and information from the IMO Data Collection System (DCS).

Fuel Uptake

The latest developments in vessel uptake of alternative fuels provided by DNV's Alternative Fuel Insight (AFI) platform.

Fuel Supply

The latest developments in bunkering infrastructures for alternative fuels provided by DNV's Alternative Fuel Insight (AFI) platform.

Fuel Prices

The global alternative marine fuel price premiums and historical trends from Argus Media.

[Discover More](#)



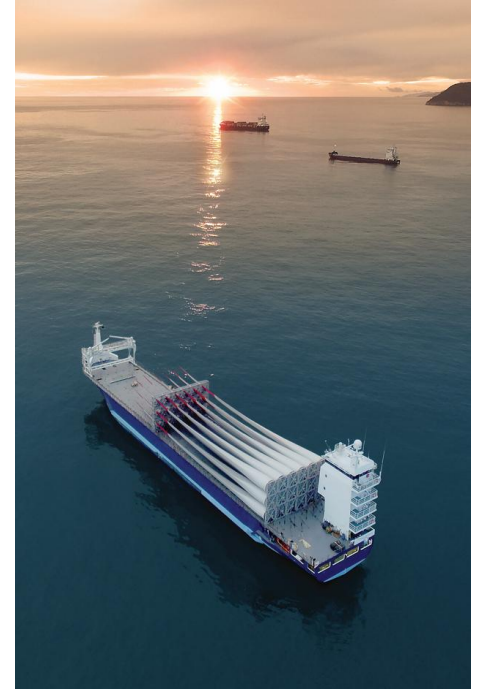
<https://futurefuels.imo.org/>

For information:
futurefuels@imo.org

4. Conclusion

Conclusion

- Implementing the IMO GHG Strategy requires continuous efforts on different fronts:
 - Enhanced energy efficiencies
 - Effective regulatory incentives to drive the shift to low emission fuels
 - Marine fuel sustainability assessment framework
 - Robust safety provisions and updated training standards for the maritime workforce
 - Increased technical cooperation and capacity-building
- IMO continues to lead global coordinated action
 - Global cooperation and industry-wide action on climate change is possible
 - Opportunities at national and local level to contribute to shipping decarbonization, e.g.: role of ports, energy producers, etc.
- 7.4% of ships in operation by tonnage can operate on alternative fuels, but they represent 49.3% of the order book:
 - 36% capable of being powered by LNG,
 - 9.6% by methanol (source: DNV)



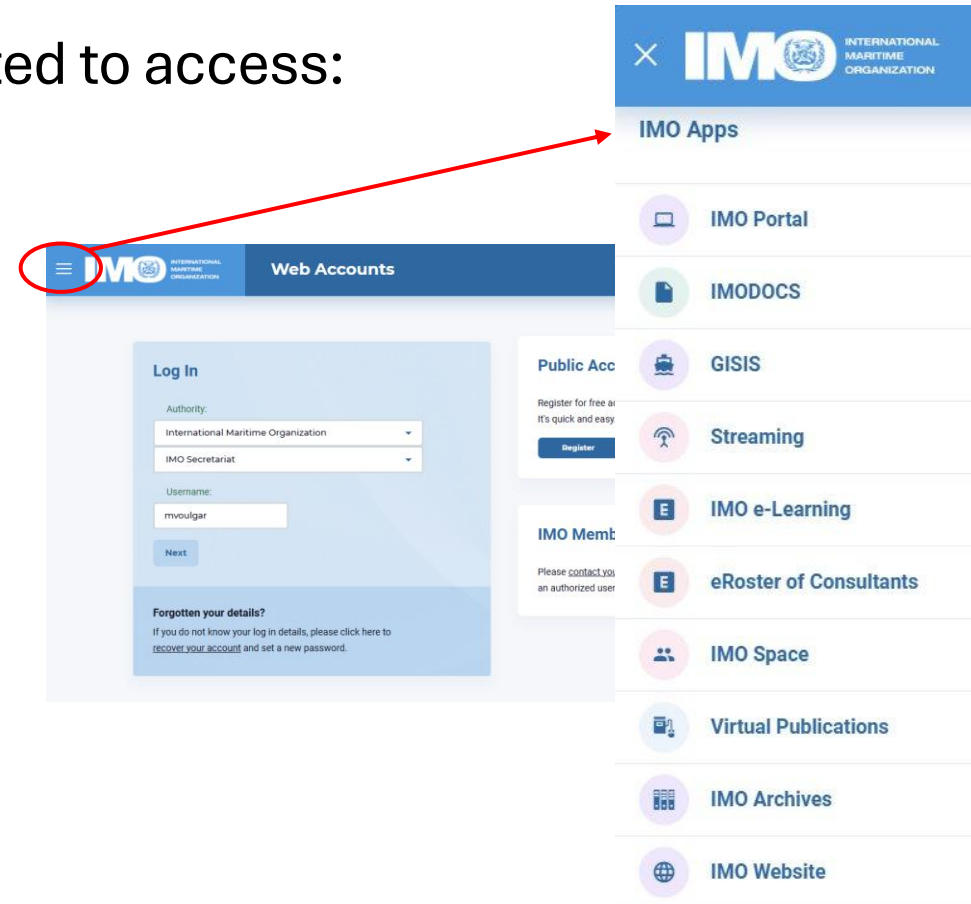
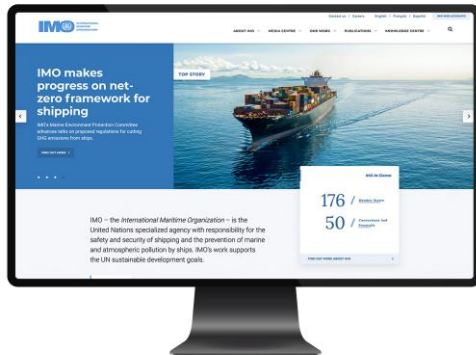
Access to IMO information

IMO website (www.imo.org)

Personal **IMO web account** (public user) can be requested to access:

- IMODOCS
- Global Integrated Shipping Information System (GISIS)
- Streaming
- e-Learning platform (IMO e-Learning)

Maritime Knowledge Center



(<https://webaccounts.imo.org>)

Thank you.

International Maritime Organization

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Iris Leung

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Regional perspective on pricing and market update on Asia bio-bunkers

Platts®

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Commodity Insights

Asia Biobunkers

Pricing and Market Update

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Greater push for global maritime decarbonization in recent years

IMO Carbon Intensity Indicator (CII)

Each year, ships of 5,000 gross tonnage and above **collect and report fuel consumption data**.

On the basis of this data,

A CARBON INTENSITY RATING IS ASSIGNED TO THE SHIP, FROM A TO E



Poorly rated ships **have to implement**

A PLAN OF CORRECTIVE ACTIONS, and the company is regularly audited incentives may be provided to best rated (A/B) ships

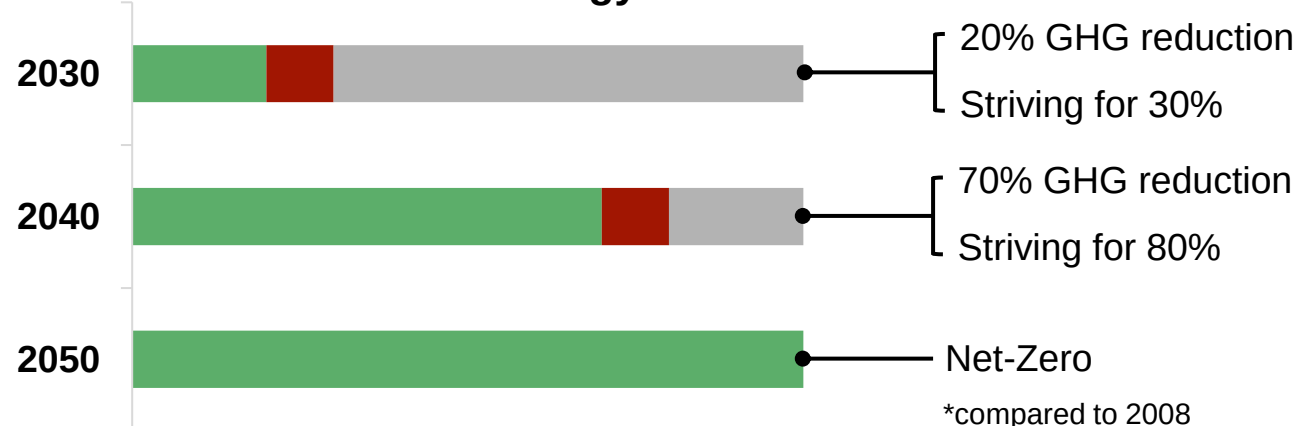


Source: International Maritime Organization

IMO GHG Pricing (from 2028) approved at MEPC 83

- Reduce required GHG fuel intensity, else buy Tier 1 units at \$100/tCO₂e
 - Reduce by 4% – 17% in 2028
 - Reduce by 30% – 43% in 2035
- Surplus units generated can be sold as Tier 2 units at \$380/tCO₂e

2023 IMO GHG Strategy

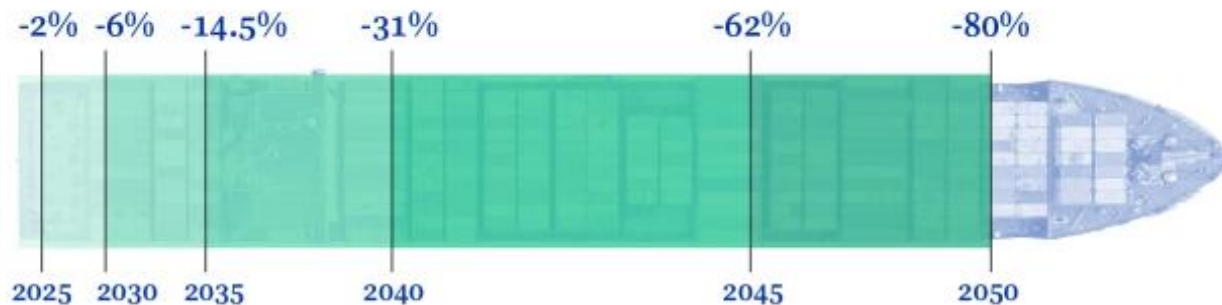


EU regulatory compliance boost mandatory demand for biobunkers

FuelEU Maritime (from Jan. 1, 2025)

Ships above 5,000 gross tonnage calling at European ports must reduce their yearly average greenhouse gas (GHG) intensity of the energy used following targets that gradually increase over time

Annual average carbon intensity reduction compared to the average in 2020



Source: European Commission

EU Emissions Trading System (ETS)

Extended to cover CO₂ emissions from all ships of 5,000 gross tonnage and above entering EU ports, since Jan 2024

- Covers 100% of GHG emissions for voyages within EU ports
- Covers 50% of GHG emissions for voyages into or out of EU

Biobunkers – a “drop-in” alternative fuel for maritime decarbonization

Alternative Fuel	Comparative Analysis			
	Energy Cost (\$/GJ)	GHG Emissions	Capital Cost	Growth Outlook
Biofuel				Short Mid Long
LNG*				
Methanol*				
Ammonia*				

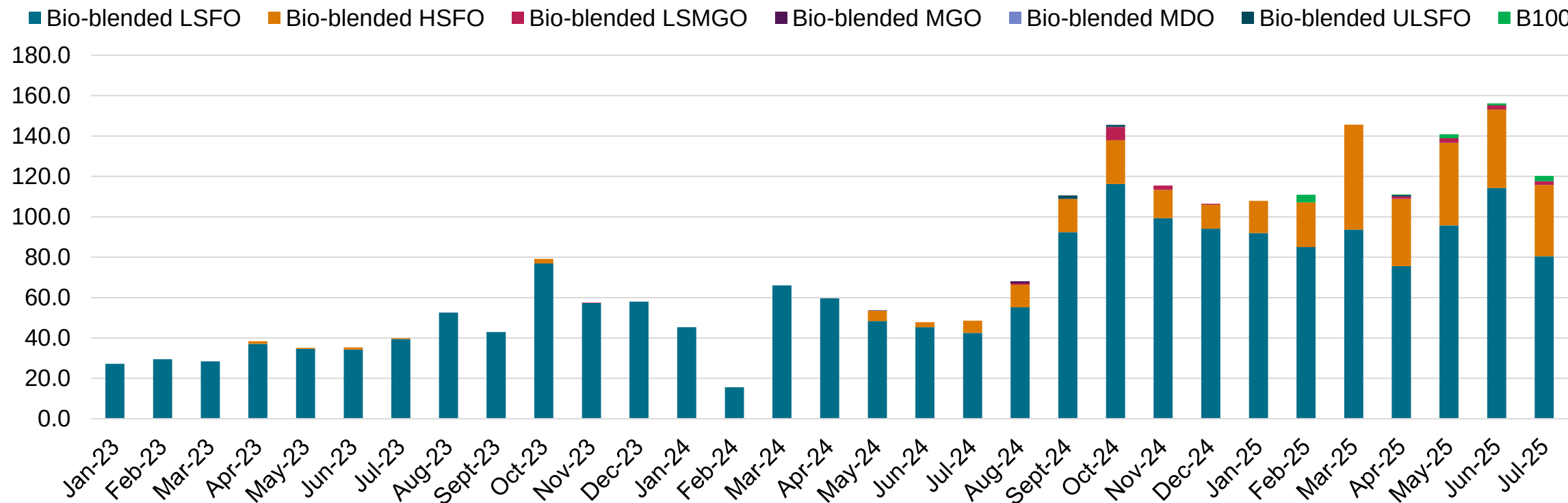
*Notes: Fossil-based LNG and renewable methanol/ammonia are considered in the above comparison

Source: S&P Global Commodity Insights

Singapore is the biggest market for biobunkers in Asia

Strengthened demand for Singapore biobunkers in 2025

Singapore biobunker sales (in '000 metric tons)

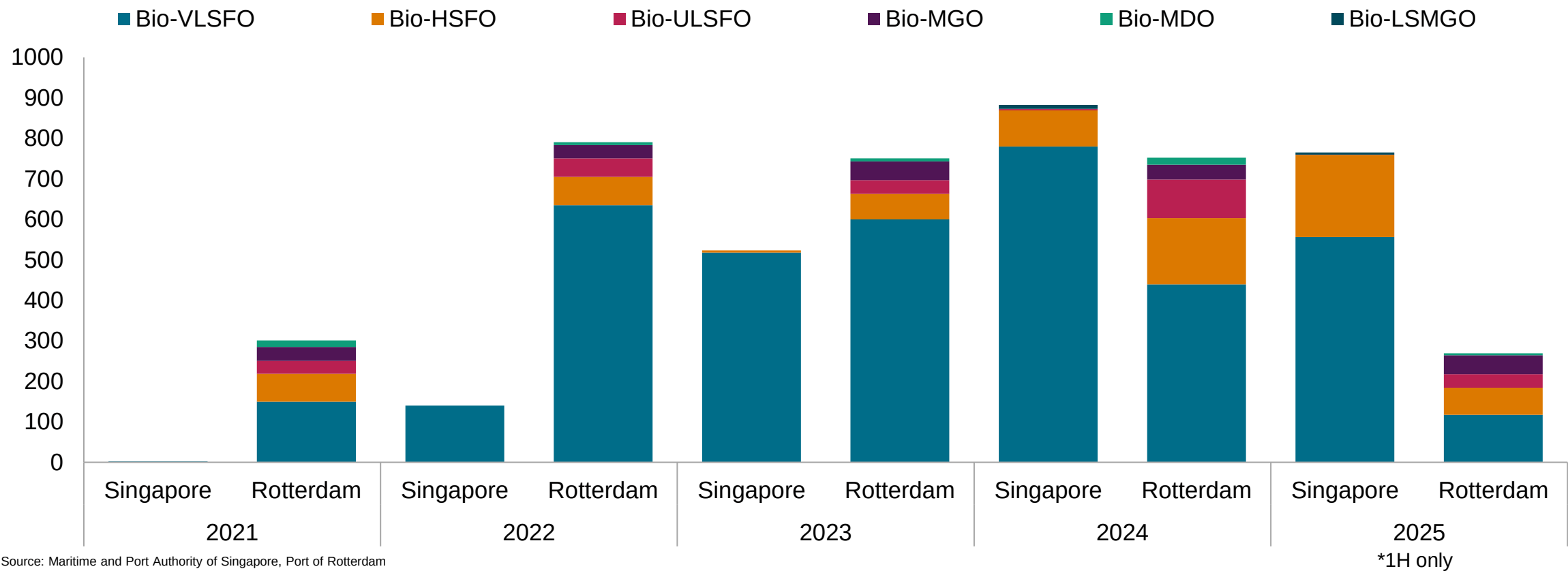


Source: Maritime and Port Authority of Singapore (MPA)

Singapore exceeds Rotterdam's annual biobunker sales since 2024

Singapore's cost competitiveness supported by bio-feedstock availability in Asia

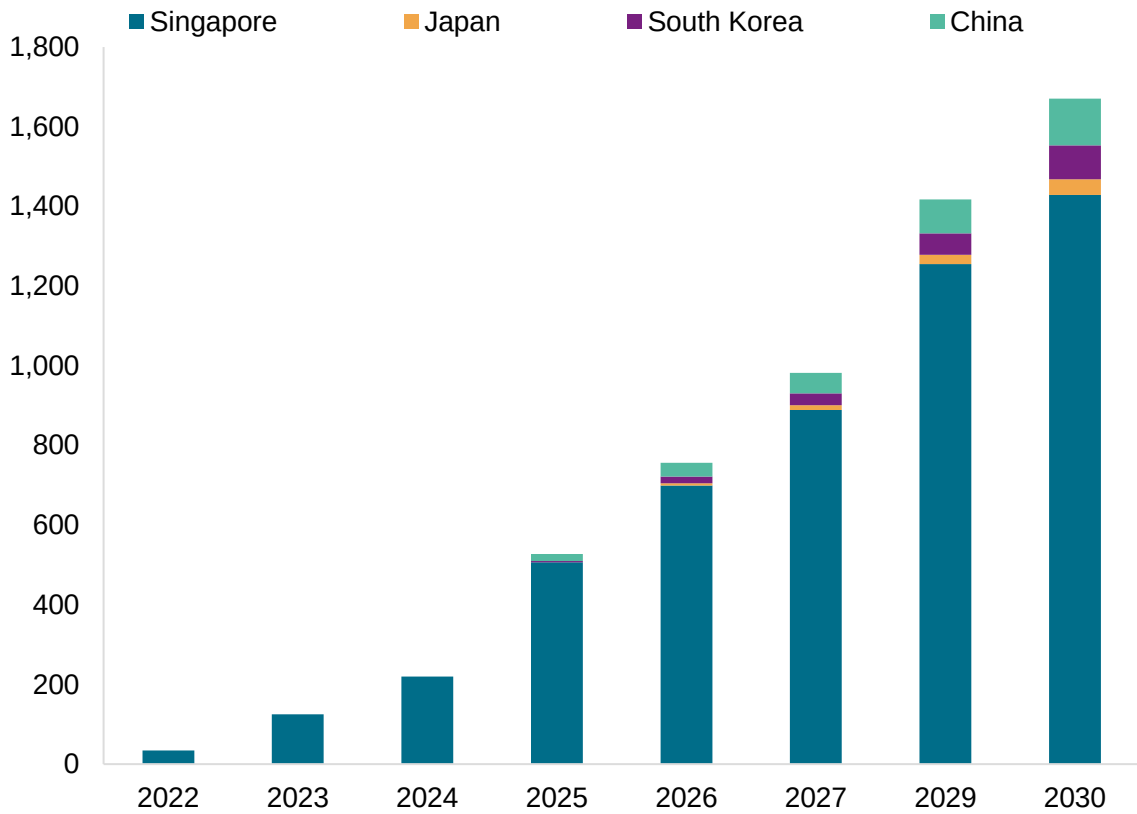
Singapore and Rotterdam marine biodiesel sales (in '000 metric tons)



Source: Maritime and Port Authority of Singapore, Port of Rotterdam

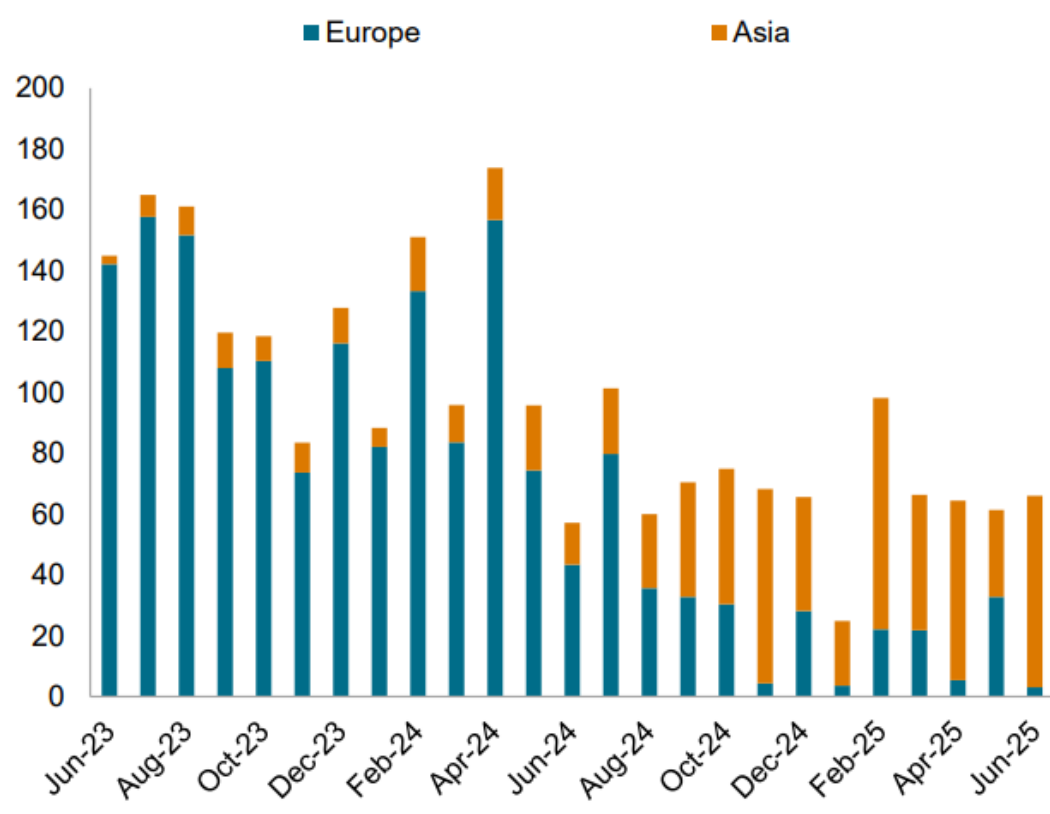
Tightening regulatory compliance support biobunkers growth in Singapore

Biodiesel demand from bio-bunkers, by country
(in '000 metric tons)



Source: S&P Global Commodity Insights
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China Biodiesel Exports, by region (thousand metric tons)



Data compiled Aug. 24, 2025
Source: S&P Global Commodity Insights
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Biobunkers are mainly supplied in Singapore and Rotterdam

Rotterdam is a pioneer biobunkering port, with **B30** being the common blend. EU regulations and HBES support biobunker uptake.

Some biobunkering activity has been observed in the Mediterranean Sea, especially for cruise ships.

Despite competitive pricing, the UAE only sees a few small biobunker inquiries in a month.

PLATTS EUROPE BIOBUNKER PRICES

- Biobunkers B30 Rotterdam UCOME (\$/mt) ABKRA00
- Biobunkers B30 Rotterdam UCOME Premium (\$/mt) ABKRE00
- Biobunkers B30 Rotterdam FAME 0 (\$/mt) ABKRB00

Singapore is the largest biobunkering hub in Asia, with a gradual transition from **B24** to **B30** seen since March.

Without a biobunker blending policy in China, B24 is blended in Hong Kong or Singapore and delivered to mainland Chinese ports.

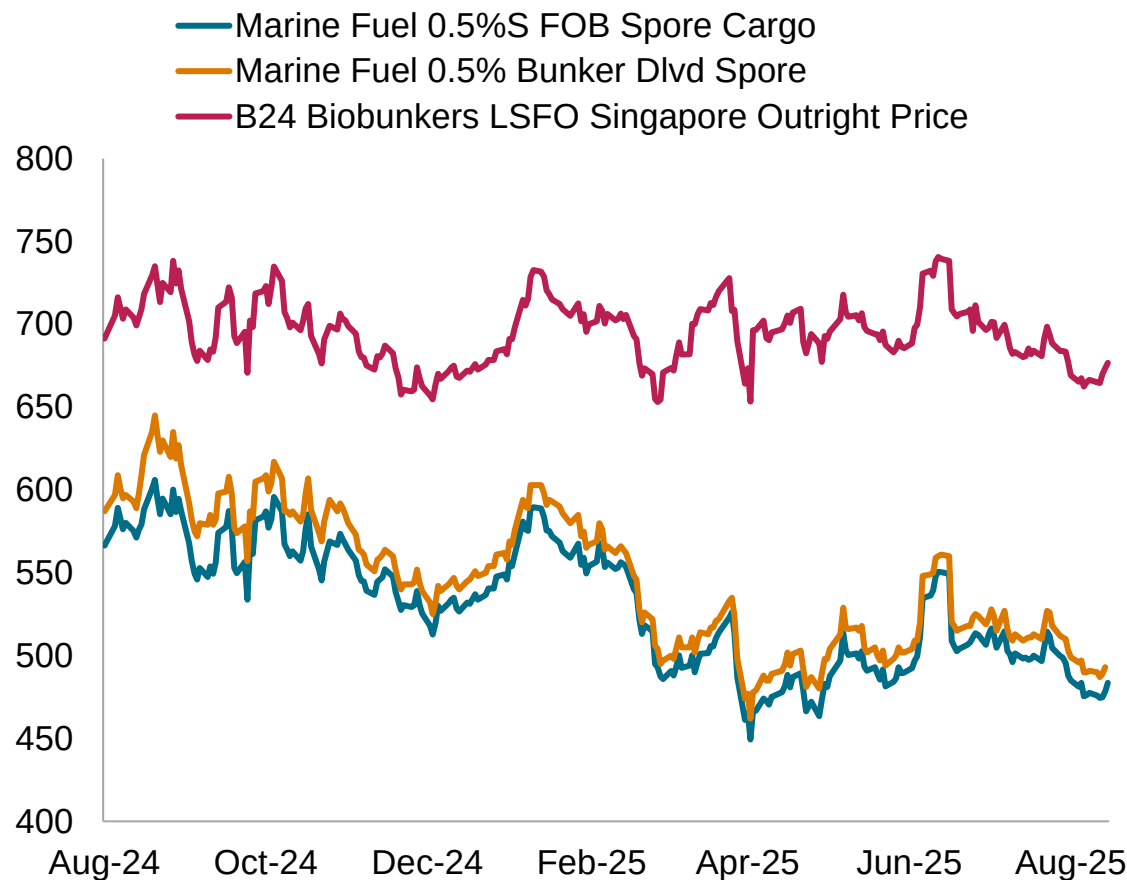
Supply of biobunkers is available across Asia, including B24 in Japan, B30 in Korea and B40 in Indonesia.

PLATTS APAC BIOBUNKER PRICES

- B24 Biobunkers LSFO Singapore outright price / premium (\$/mt) LSFOO00 / LSFOB00
- B24 Biobunkers HSFO Singapore outright price / premium (\$/mt) HSFOO00 / HSFOB00
- **[UPCOMING]** B30 Biobunkers LSFO / HSFO Singapore

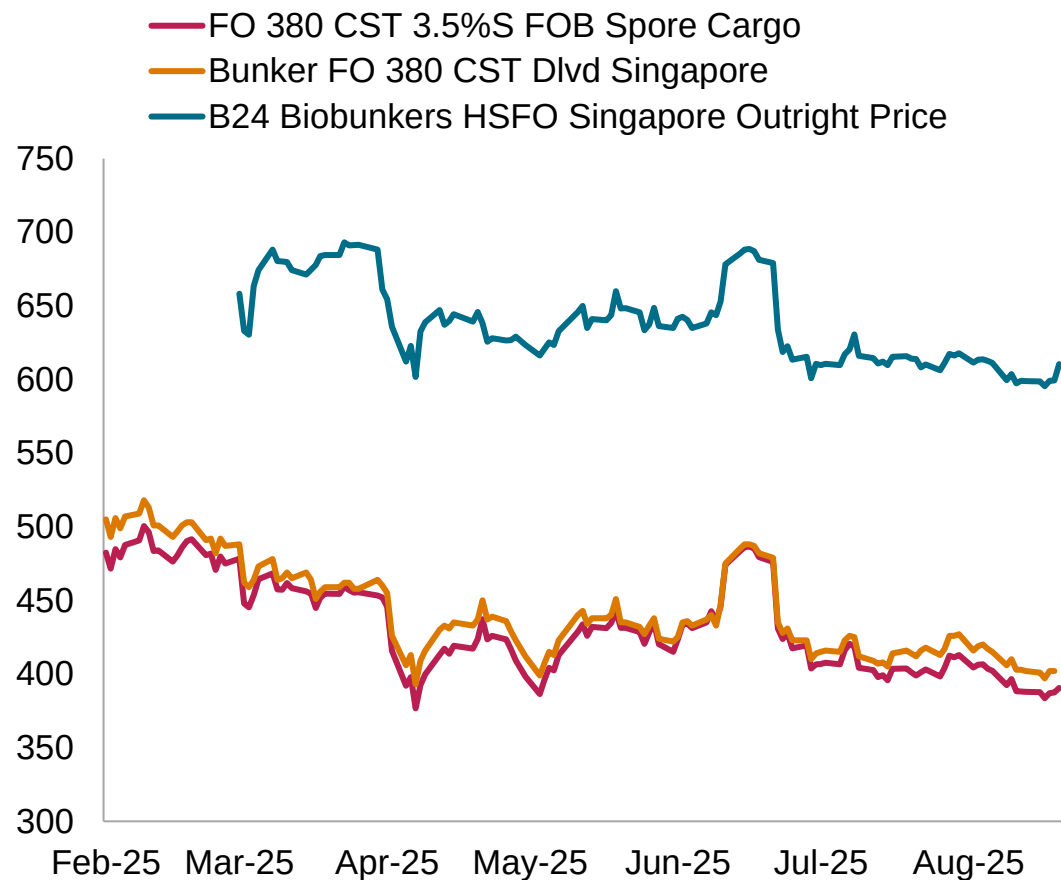
Biobunkers priced at a premium to conventional bunkers

Singapore B24 low sulfur fuel oil spot price, \$/mt



Source: S&P Global Commodity Insights.

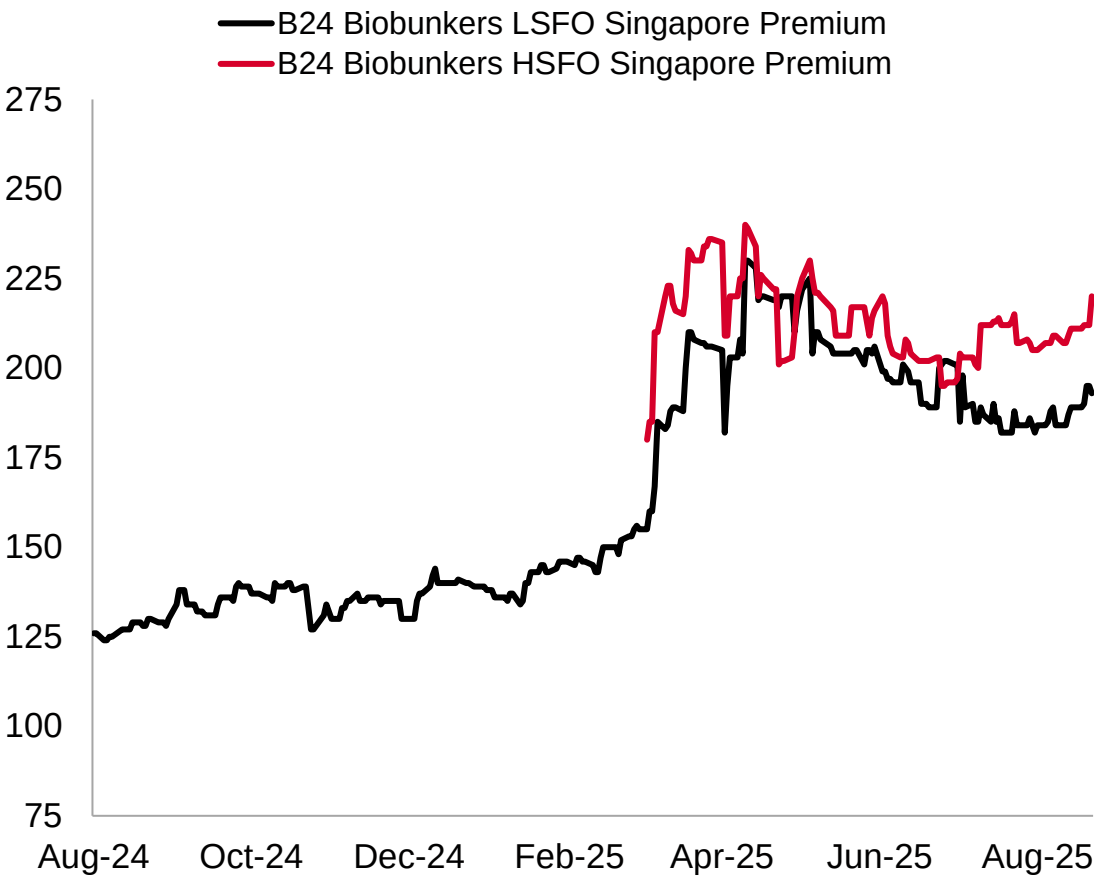
Singapore B24 high sulfur fuel oil spot price, \$/mt



Source: S&P Global Commodity Insights.

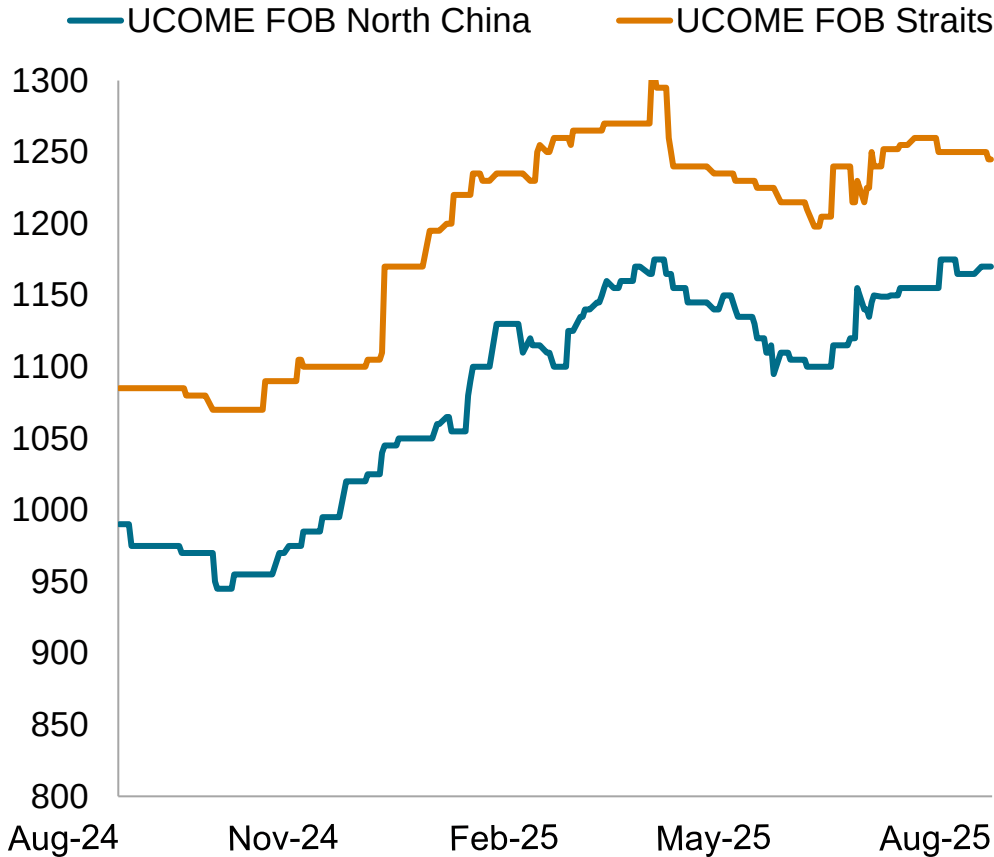
Singapore biobunker premiums driven by UCOME costs

Platts Singapore biobunker spot premiums, \$/mt



Source: S&P Global Commodity Insights.

Platts Asia UCOME spot prices, \$/mt



Source: S&P Global Commodity Insights.

Biobunkers offer a comparatively affordable option in the transition to lower-carbon alternatives

[Platts global bunker fuel cost calculator](#)

Monthly average cost in \$/Gj, June 2025



Questions?

Contact us

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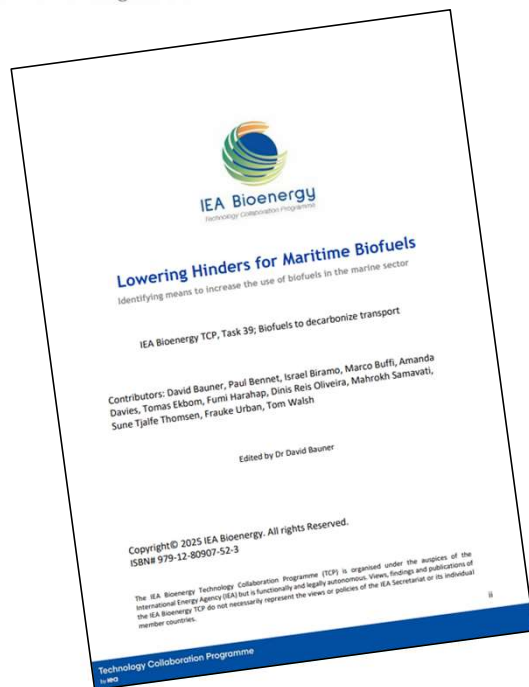
<https://www.spglobal.com/commodityinsights/>



Tom Welsh

CEO, Renetech BioResources
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IEA Bioenergy Task 39

Lowering Hinders for
Maritime Biofuels -
identifying means to
increase the use of
biofuels in the marine
sector



Lowering Hinders for Maritime Biofuels – identifying means to increase the use of biofuels in the marine sector

Global Biofuels Alliance

Task 39 - Biofuels to Decarbonize Transport T3 Project-Maritime Biofuels

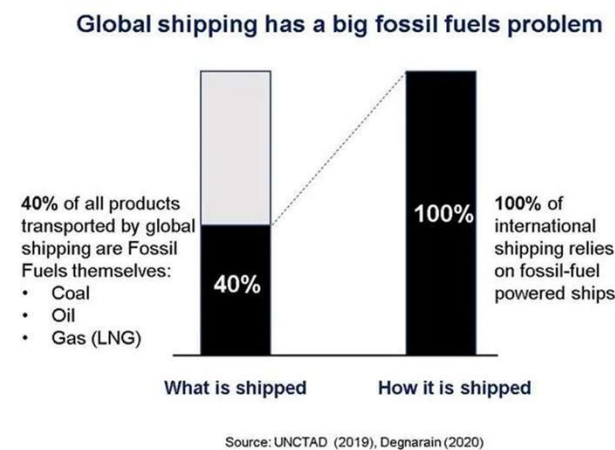
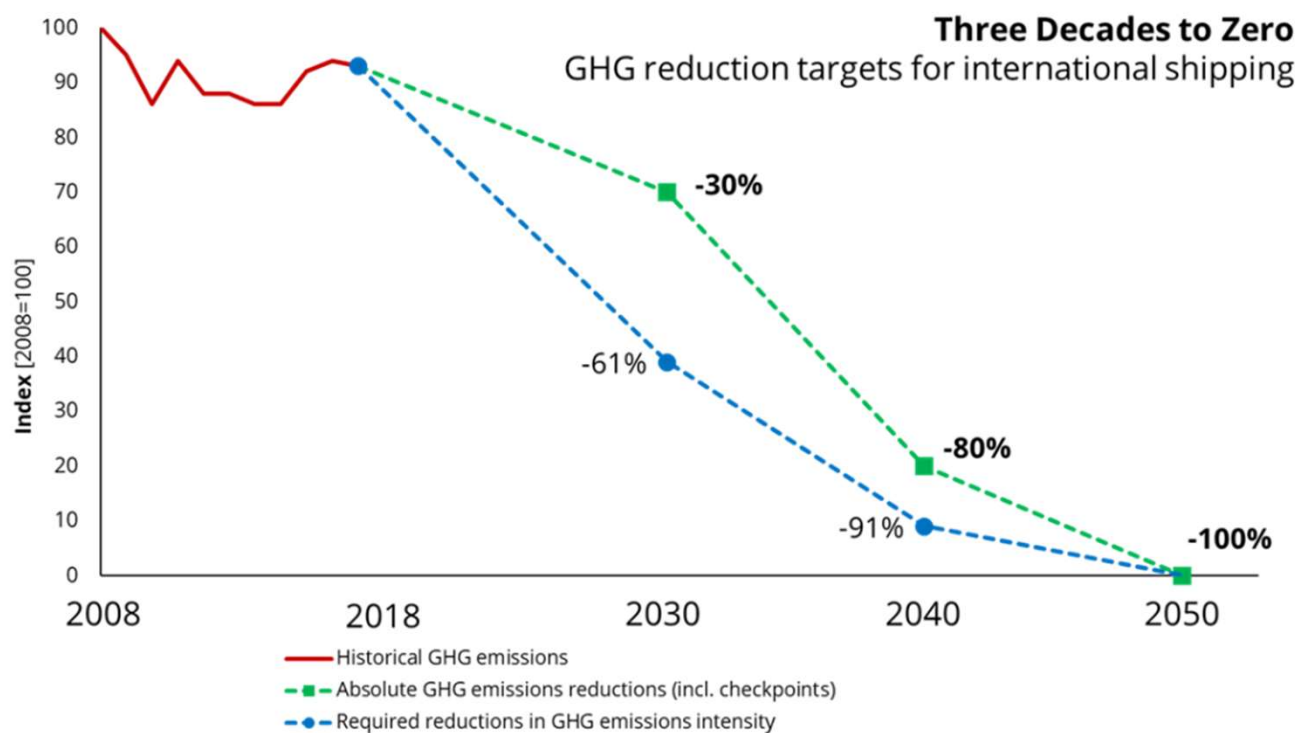
Tom Walsh CEO, NTL Renetech Bioresources Ltd, Ireland

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Agenda

- Background
- 2024-2025 Report highlights
 - Outline
 - Reference group
 - Biomass Sourcing
 - System level scenario outlook
 - Innovation
 - Maritime Fuel qualities
 - IMO and EU regulations
 - Market development and Investment
- Program of work 2025-2027
 - Case studies
- Conclusion

Background



A new climate deal for shipping: Three decades to zero. (2023, June 13). World Bank Blogs. <https://blogs.worldbank.org/transport/new-climate-deal-shipping-three-decades-zero>

2025 Report outline

1 Background

- 1.1 Introduction – IEA and task 39
- 1.2 Objectives, Goals, Methodology
- 1.3 Shipping industry history
- 1.4 Marine fuel use today
- 1.5 Maritime biofuels and its potential benefits

2 Developing the market for sustainable marine fuels (state of the art)

- 2.1 Introduction
- 2.2 Biomass sourcing
- 2.3 Biofuel production
- 2.4 Distribution and bunkering
- 2.5 Fuel use
- 2.6 Energy efficiency
- 2.7 Conclusion



3

- 3.1 Introduction
- 3.2 System level scenario outlook
- 3.3 The role of regulation
- 3.4 Developing biofuel production
- 3.5 Distribution and use of biofuels
- 3.6 Energy efficiency measures to enable biofuels
- 3.7 The need for investment
- 3.8 Case study: Marine Fuels from Pyrolysis of Biomass – A Solution For New Zealand?

- 3.9 Case Study: Interview with MPA, Singapore

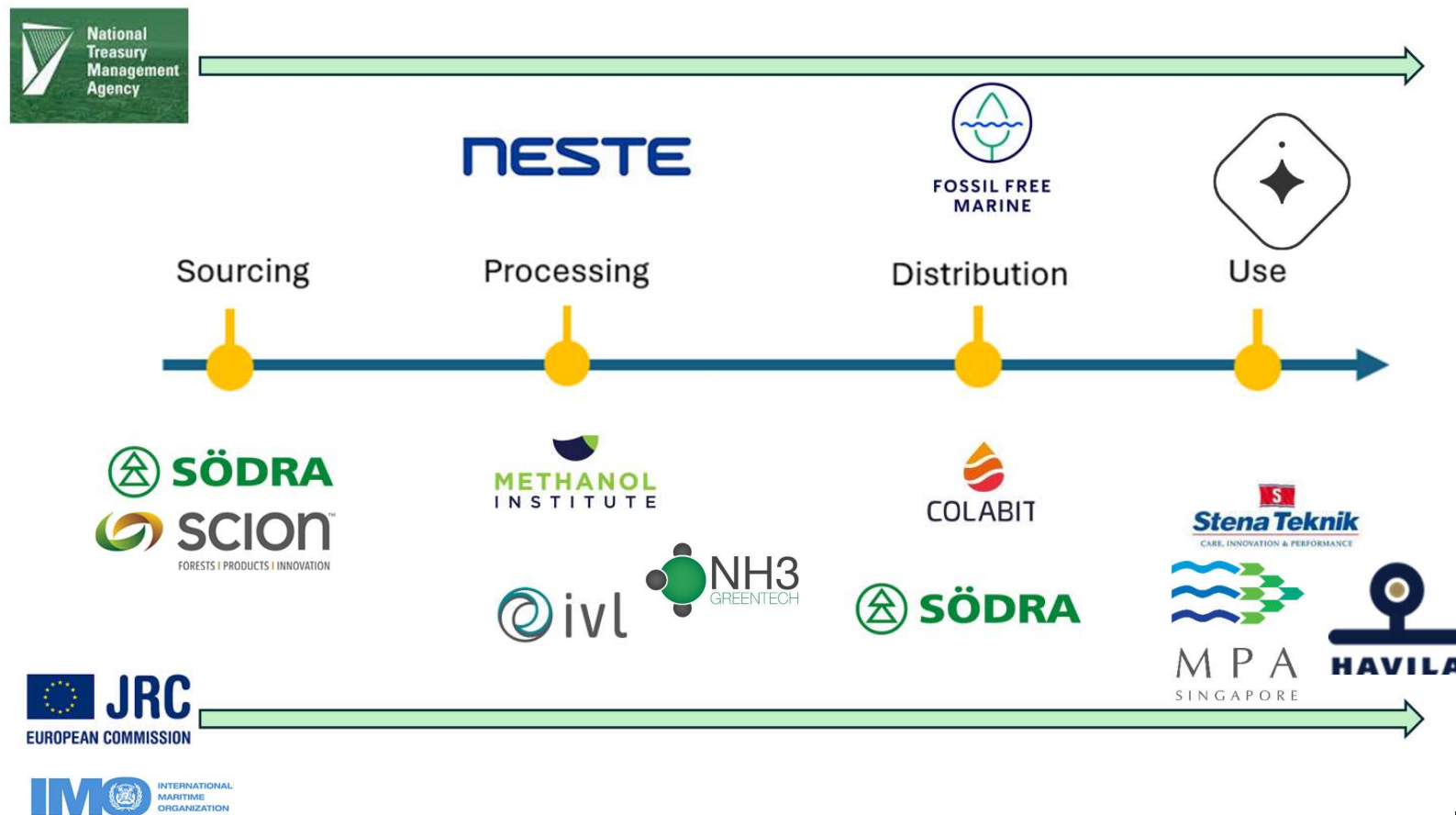
4 Analysis and summary

- 4.1 IMO and DNV roadmaps to 2050
- 4.2 Discussion

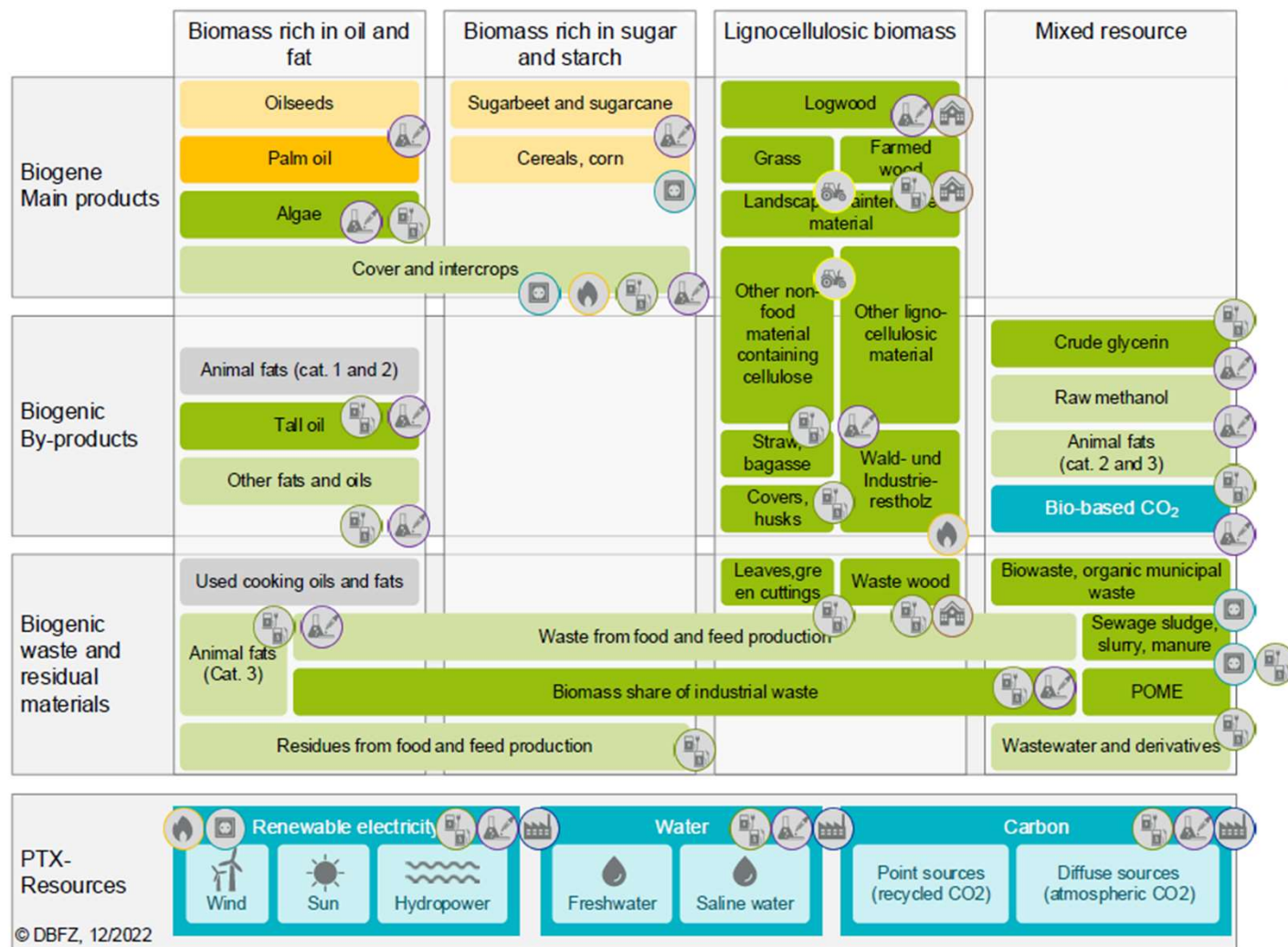
Report link

<https://www.ieabioenergy.com/wp-content/uploads/2025/04/IEA-Bioenergy-TCP-Task-39-T3-Maritime-Biofuel-Hinders-Report-revised.pdf>

Reference group and interviewees



Biomass sourcing



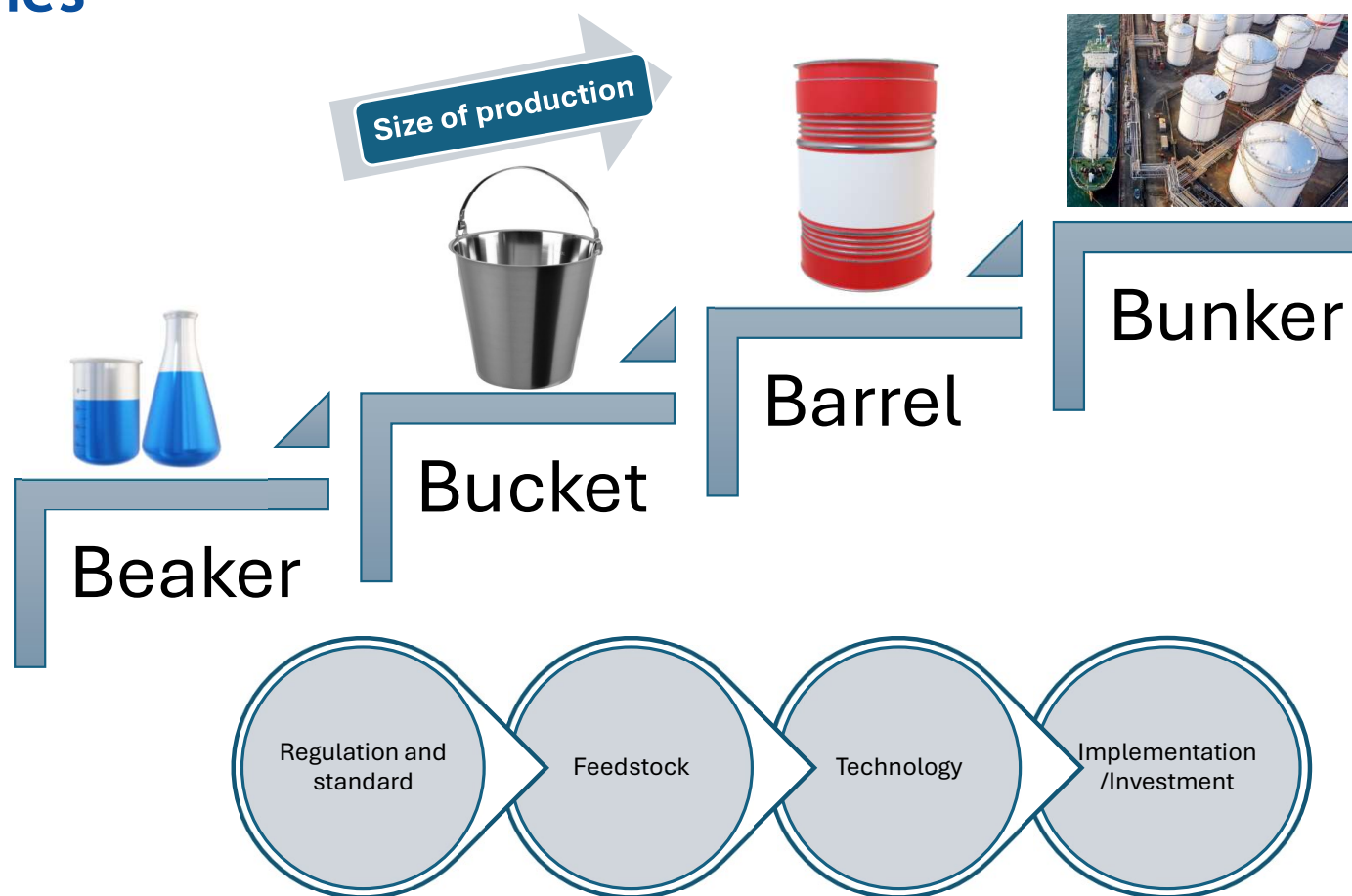
Systems level scenario outlook

Economic growth	International trade	Climate policy	Carbon price	Fossil fuel use	Increased use of biofuels	GHG emissions
High	High	Strong	High	Medium	Medium to high	Medium
		Medium	Medium	High to medium	Medium to low	Medium
		Weak	Low	High	Low	High
Medium	Medium	Strong	High	Medium	Medium	Medium
		Medium	Medium	Medium	Medium	Medium
		Weak	Low	High	Low	High
Low	Low	Strong	High	Low to medium	High to medium	Low to medium
		Medium	Medium	Medium	Medium	Medium
		Weak	Low	High to medium	Low to medium	Medium

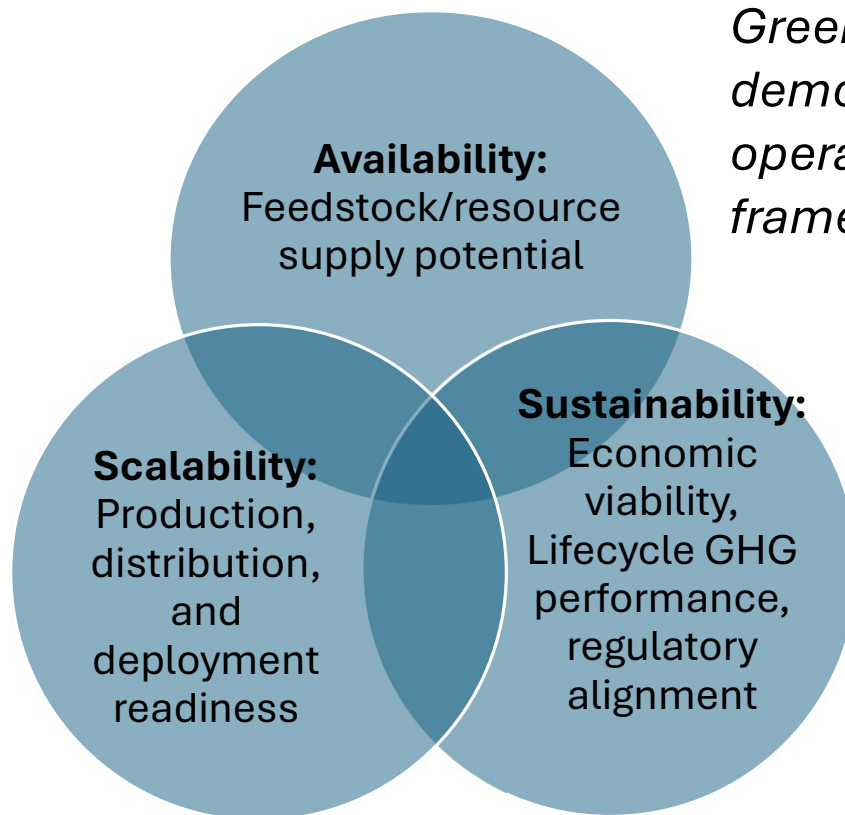
Source: Frauke Urban (KTH, Sweden), Mahrokh Samavati (Ramböhl), Fumi Harahap (Ramböhl)



Innovation ladder - from lab scale to commercial fuel use in engines

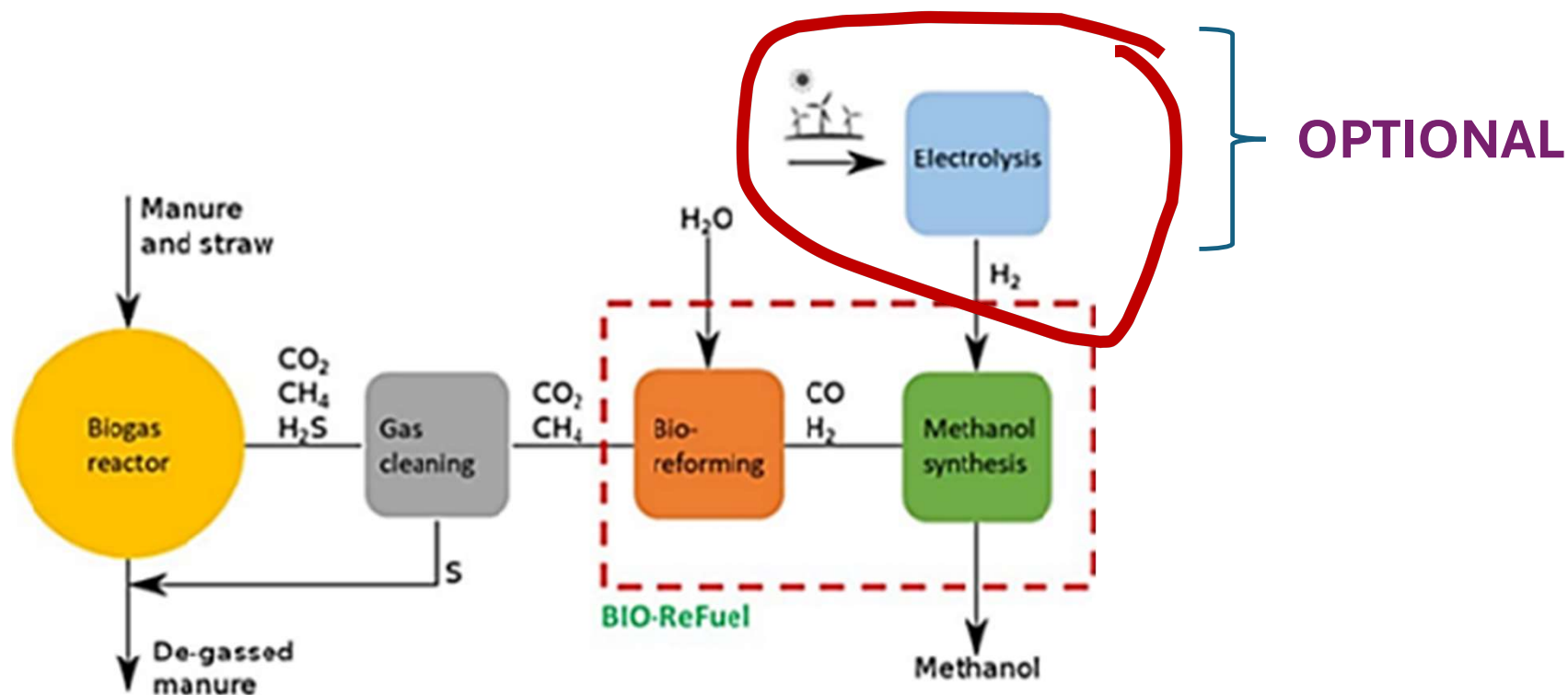


Sustainability-Availability-Scalability Framework for Marine Biofuels Evaluation



Green Corridors serve as demonstration platform to operationalize this framework

Innovation example: Producing methanol from Anaerobic Digestion, with or without adding hydrogen

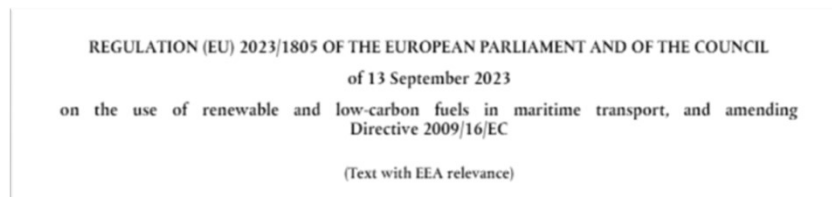


List of fuel characteristics - fossil vs biofuels

Fuel type	Volumetric energy density	Gravimetric energy density	Carbon intensity	SO _x Emissions
	[MJ/L]	[MJ/kg]	[TCO _{2e} /TJ]	
HFO	38	39	77-87	High
MGO	37	43	87	High
LNG (liquid)	21	49	63	None- Low
RNG (liquid)	21	49	~10	None- Low
Methane (gas)	0.034	50	< ~10	None
Ethanol	16	20	24, 34**	None
DME	21	27	NA	None
Biodiesel	19	29	60 (oil crops)	None
Biocrude	35	38	NA	None-Low
Pyrolysis Oils	16	17-20	NA	NA
HVO	25	33	8-25	None
Methanol*	16	20	~0, ~10 (wood)	None
H2* (liquid)	8.5	120	~0	None
Ammonia* (liquid)	13	19	~0	None
Batteries**	1.3	0.7	~0	None

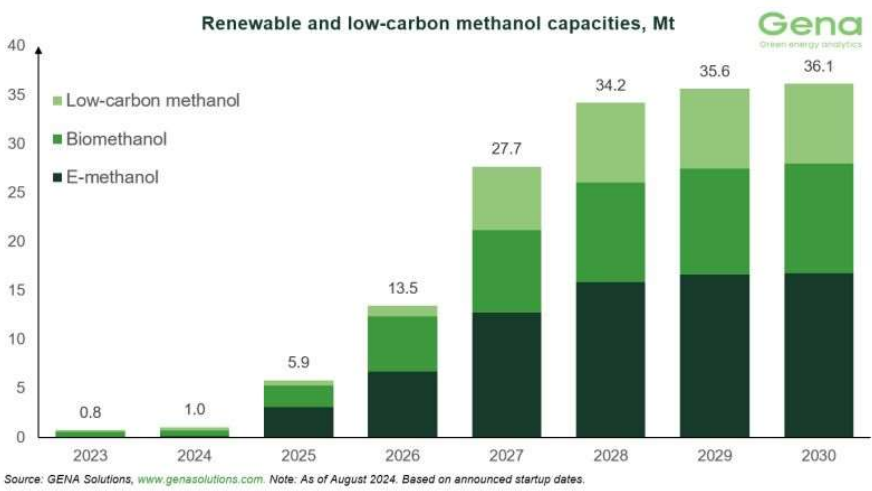
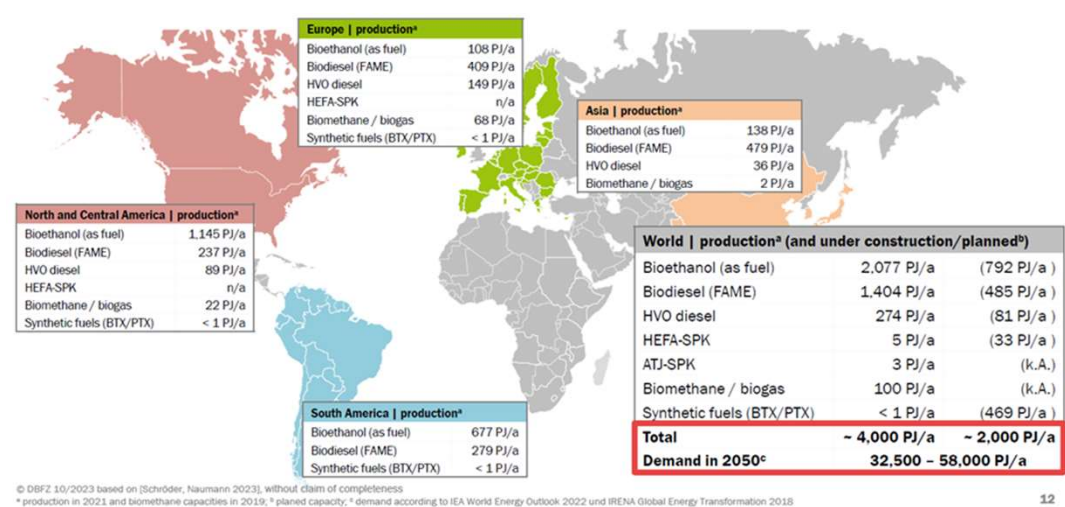
Simonsen, Weiss, van Dyk, van Thuijl, and Thomsen (2021); *Progress towards biofuels for marine shipping; Status and identification of barriers for utilization of advanced biofuels in the marine sector*. IEA TASK 39, June 2021 ([here](#))

Regulation



- IMO CII, EEDI, EEXI
- New Chapter 5 of MARPOL Annex VI containing regulations on the IMO net-zero framework, including:
 - a goal-based marine fuel standard regulating the phased reduction of the marine fuel's **GHG intensity**; and
 - economic mechanisms to incentivize the transition to net-zero.
- EU ETS (Emissions Trading System) for ships > 5000 gross tonnes
- FuelEU Maritime Directive – on-board ship GHG intensity
- European Energy Taxation Directive – bunker fuel tax
- RED III sets a binding combined sub-target of 5.5% for advanced biofuels and RFNBOs (min. 1%) by 2030
- Singapore Workshop Agreement 2:2022 (marine biofuel)
- ISO 8217, 2024 - modification including non-fossil sources (e g methanol)
- International Sustainability and Carbon Certification (ISCC)

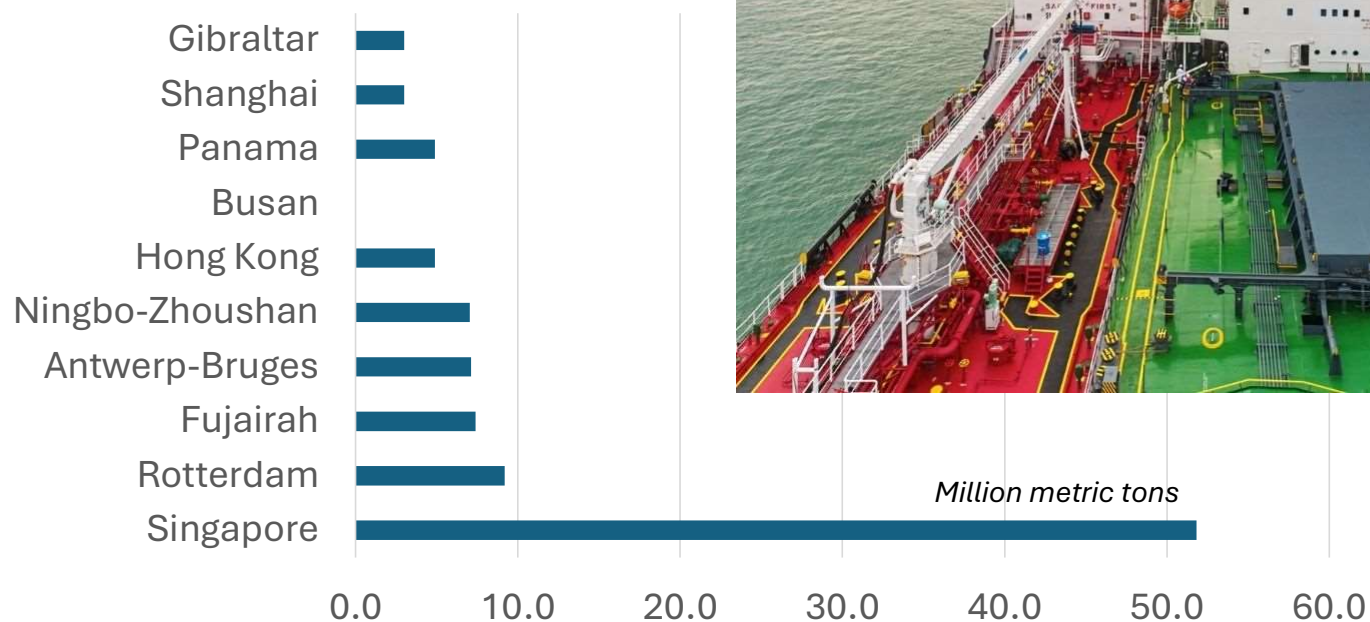
Renewable fuel in the international market



Renewable fuel in the international market projected upto 2050 (Source DBFZ (2023))

Coming green methanol pipeline globally as of August (MI, 2024)

World's largest bunkering ports 2023

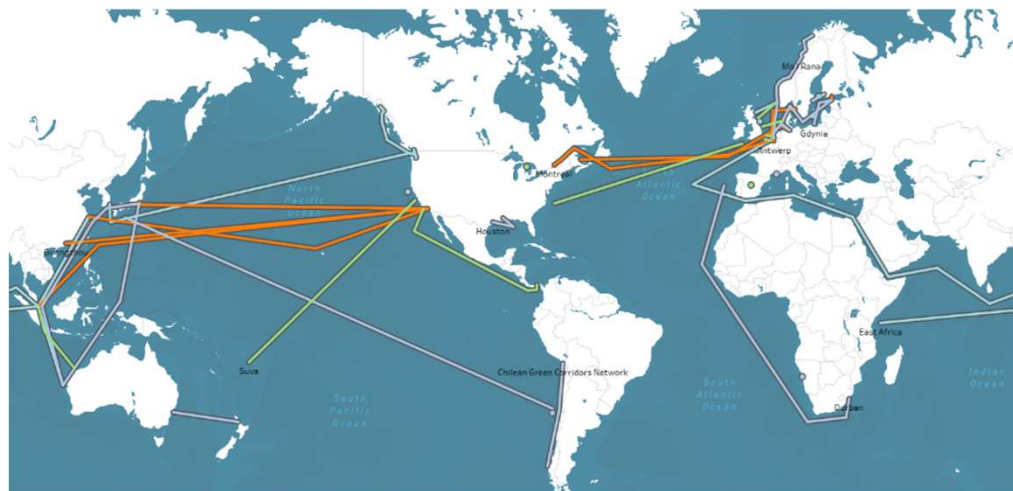


Creating Markets for Biofuels

	Challenges		Opportunities		Strategies
	Technical	Economic	Technical	Economic	
BIOMASS SOURCING	Local access to biomass for regional supply, scaling	Funding, Scaling,	Clear certification for feedstocks, development of biogas substrates (for methane and methanol production) supply	Incentives for certification, supply and methane production	Develop regional certification rules with all stakeholders
BIOFUEL PRODUCTION	Regional capability,	Funding, offtake risk	investment in sustainable production, biogenic CO ₂ for methanol production	Incentives, credit line, regional supply (less transport)	Supply contracts, investment support
DISTRIBUTION & BUNKERING	Matching supply and demand, certification, feeder vessels and fueling methods	Securing regional profitability, competition from aviation and bioplastics markets	Assessing the market - early entry may render significant demand	Incentives for biofuel distribution bunkering, blending. investment for efficiency	Certification, economic incentives, carbon pricing, regulation
BIOFUEL USE	Vessel compatibility, safety (e.g. for bio-ammonia), availability, leakage (methane and hydrogen)	Securing adherence (shadow fleet minimization) by market actors, oversee economic viability for fleets	Green corridors, e-fuels Energy efficiency measures such as efficient hull design, sails and hull cleaning	EEXI, EEDI, Incentives	IMO roadmap adherence, initial economic support for sustainable biofuels

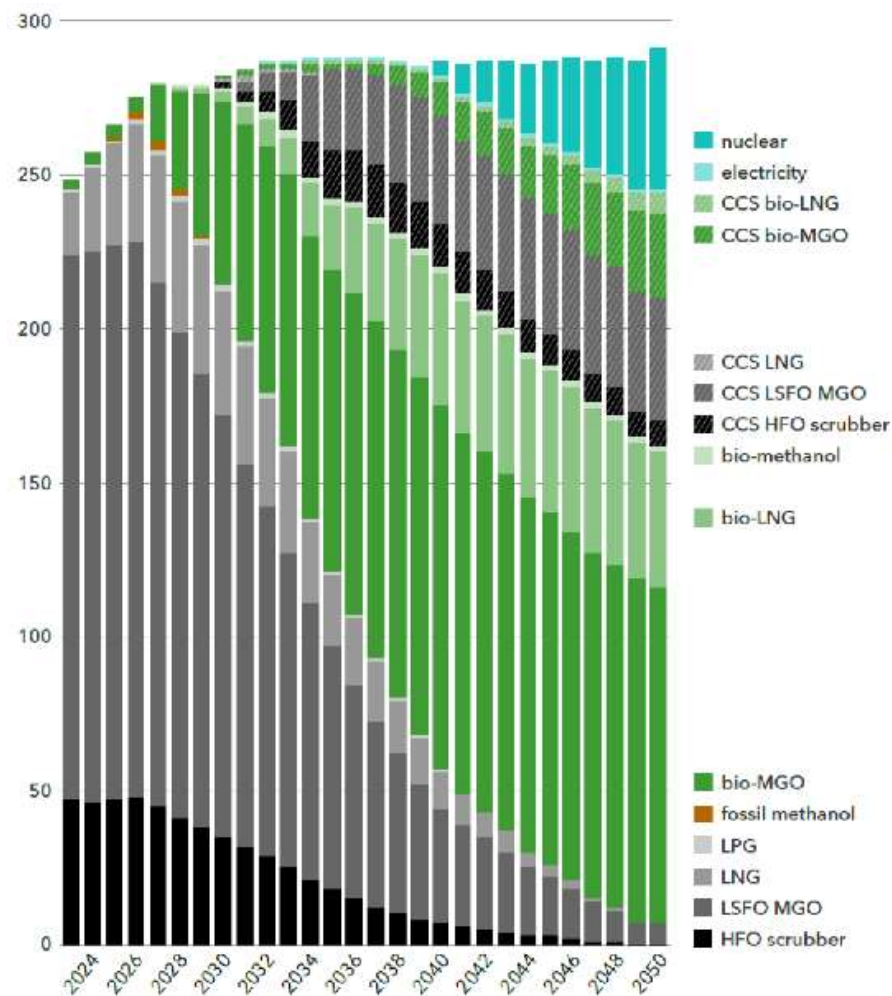
Green Corridors: Operationalizing Biofuel Transitions

- Analyse full value chains in real-world shipping
- De-risk adoption: Port-to-port fuel certainty
- Align standards, investments, and policy incentives
- Coordinate market stakeholders (port, fuel, engine, operator)
- Serve as models for broader scale-up
- Support policy: EU ETS, FuelEU Maritime, IMO GHG rules



DNV biofuel scenario (2024-08)

- Bio-methanol and bio-MGO dominate
- Rapid phase-out of fossil methanol
- Slow phase-out of (fossil) LNG
- Nuclear for near-shore
- BECCS for bio-LNG and bio-MGO as feasible
- CCS for LNG, MGO and HFO as feasible





Program of Work - Six Projects (2025 to 2027)

		P1 - Implementation Agenda (including Emerging Markets)	P2 - Advanced Biofuels Demonstration	P3 - Biofuels for Heavy Duty Transportation	P4 - SAF	P5 - Marine Biofuels	P6 - Synergies of biomass and electricity- based technologies for fuels
		Leader: Germany	Leader: Austria	Leader: Sweden	Leader: USA	Leader: Ireland	Leader: Germany
SP1 - Conversion Technologies, Markets and Deployment	Technologies and Deployment (Leader: Germany)	P1. 1	P2.1	P3.1	P4.1	P5.1	P6.1
SP2 - System Aspects, Biomass Supply, Sustainability	Sustainability, Certification, Sourcing, LCA, TEA, Efficiencies, Policies (Leader: Austria)	P1.2	P2.2	P3.2	P4.2	P5.2	P6.2
SP3 - Outreach and Dissemination	Cross-cutting activities, partnerships, preparation of dissemination materials, factsheets, infographics, press releases, dashboard, database and Task 39 Magazine (Leader: Sweden)	P1.3 (Biofuture Platform, UNIDO)	P2.3 (Task 33, Task 34, Task 42)	P3.3 (AMF, Sustainable Combustion TCP, IETS)	P4.3 (Task 33, Task 34, AMF TCP, Sustainable Combustion TCP)	P5.3 (IMO, Task 33, Task 34, DNV, AMF TCP, Sustainable Combustion TCP)	P6.3 (Task 33, Task 34, Task 37, Task 40, Task 45, AMF, Hydrogen TCP, possibly an Intertask activity)
Countries		Brazil, EU, Germany	Austria, China, Germany, USA	Brazil, USA, Sweden, Ireland	Belgium, Brazil, China, EU, Germany, Japan, the Netherlands, Sweden, USA, Norway	Brazil, EU, Ireland, the Netherlands, New Zealand, Sweden, Norway	Austria, Germany, USA

Biomethane (2025): Drop-In Renewable Gas for Marine Use

- Availability: Municipal & agricultural waste; proven digester technology
- Scalability Barriers: Feedstock aggregation, methane slip, small-medium scale
- Sustainability: Cost competitiveness, high GHG reduction if methane capture is optimized
- Infrastructure Synergy: Compatible with LNG vessels & port systems
- Green Corridor Example: Viking Line Group-LBG trial, Rotterdam-Singapore Green and Digital Shipping Corridor (GDSC) initiative.
- Technology Examples: Havila Voyages methane-electric hybrid cruise ships, Wasaline transition to 2030 in agreement with Gasum.
- Next Steps: Policy credits for avoided emissions; methane slip reduction



Bio-Ethanol (2026): Liquid Biofuel with Global Supply Potential

- Availability: Abundant 1G & 2G feedstocks (corn, sugarcane, residues)
- Scalability Barriers: Engine compatibility, safety codes (IGF), cost
- Sustainability: Must avoid food vs. fuel conflict; **RED II certified**
- Infrastructure Synergy: Uses existing tanks, pipelines, barges
- Industry Activity: [Wärtsilä-Raízen trials](#)
- Mitigation: Incentivize dual-fuel retrofits; fast-track IMO code adoption



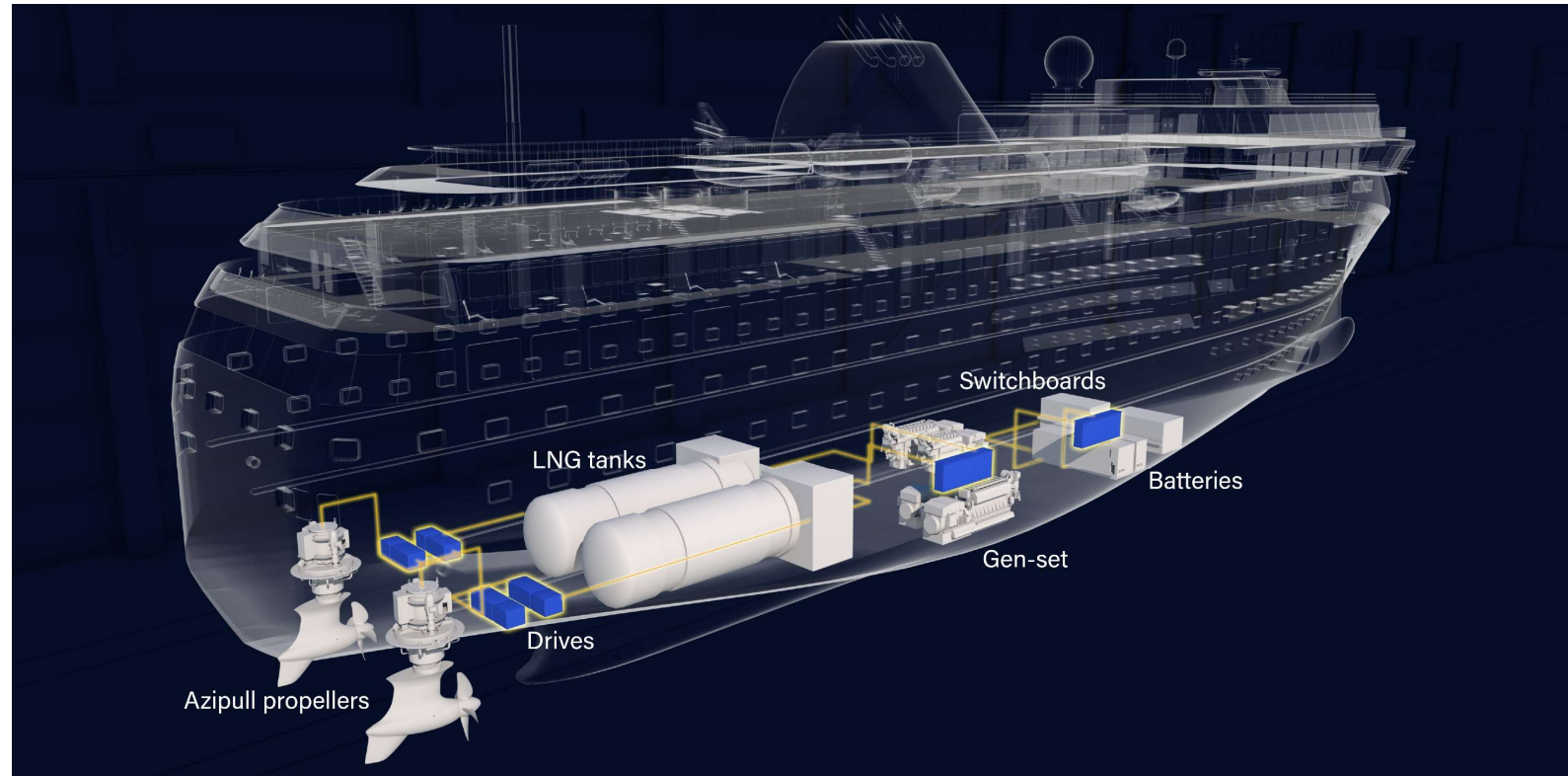
E-Methanol (2027): Synthetic Fuel for Last Mile Decarbonization Efforts

- Availability: Tied to renewable electricity & captured CO₂
- Scalability Barriers: Electrolyzer cost, CO₂ sourcing, CAPEX intensity
- Sustainability: Zero-carbon pathway if powered by green inputs
- Infrastructure Synergy: Ambient liquid- fits existing bunkering
- Market Signal: European Energy e-methanol plant, Maersk's methanol ships - EU FuelEU regulation support
- Mitigation: Targeted green corridors - LCOF + MAC metrics to assess cost-effectiveness



Plug-in
hybrid -
LNG/LBG
& battery

Havila
Voyages,
Norway -
existing
ship



Wind-assisted Propulsion Systems under implementation for 2024-2025 - EU supported projects



7-10% reduction of fuel consumption for one wing on a RO-RO vessel is possible



52 seagoing ships now in operation and 97 newbuilds with WAPS ordered (as of January 2025)
DNV, 2025

Maersk invests in dual fuel methanol vessels and Green Methanol production



- Maersk has taken delivery of 18 new dual-fuel vessels with a total of over 300 000 TEU
- Maersk has agreed with Japanese energy company ENEOS and A.P. Moller Holding to jointly invest \$100 million in green methanol project developer C2X, primarily to fund the final development phase of the Beaver Lake Renewable Energy (BLRE) plant in Louisiana, with a planned production of 500,000 metric tons of green methanol per year.

IMO FutureFuels by DNV - focus on ships and molecules



Powered by DNV Alternative Fuels Insight
Visit [Alternative Fuels Insight here](https://futurefuels.imo.or)

Overview

LNG

Methanol

Ammonia

Hydrogen ICE

Fuel Cell

LPG

Battery

Scrubber

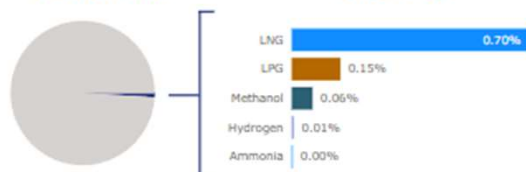
Percentage of ships in operation

Conventional fuels

99.08%

Alternative fuels

0.92%



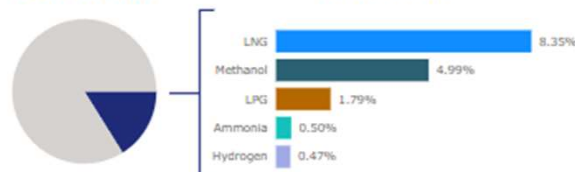
Percentage of ships on order

Conventional fuels

83.90%

Alternative fuels

16.10%



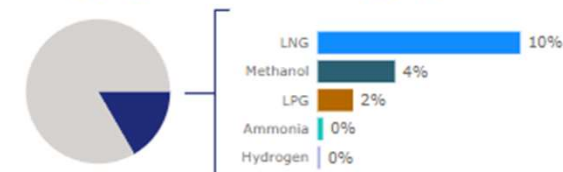
New contracts in the last 12 months

Conventional fuels

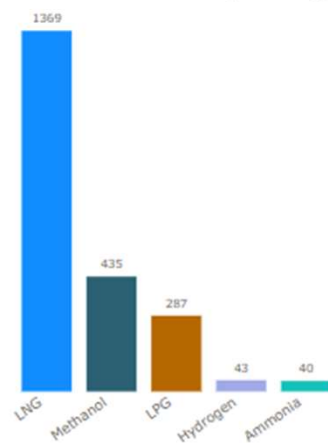
83%

Alternative fuels

17%

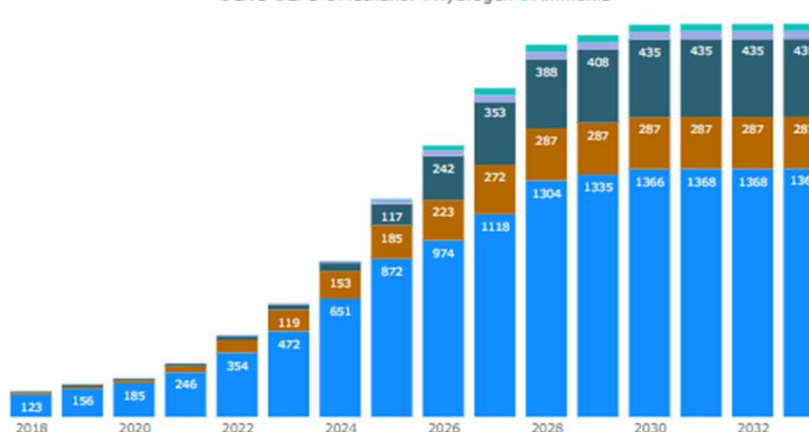


Number of vessels by fuel type



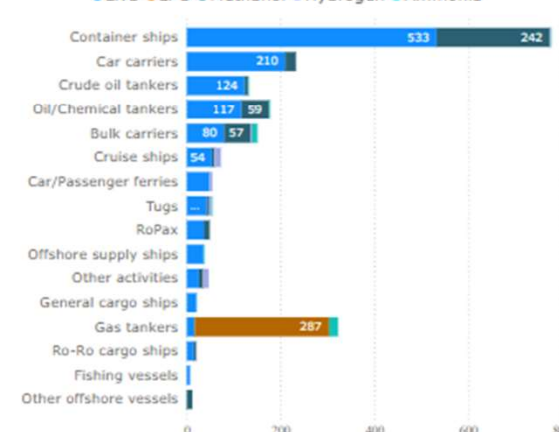
Growth of alternative fuel uptake by number of ships

● LNG ● LPG ● Methanol ● Hydrogen ● Ammonia



Number of vessels by fuel type

● LNG ● LPG ● Methanol ● Hydrogen ● Ammonia



<https://futurefuels.imo.or>

Key recommendations

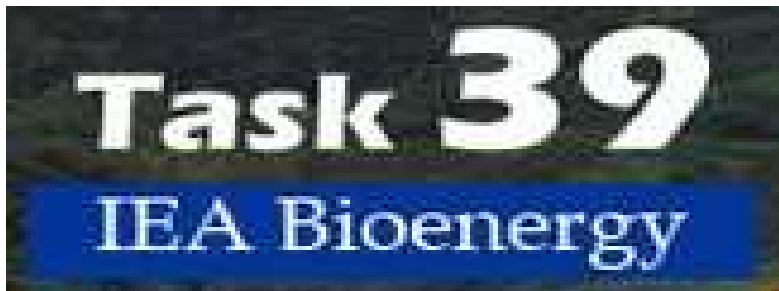
- **Availability, Scaleability and Sustainability** should be the framework for analysis and implementation across each biofuel value chain from feedstock to production technology to biofuel use. **Green Corridors** is an integrated means to test and demonstrate.
- **Research, innovation and commercialisation policy** should focus on the **bucket to barrel** sector if it is to have an impact in terms of availability by 2030.
- **Risk Mitigation:** Electric, Biofuels and Efficiency measures go hand in hand. The combustion engine will not go away quietly. Scenario planning - what if the lights are switched off?

Thank you!

Tom Walsh

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IEA Bioenergy
Technology Collaboration Programme

www.ieabioenergy.com

Technology Collaboration Programme
by **iea**

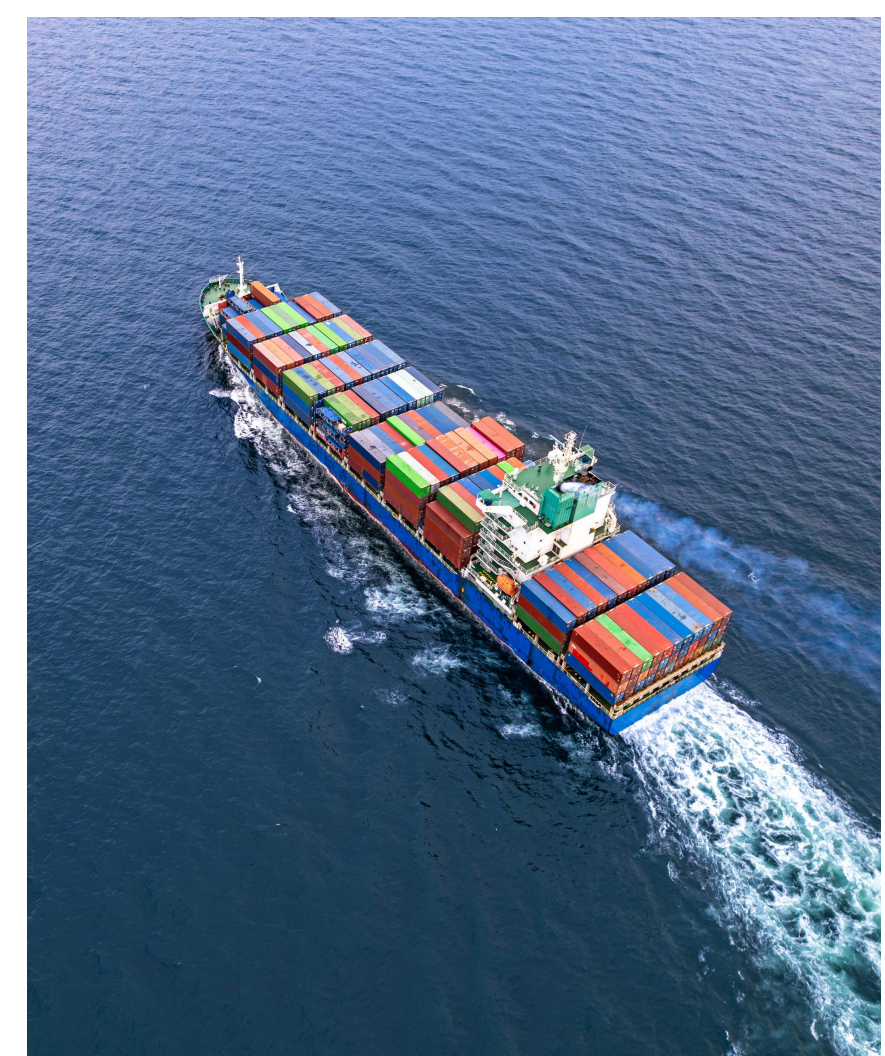
Sanjukta Subudhi

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Energy and Resources
Institute (TERI) , IFGE

Indian maritime
biofuel landscape and
scientific
advancements in
marine biofuels



MARINE BIOFUELS WEBINAR: Sailing Towards a Sustainable Future



'Indian maritime biofuel landscape and scientific advancements in
maritime biofuels'

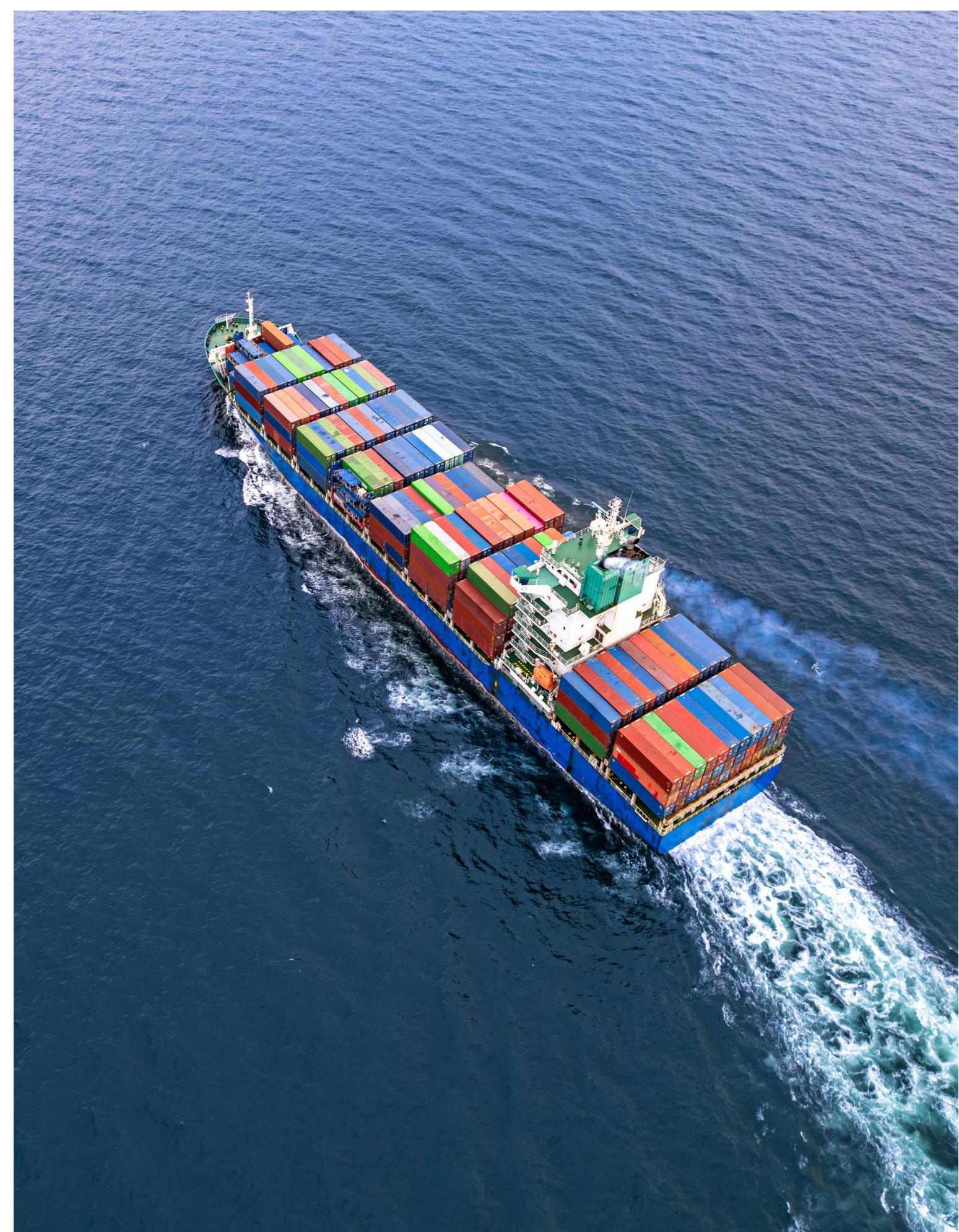
Dr. Sanjukta Subudhi (ssubudhi@teri.res.in)

26/August/2025

THE ENERGY AND RESOURCES INSTITUTE (TERI), India

CONTENT

- ✓ About TERI
- ✓ Indian Maritime landscape and Net zero goal
- ✓ List of Drop in biofuels
- ✓ Green Initiatives on Adoption of drop in Biofuels in Indian Maritime sector
- ✓ Harmonization of Biodiesel standard

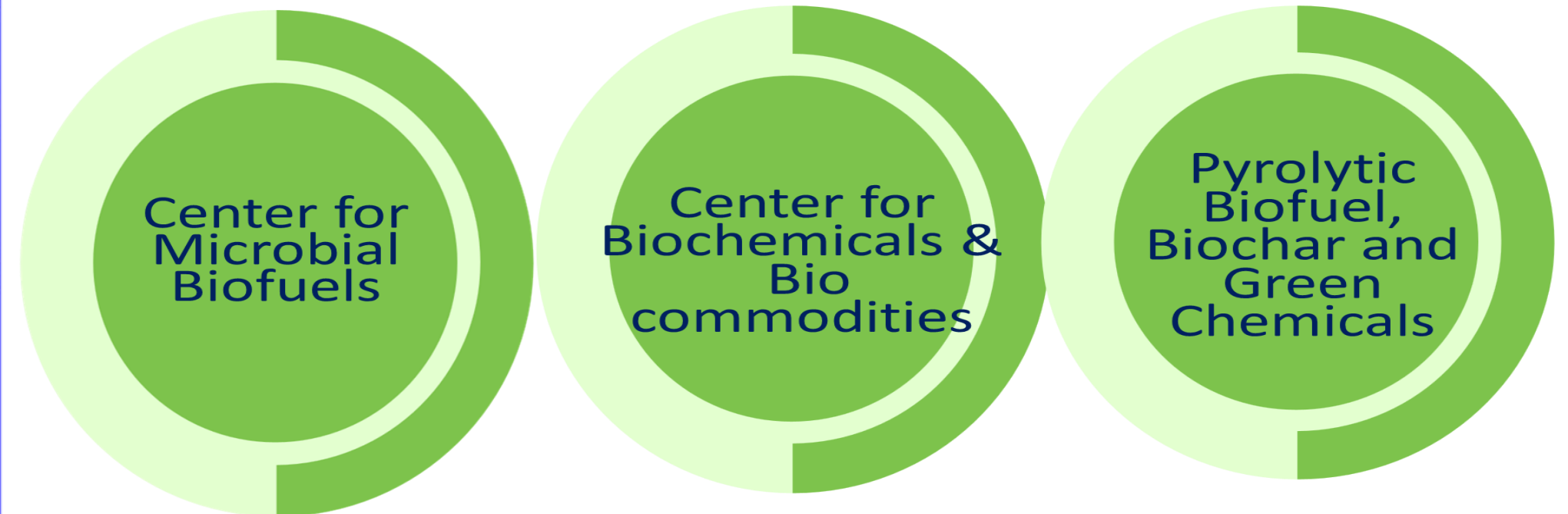
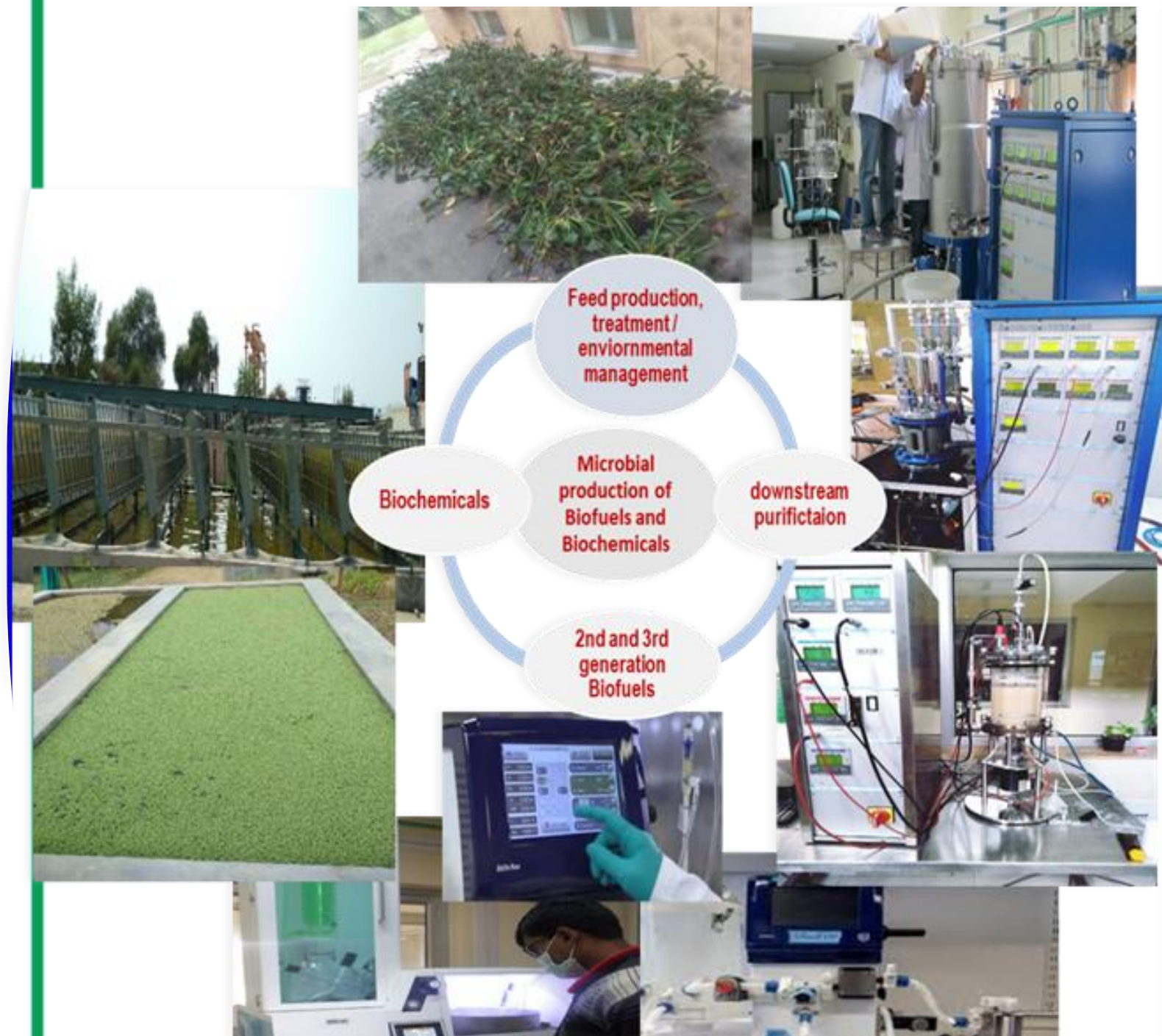


The Energy and Resources Institute (TERI)

- ✓ The Energy and Resources Institute (TERI) is an independent, research organization, headquartered in New Delhi, with regional centers in Gurugram, Bengaluru, Guwahati, Mumbai, Panaji, and Nainital.
- ✓ TERI is powered by a 1,000+ multidisciplinary team of scientists, engineers, economists, and sociologists
- ✓ Over five decades, TERI has established itself as a research leader, developing evidence-based, science-backed interventions
- ✓ Our work spans cutting-edge innovations in renewable energy, Green shipping, Biofuels, climate change and air quality, water, sustainable agriculture, sustainable infrastructure,
- ✓ As a think tank, TERI has aligned itself with global and national priorities, including India's ambitious net zero targets,



The Energy and Resources Institute: Advanced Biofuels research



India's Maritime Landscape



- ✓ India has a 7,500 km long coastline with 12 major and 200+ non-major ports, making it one of the world's largest maritime nations.
- ✓ Around 90% of nation's trade volume is carried by sea, highlighting this sector's significant contribution to India's economic growth. India has taken proactive measures, such as the Sagar Mala Program, National Waterways Act, and Inland Vessels Bill, to foster the development of this sector.
- ✓ With strategic geographic positioning, India aspires to be a global shipping and logistics hub, serving as a trade gateway for Asia and beyond.
- ✓ Total marine fuel consumption by Indian ships accounted for 1.24 million tonnes (2022), comprising HFO Heavy Fuel Oil), MDO (Marine Diesel Oil), and MGO (annual energy consumption of 55.8 Quadrillion Joules (QJ).
- ✓ HFO/MDO/MGO demand is projected for 1.43 million tonnes in 2030. The long-term trajectory expected for a gradual decline in conventional fuel use, replaced by green fuels, LNG, hydrogen, ammonia.

India's Commitment to Sustainable Maritime Development

Vision 2047: Ports of the Future

- The Maritime India Vision 2047 sets a roadmap for world-class, green, & digital ports.

- ✓ India's shipping sector has set ambitious goal to reduce carbon footprint with a target to achieve net zero goal by 20270.
- ✓ Aims to achieve net zero emissions at all major ports by 2047
- ✓ Decarbonization strategy:
 - To reduce Green House Gas emissions through use of mix of green fuels; Biofuels, Green hydrogen, Green ammonia and LNG and synthetic fuels including methanol (bio and E-methanol)



National Center of excellence on Green Ports and Shipping (NCoEGPS)



Ministry of Ports, Shipping and Waterways (MoPSW), Government of India, established **National Centre of Excellence for Green Port and Shipping (NCoEGPS)** at The Energy and Resources Institute (TERI).



(i) Paradip Port Trust (ii) V. O. Chidambaranar Port Trust (iii) Deendayal Port Authority (iv) Cochin Shipyard Limited

- To promote carbon neutrality and the circular economy (CE) in the Indian maritime industry, this center conducts a variety of studies on policies and regulations that support green ports, green shipping, and the blue economy, as well as alternative technologies.



Wind Energy



Bio-Fuels



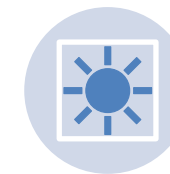
Fuel cell for Long Haul Shipping



Hydrogen Storage Tanks



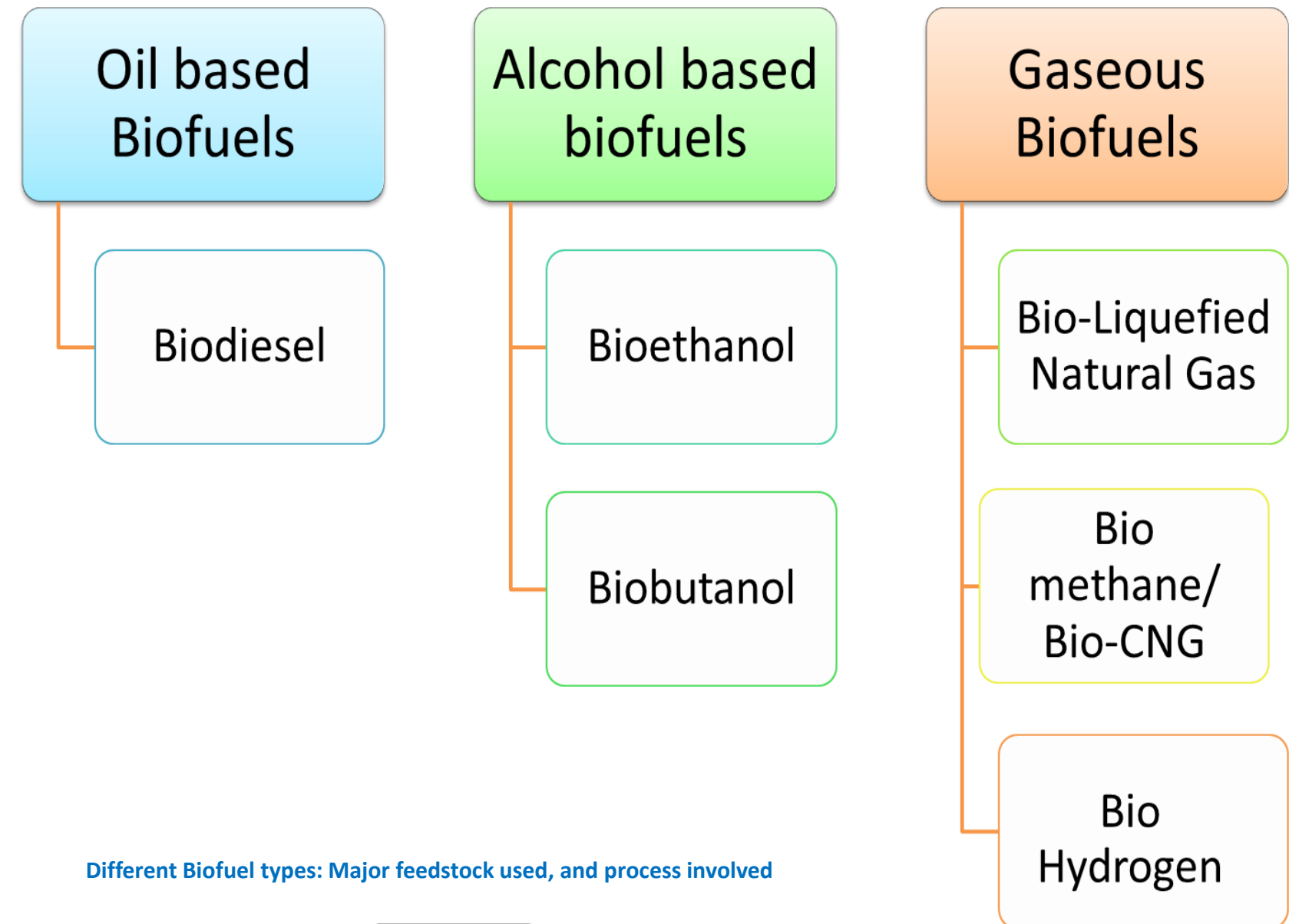
Green Ports



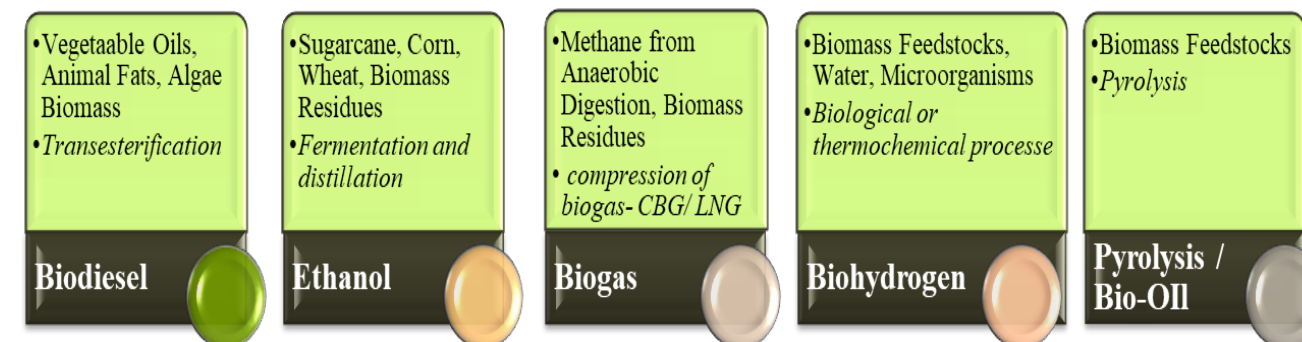
Solar Power

India's Maritime biofuel Landscape

- ✓ India's is promoting green shipping initiatives including use of biofuels, green hydrogen and ammonia
- ✓ Liquid and gaseous biofuels such as; Biodiesel, bioethanol, bio-butanol, Bio-methanol, bio-methane/ bio-CNG, biohydrogen and bio-LNG, have great potential for adoption in maritime transportation. **IMO frameworks encourage India to scale LNG and biofuel adoption in the 2030 horizon**
- ✓ Liquid biofuels are '**technologically ready**' drop in fuels for existing engines and do not require retrofitting, (can be produced from renewable biobased resources/ biomass).
- ✓ Biodiesel (oil based liquid biofuel) has similar properties like that of conventional marine fuels and thus can be **used directly as drop in fuel for blending in marine fuel**



Different Biofuel types: Major feedstock used, and process involved



Drop-in Biofuels

Drop-in biofuels are liquid bio-hydrocarbons that are functionally equivalent to petroleum fuels and are fully compatible with existing petroleum infrastructure”.

Characteristics: drop-in biofuels generally consist of a mixture of many different types of hydrocarbons, the properties of which, just like petroleum fuels, are typically characterized by the functional characteristics of the mixture, such as distillation profile, viscosity, acidity, etc.

Production Process: drop-in” biofuels can be produced, continue to be summarized in the four broad categories below:

- Oleochemical,
- Thermochemical,
- Biochemical, and
- Hybrid pathways

Marine Diesel & Renewable Diesel

Fuel property	MDO (ISO 8217 DMB)	MGO (ISO 8217 DMA)	RMA10 Diesel Fuel	Diesel fuel ASTM D975 (Elgharnawy et al., 2021)	Biodiesel ASTM D6751(Elgharnawy et al., 2021)	Diesel	FAME Biofuel	Soybean Methyl ester oil Sme (B20)	Jatropha Biodiesel (B20)	Spirulina biodiesel (B20)	Waste Plastic Pyrolysis oil (wppo) B20	LNG (Sagin et al., 2023)	Petroleum Gas (Sagin et al., 2023)	Hydrogen (Sagin et al., 2023)	Mixture of alcohols (methanol and ethanol) (Sagin et al., 2023)	Ethanol (Wang and Li, 2022)
Viscosity at 40 °C (sSt)	2 to 11 (mm ² /s)	2 to 6 (mm ² /s)	12	2.5	1.9-6	0.003 (Pa.s)	15	0.0041 (Pa.s)	0.0048 (Pa.s)	0.0036 (Pa.s)	0.017 (Pa.s)	-	-	-	-	1.2 (Mpa.s)
Density at 15 °C (kg/m ³)	<900	<890	865	850	-	830	850	839.6	839.234	836.17	826.98	0.7 (gas)	1.8-2.5 (gas)	0.1 (gas)	790-800	790
Sulphur content (%)	-	-	0.09	10(ppm)	500 (ppm)	0.025	0.02	0.0011	0.0024	0.0014	0	-	-	-	-	-
Calorific value (MJ/ kg)	42	-	-	45	37.3	42.5	-	41.39	42.53	42.28	43.29	50	47.5-48.5	120-140	22.5	26.8
Cetane number	>40	>35	-	40-55	65	48	-	48.68	52.7	51	51	-	-	-	-	8

Renewable/ Green Diesel

Fuel property	RMA10 Diesel Fuel	FAME Biofuel	Diesel	Soyabean Methyl ester oil Sme (B20)	Jatropha Biodiesel (B20)	Spirulina biodiesel (B20)
Viscosity at 40 °C (sSt)	12	15	0.003 (Pa.s)	0.0041 (Pa.s)	0.0048 (Pa.s)	0.0036 (Pa.s)
Density at 15 °C (kg/m ³)	865	850	830	839.6	839.234	836.17
Sulphur content (%)	0.09	0.02	0.025	0.0011	0.0024	0.0014
Calorific value (MJ/ kg)			42.5	41.39	42.53	42.28
Cetane number	-	-	48	48.68	52.7	51

Indian Maritime Landscape: Initiatives Adoption of biodiesel in maritime transportation

- Considering the IMO's Net zero goal, Directorate General of Shipping (DGS) in India, issued Merchant Shipping Notice No. 16 of 2023, in November 2023 for use of biofuels and their blends on Indian Ships.
- DGS permits Indian ships to use biofuels, and their blends as drop in fuels. Additionally, this notice specifies specifications for liquid drop-in biofuels that are compatible with heavy fuel oil (HFO), light diesel oil (LDO, DMB), and marine gas oil (MGO).

Requirements biofuel and its blends supplied to Ships

Biofuels	Standard	Parameters
Biofuel Blend	ISO 8217 (MARPOL ANNEX VI)	❖ Lubricity ❖ Oxidation stability ❖ Kinematic viscosity ❖ Cold-flow properties only for biofuel component ❖ Water content ❖ Acid number ❖ BDN shall incorporate only density, viscosity, water content, Sulphur, flash point and acid number.
FAME biodiesel and blend	EN 14214 Liquid petroleum products	
Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels standards	ASTM D6751 Standard Specification	
HVO biofuels and biofuel blends	EN 15940 Automotive fuels	

For liquid biofuel as drop in fuel, flash Point recommended by DG shipping:

- ❖ **Not less than 60°C.**
- ❖ determined by a closed cup test in accordance with [ISO 2719](#)
[Determination of flash point – Pensky- Martens closed cup method.](#)
- ❖ [Bunker Delivery Note](#) should state the flash point of biofuel used

Sustainability Certification

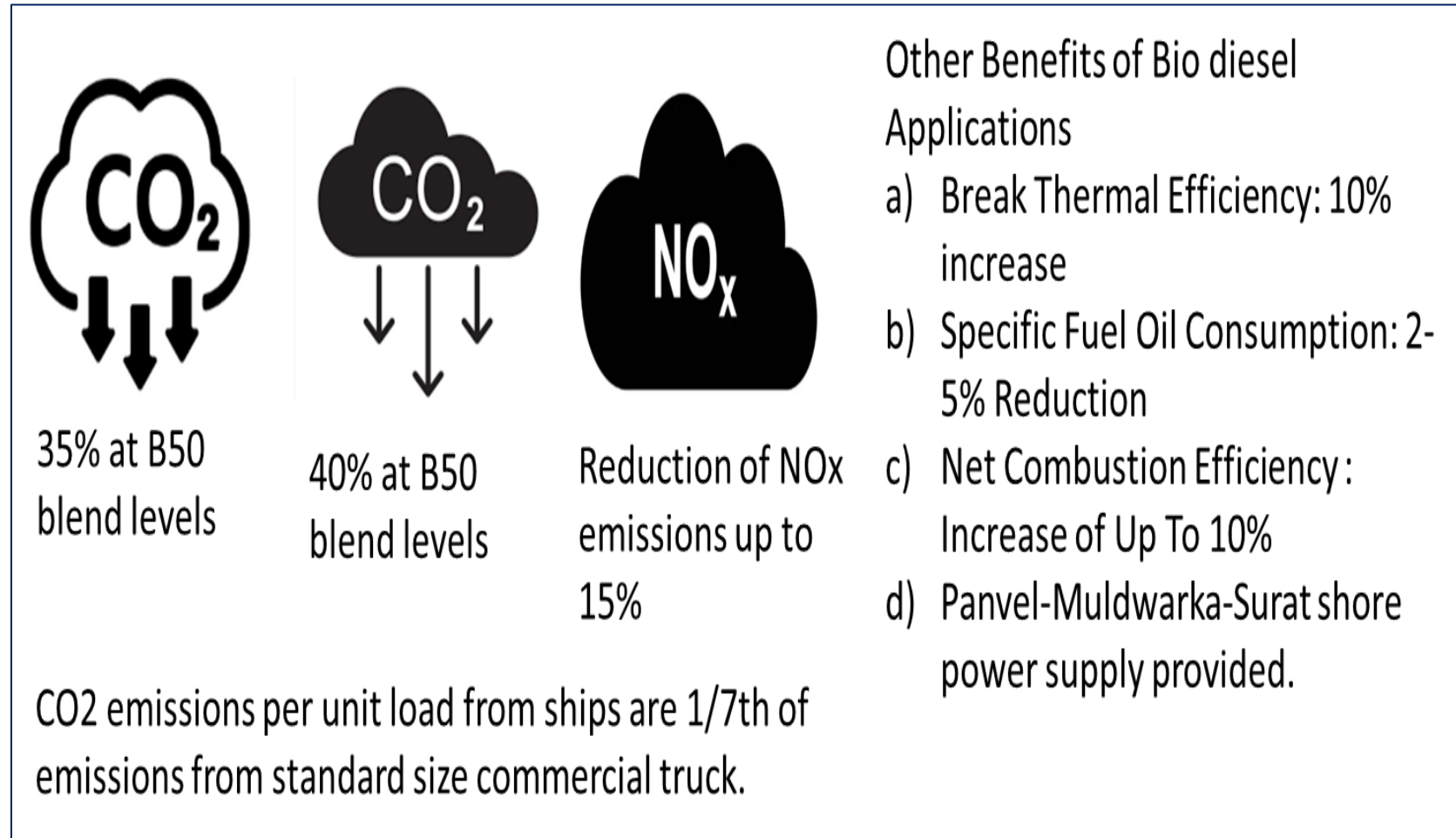
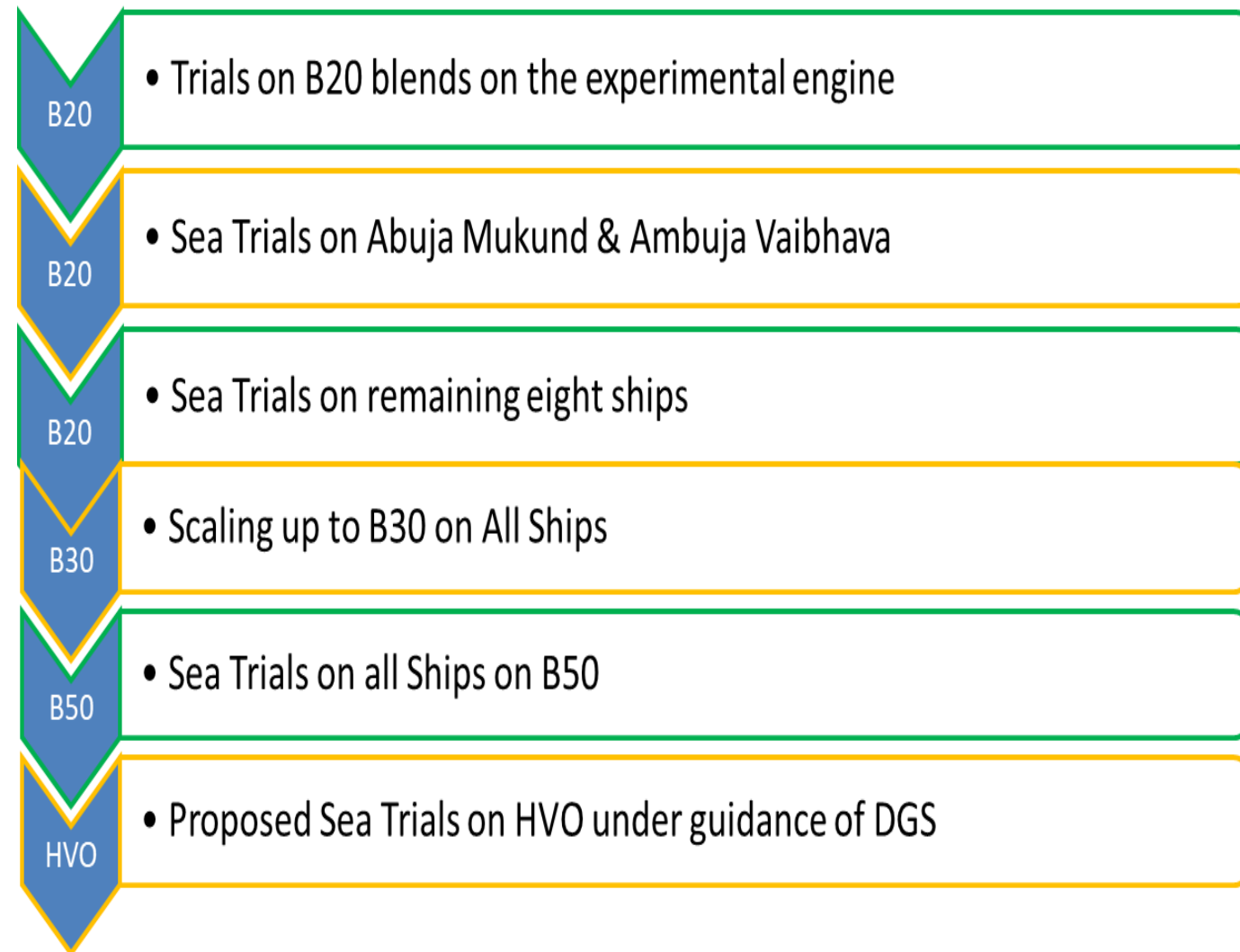
- ❖ **No biofuels shall be supplied to ships in unblended or blended form without having been certified** by an international certification scheme, meeting its sustainability criteria.
- ❖ **A Proof of Sustainability or similar documentation mentioned above should be provided** along with the Bunker Delivery Note

Biofuel blend trial case studies

Under the directives of DGS Biodiesel blend trial (B20-B-50) studies were conducted by two major shipping companies of India;

- ✓ Ambuja Shipping Servies Ltd. (Ambuja Cement) and
- ✓ Great Eastern Shipping Co. Ltd.,
(in coordination with Indian Registrar of Shipping).

Case studies on biodiesel blend trial done by Ambuja shipping services Ltd. (ASSL)



Impact of B30 blend trial on GHG emission reduction and engine performance

Case studies on biodiesel blend trial done by Great Eastern Shipping Company Ltd. (GE)

BIOFUEL Blend trial

- GE did India's first trials on an MR tanker in international waters using biofuel Blended VLFSO (B20 - derived from UCO).
- No challenges were faced during the trials.

Impact:

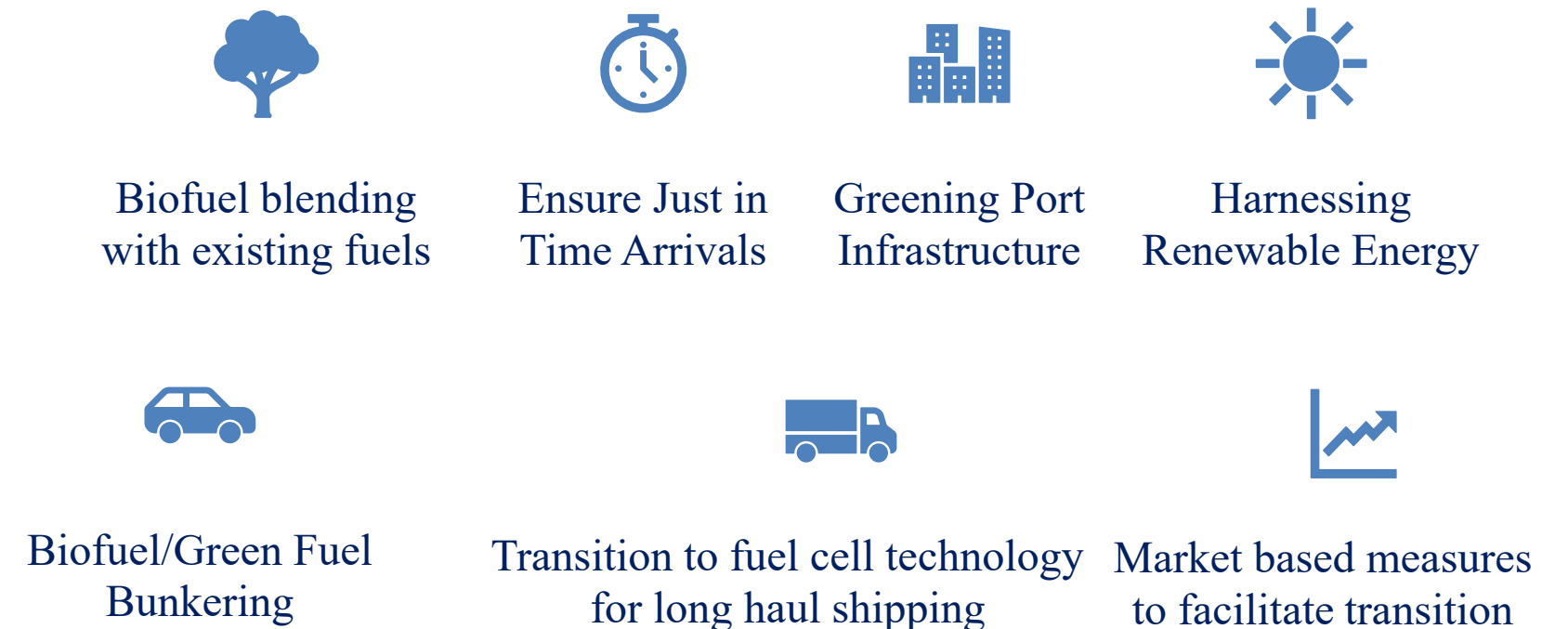
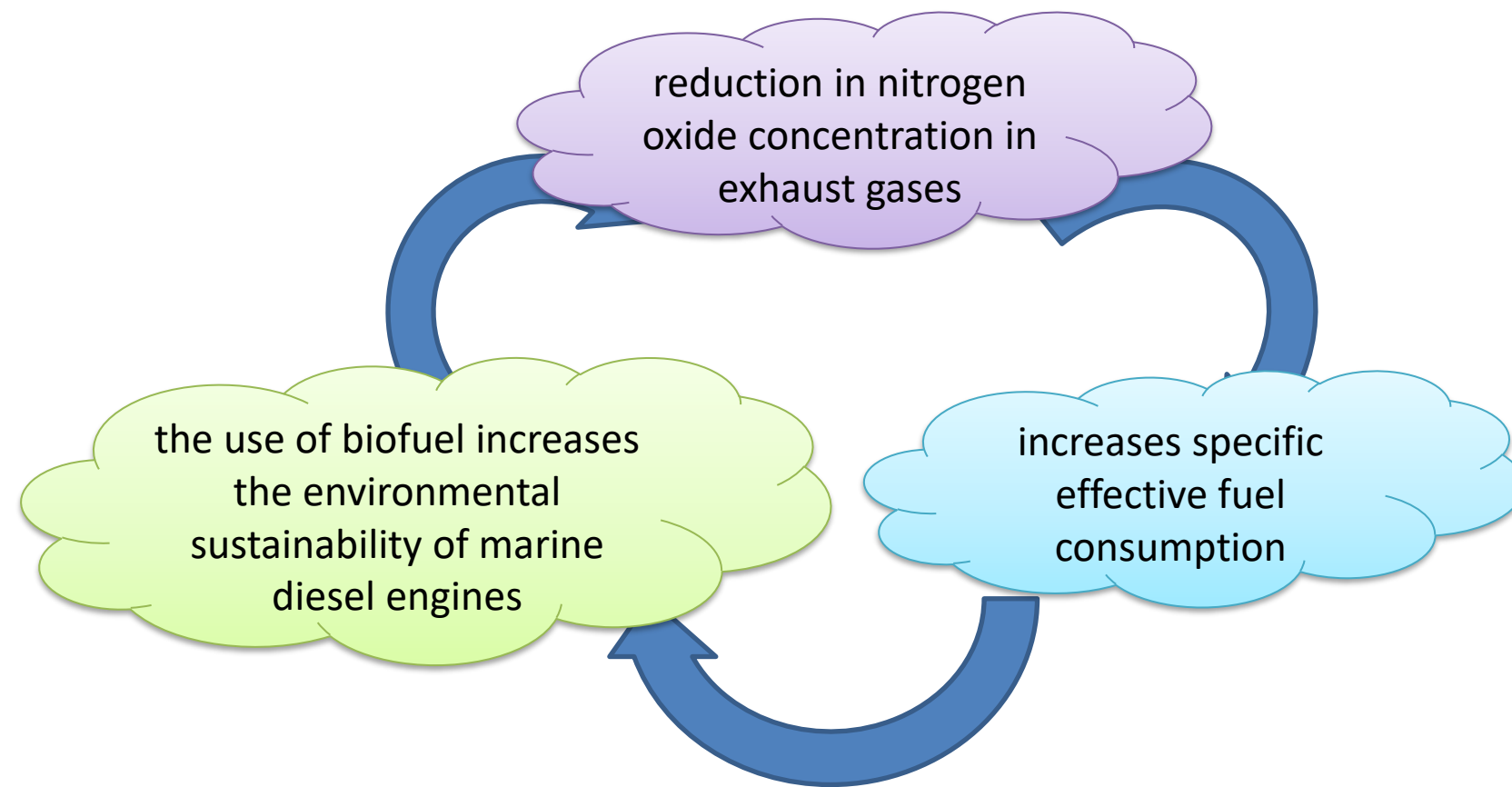
- CO2 Emission Reduction 80-90% compared to VLSFO /LSMGO. (depending on Blend Ratio)
- Can be used on all engines and fuel systems with less or no modification and expenditure.
- Faster implementation compared to all options with hardly any downtime for ships.

Results



- 1) No operational challenges faced by vessel while bunkering, handling and consumption of biofuel blend B20M.
- 2) Observed that for Main Engine NOx ppm was reduced by 3.75% during Loaded passage & 2.32% during Ballast Voyage as compared to VLSFO.
- 3) Reduction of 2.68% during Ballast voyage and 4.31% during loaded voyage was observed for CO2 emission (as per tank to wake). Considering life Cycle analysis as declared by the fuel supplier, the well to wake emission saving for CO2 was found to be approx.20 %.
- 4) For Auxiliary Engine the emission reduction for NOx was 12.62% and for CO2 it was 1.30%. Considering life Cycle analysis as declared by the fuel supplier, the well to wake emission saving for CO2 is found to be approximately 18 %.
- 5) For the Auxiliary Boiler there was reduction of 26.56% for NOx & reduction of 32.47% of CO2 as compared to the VLSFO, which is considerable if the percentage in savings as above for LCA is added up.

Indian Maritime Landscape: Green Initiatives



Harmonization of Biodiesel standard for adoption in maritime transportation;

- Based on the biodiesel blend trial studies, **Directorate General of Shipping, The Energy and Resources Institute and Ministry of Ports Shipping and Waterways**, took proactive initiatives in coordination with **Bureau of Indian Standard (BIS)** for harmonization of Biodiesel standard for adoption in Indian maritime sector keeping in line with ISO standard **ISO 8217: 2024**

Biofuel Bunkering : Pathway towards sustainability



भारत सरकार / GOVERNMENT OF INDIA
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
नौवहन महानिदेशालय, मुंबई
DIRECTORATE GENERAL OF SHIPPING, MUMBAI
DGS (Engineering) Circular No. 32 of 2025

File No. - 13-22011/5/2025-ENGG – DGS, C. No: 34580		Date: 22/07/2025
Subject: Biofuel Bunkering Guidelines		
References:	(1) Merchant Shipping Notice No. 03 of 2014 (2) Merchant Shipping Notice No. 14 of 2023	
1. Background		
1.1 Increasing global emphasis on decarbonising the maritime sector has accelerated the adoption of biofuels as a sustainable alternative to conventional marine fuels. Biofuels, particularly drop-in types such as Fatty Acid Methyl Esters (FAME), Fatty Acid Ethyl Esters (FAEE), Straight Vegetable Oils (SVO), Hydrotreated Vegetable Oils (HVO), Bio-FT-diesel (bio-Fischer-Tropsch diesel) and Biomass-to-Liquid (BTL) fuels, offer considerable benefits by reducing lifecycle greenhouse gas emissions without necessitating major modifications to existing shipboard fuel systems. However, the absence of standardised national guidelines for biofuel bunkering operations in India introduces potential challenges related to safety, fuel quality assurance, environmental protection, and operational consistency. 1.2 This proposed circular aims to bridge these gaps by establishing a clear regulatory framework for permitting, operational protocols, safety management, documentation, environmental safeguards, training requirements, and enforcement mechanisms specific to biofuel bunkering. By implementing these guidelines, the Directorate seeks to ensure safe and reliable bunkering practices, promote the use of cleaner fuels in alignment with India’s environmental commitments, and support the growth of sustainable maritime infrastructure. 1.3 These guidelines are crucial for facilitating the responsible uptake of biofuels in the shipping sector, aligning Indian practices with international conventions, and contributing to a modern, resilient, and environmentally conscious maritime ecosystem. 1.4 The Directorate General of Shipping (DGS), recognizing the critical need to reduce greenhouse gas emissions and improve air quality in Indian coastal waters and port regions, issues this circular to enable and regulate biofuel bunkering activities in accordance with established global standards and best practices.		

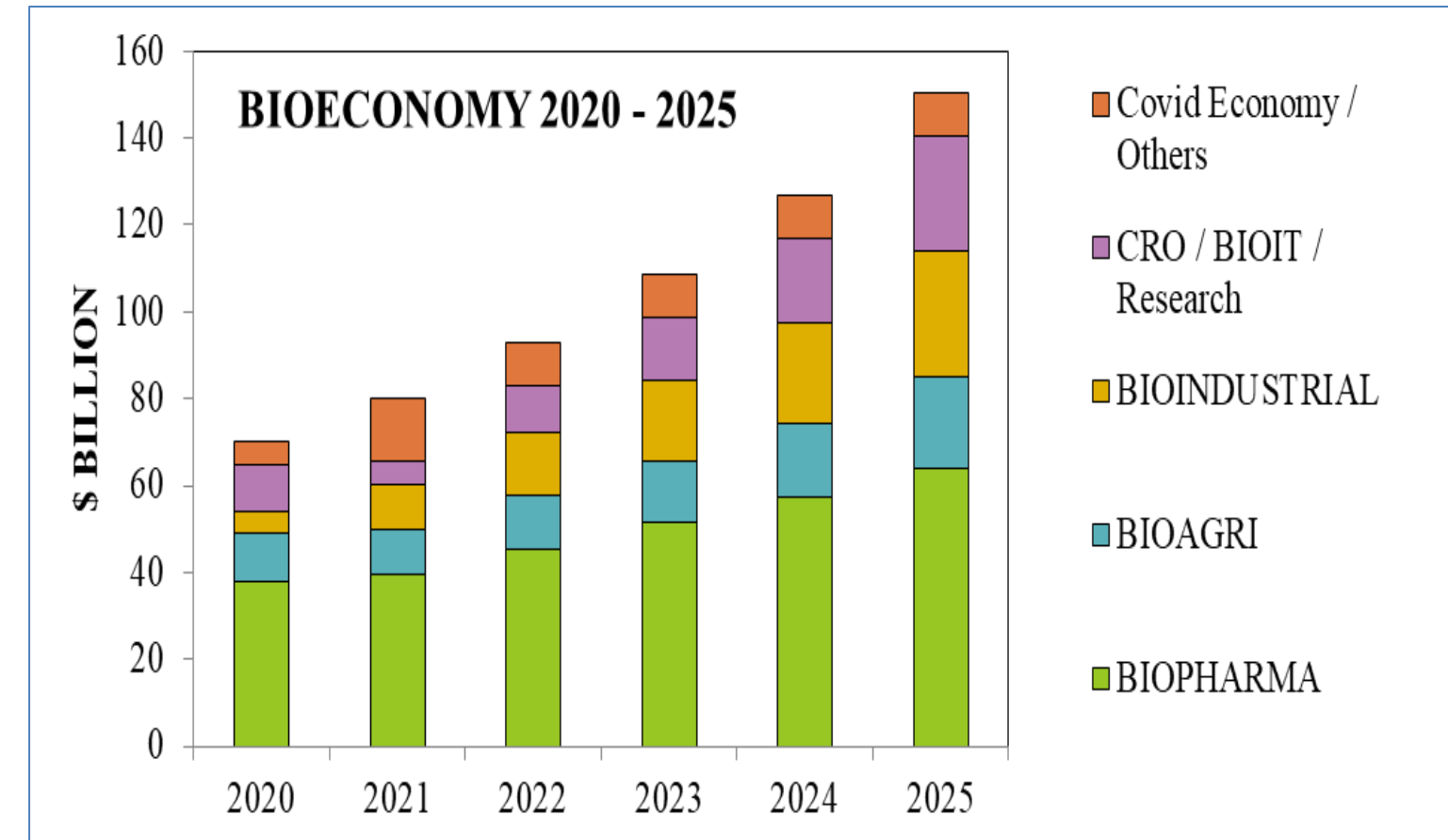
- ✓ Directorate General of Shipping, India published the biofuel bunkering guideline on 22/July/2025 that apply to all biofuel bunkering operations within Indian ports, anchorages, offshore facilities, and territorial waters,
- ✓ It covers Indian and Foreign flagged vessels receiving biofuels, as well as all entities involved in supply, storage and delivery of biofuels.

'Indian Biofuel Landscape: Scientific Advancements

Global Bioeconomy

Region / Country	Bioeconomy Value (USD Billion)	Key Sectors	Sources
India	165.7 billion USD (2024)	Biotech, Bio-agri, Bioenergy, Biopharma, Startups	PIB - BioSarathi Launch
USA	~1,000 billion USD (Estimated)	Biotech R&D, Genomics, Bio-manufacturing	Mentioned in comparison in IBER 2025 PDF
EU	~800 billion USD	Bio-based industries, Sustainable agri, Bio-innovation	Referenced in Indian Express
China	~700 billion USD (approx., 2023 Est.)	Synthetic biology, Biopharma, Bio-industrials	Cited in Entrepreneur
Brazil	~400 billion USD (includes agri-bio)	Bioenergy, Agro-biotech, Forest bioeconomy	Contextual mention in IBER 2025 PDF
Global (Overall)	>4 trillion USD (Est.)	Food systems, Renewable materials, Green energy	Highlighted as a global shift in ABLE India

India's Bioeconomy Landscape

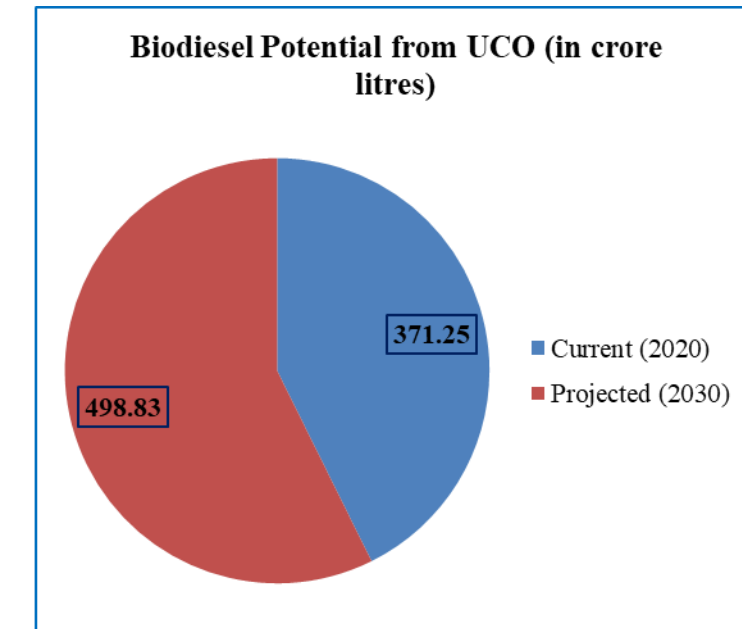
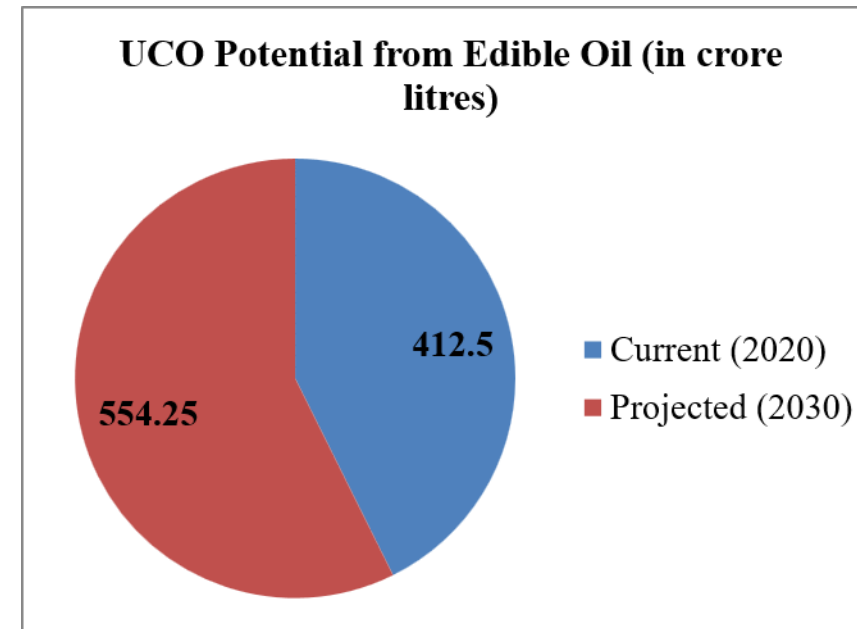


- Over last decade, India's bio-economy sector has shown exponential growth by 16-fold, starting from **\$ 10 Billion in 2014 to \$165.7 Billion in 2024**.
 - This sector is further projected to grow up to **\$300 billion by 2030**
- Driving factors;**
- Major segments contributing towards India's Bioeconomy growth are; BioPharma; Bio Agri & Bio-Industrial (Biofuels, Biochemicals, Bio-commodities), Bio-IT and Covid economy.
 - **Bio industrial sector including biofuels contributes for 47% bioeconomy growth**
 - India's vast surplus biomass availability can significantly contribute to enhance biofuel production capacity

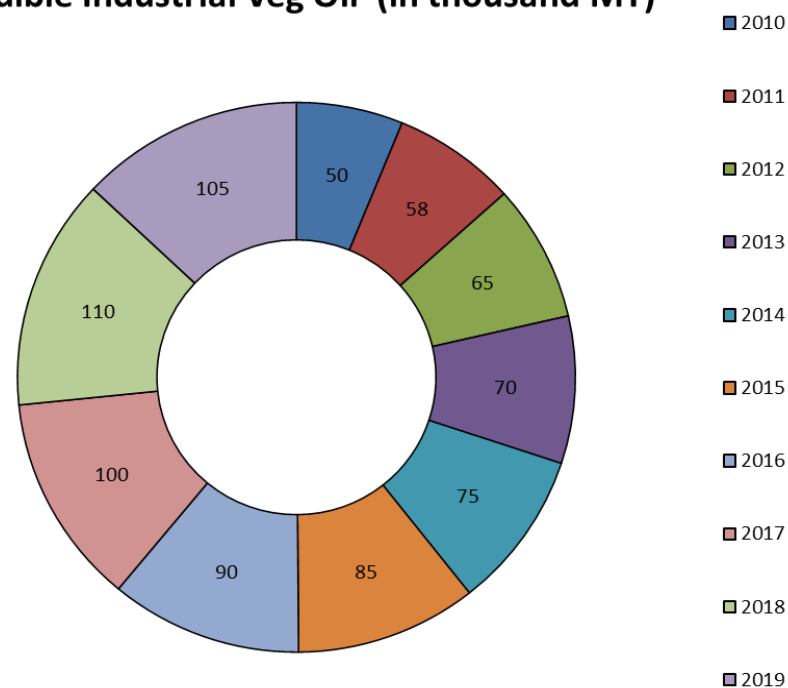
Biodiesel production and feed stock landscape

Biodiesel feedstock;

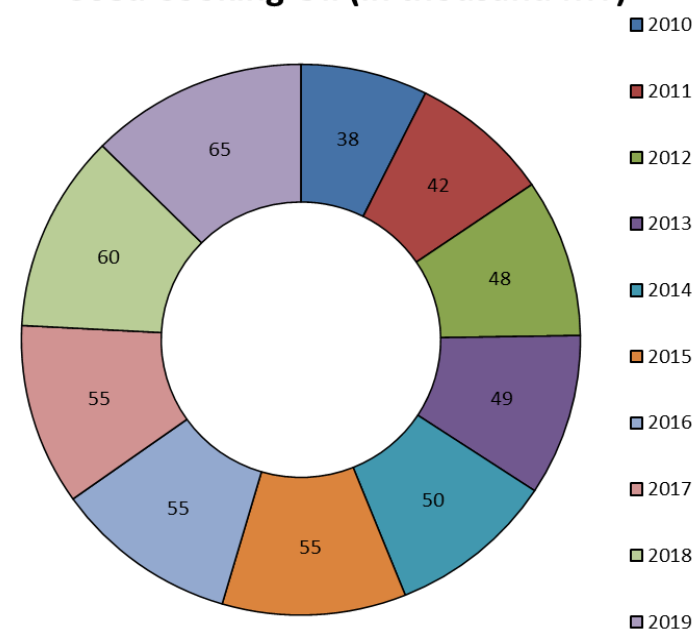
- ✓ Used Cooking Oil (UCO)
- ✓ Animal fat & tallow,
- ✓ Non-edible industrial vegetable oil
- ✓ Algae biomass
- ✓ Aquatic plant biomass



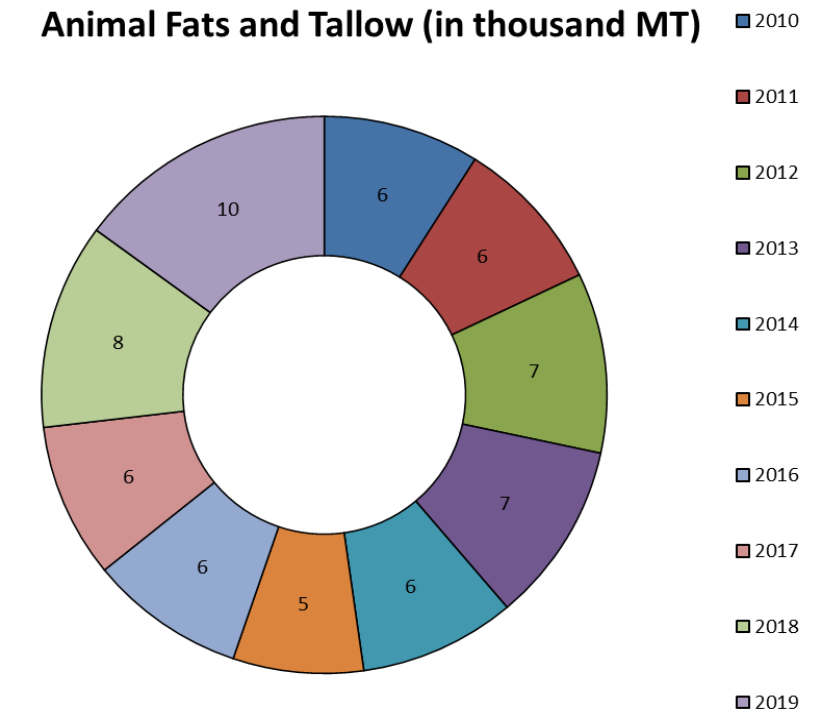
Non-Edible Industrial Veg Oil (in thousand MT)



Used Cooking Oil (in thousand MT)



Animal Fats and Tallow (in thousand MT)

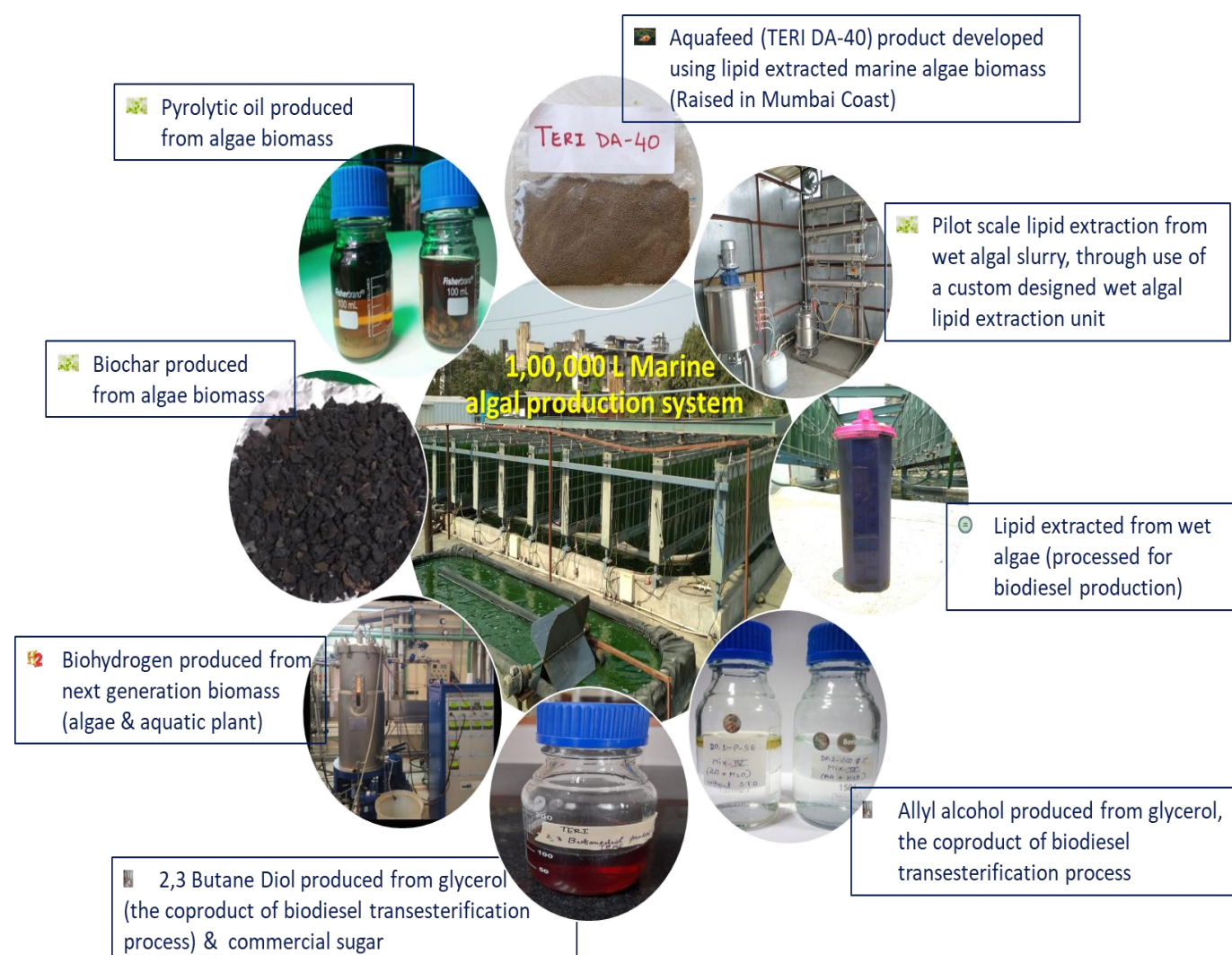


DBT-TERI Center of Excellence on Integrated production of Advanced Biofuels and bio-commodities

Scientific advancements in marine algae based advanced biofuel production

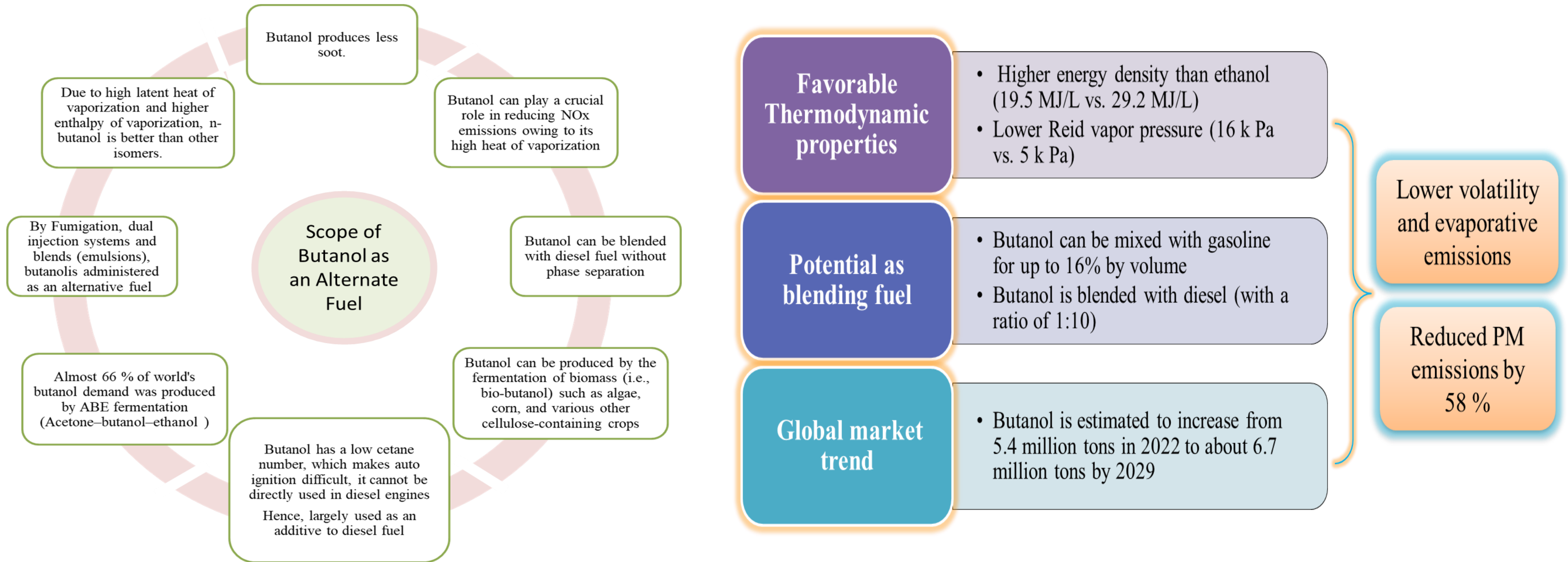


Marine algae cultivation In Mumbai coast in 100,000 liter scale specially designed photobioreactor



- 1.5 Mha land area (coastal sites across India) available for algal cultivation.
- Greta potential for marine alg2e cultivation across the coast for generation of energy algae biomass using saline water

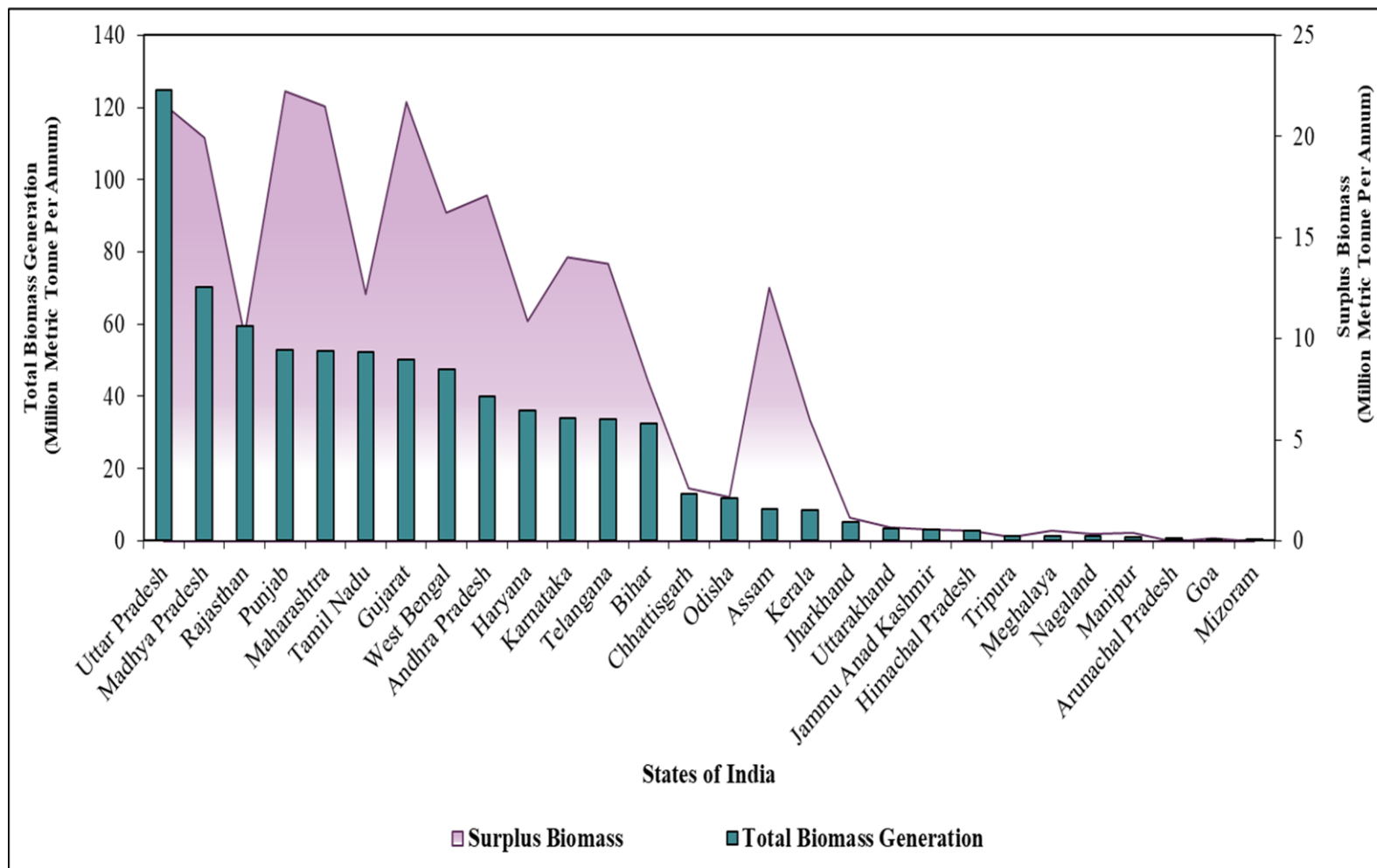
Potential of Bioa-lcohol (Biobutanol) for adoption in maritime transportation



- Biobutanol as drop-in fuel: 10% blending with marine fuel does not impact engines (secondary study data)
- Bioethanol as Drop-in fuel for maritime section: 7% blending with marine fuel does not impact engine performance beyond this it required additives (secondary data)

India's biomass landscape: Potential for contribution to India's Bioenergy basket

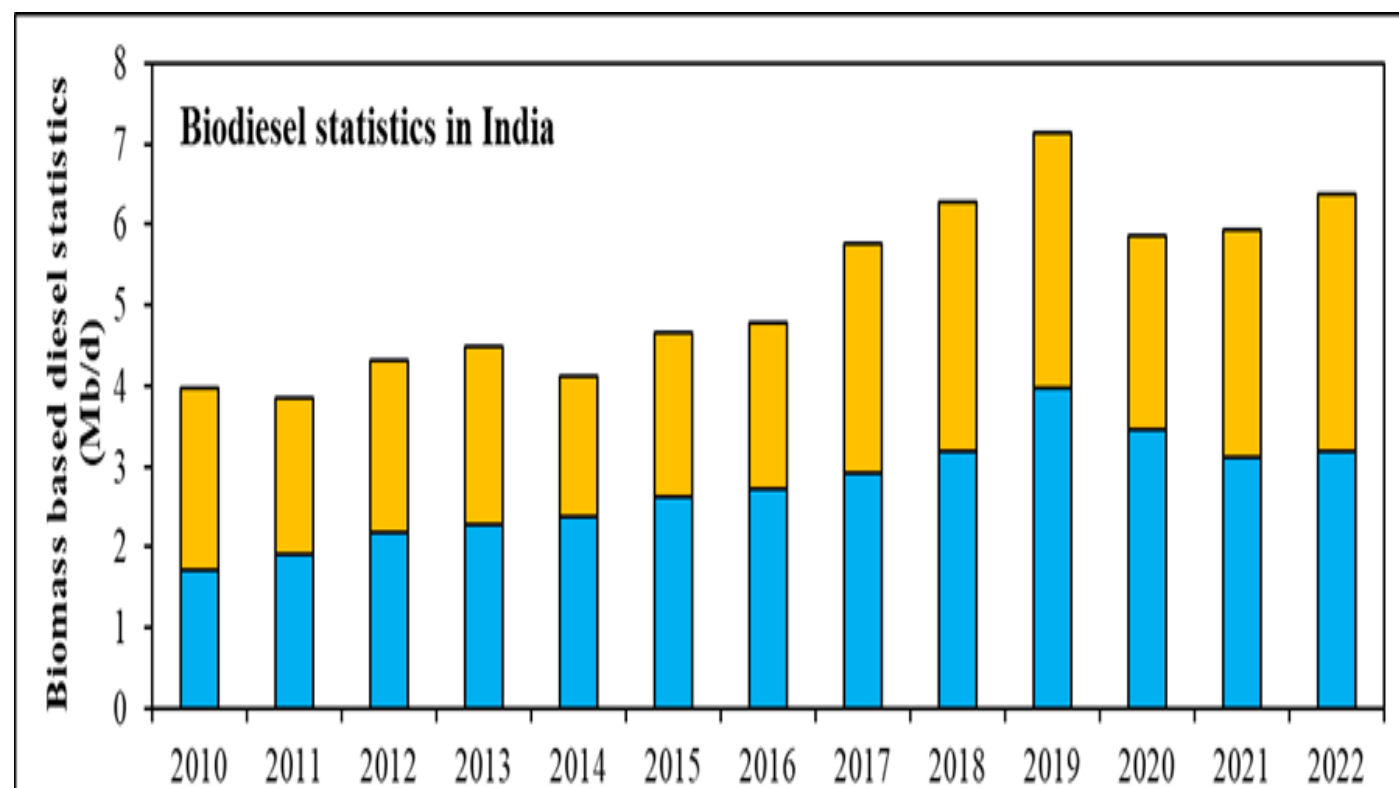
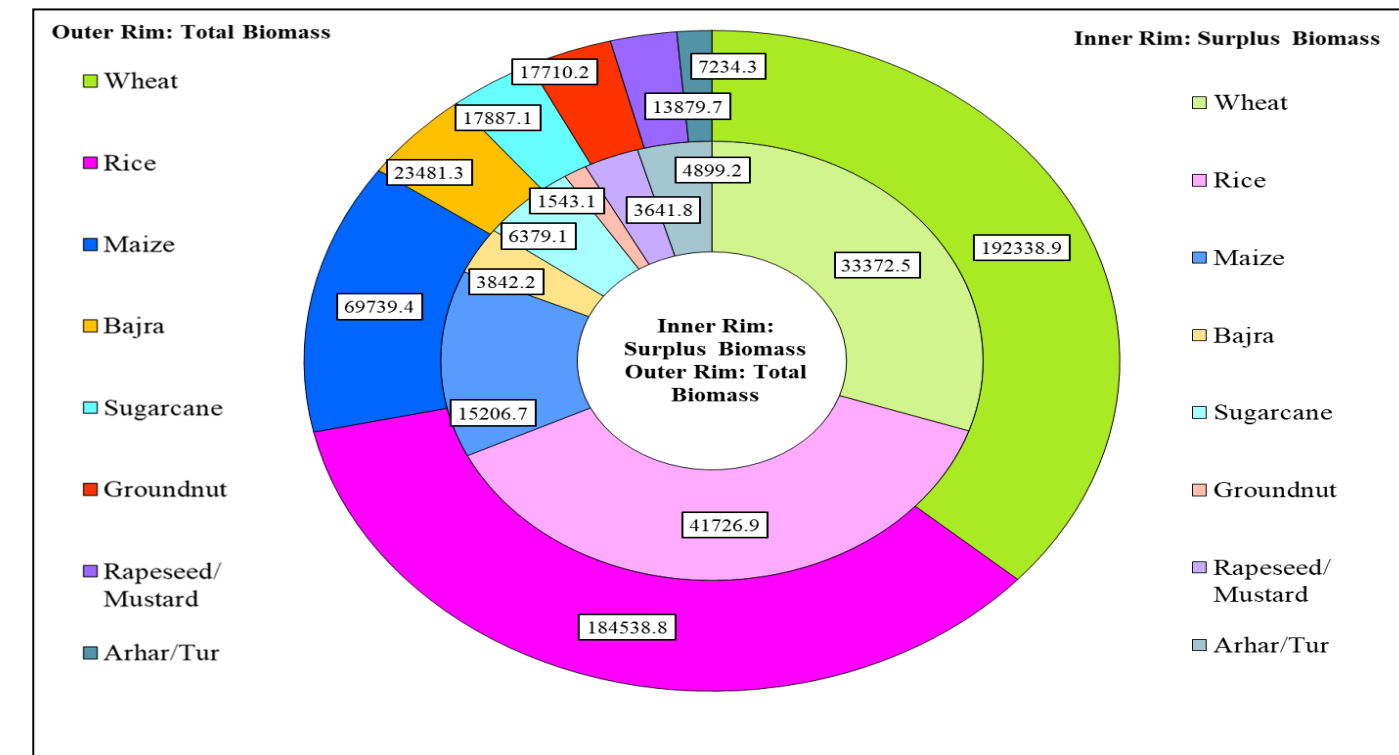
Biomass production capacity of India and availability of Surplus biomass



Biomass is available in the form of forestry waste, residue from agricultural operation, processed waste from industry, municipal/urban solid waste.

Annual Biomass production in the Country is around 750 MMT, out of which 228 MMT is surplus Biomass

TOTAL AND SURPLUS BIOMASS AVAILABLE FROM DIFFERENT CROPS IN INDIA



Bio-methanol potential for adoption in maritime sector

Feedstock

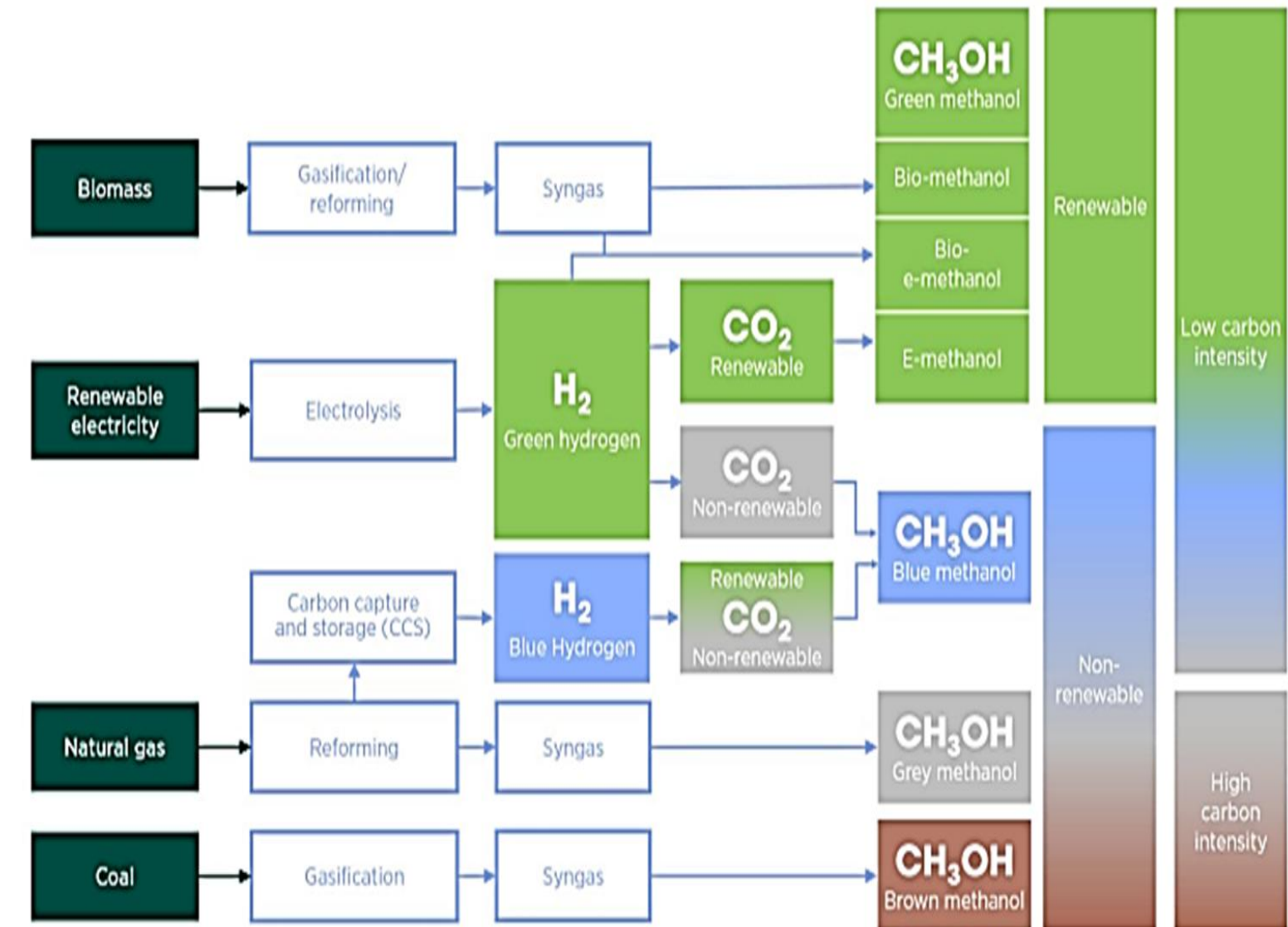
Low and carbon neutral bio-methanol from a variety of widely available renewable feedstocks such as bio-methane, municipal waste, sludge, pulp liquor and agricultural or forestry residues.

Bio-methanol production can be achieved through renewable sources like bio wastes and woods.

Production

In bio-methanol production, biomass gasification or fermentation and reforming replace fossil sources in the syngas production step. Several bio-methanol production demonstration projects and pilot plants have received attention recently in order to test the performance and competitiveness of developing an alternative low-carbon fuel.

Pathways



THANK YOU



ENERGY



AGRICULTURE



ENVIRONMENT



HABITAT



**RESOURCE
SECURITY**



CLIMATE



**HEALTH
& NUTRITION**



The End