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2nd IMO SYMPOSIUM

Overcoming barriers to global access to low- and zero-carbon marine fuels

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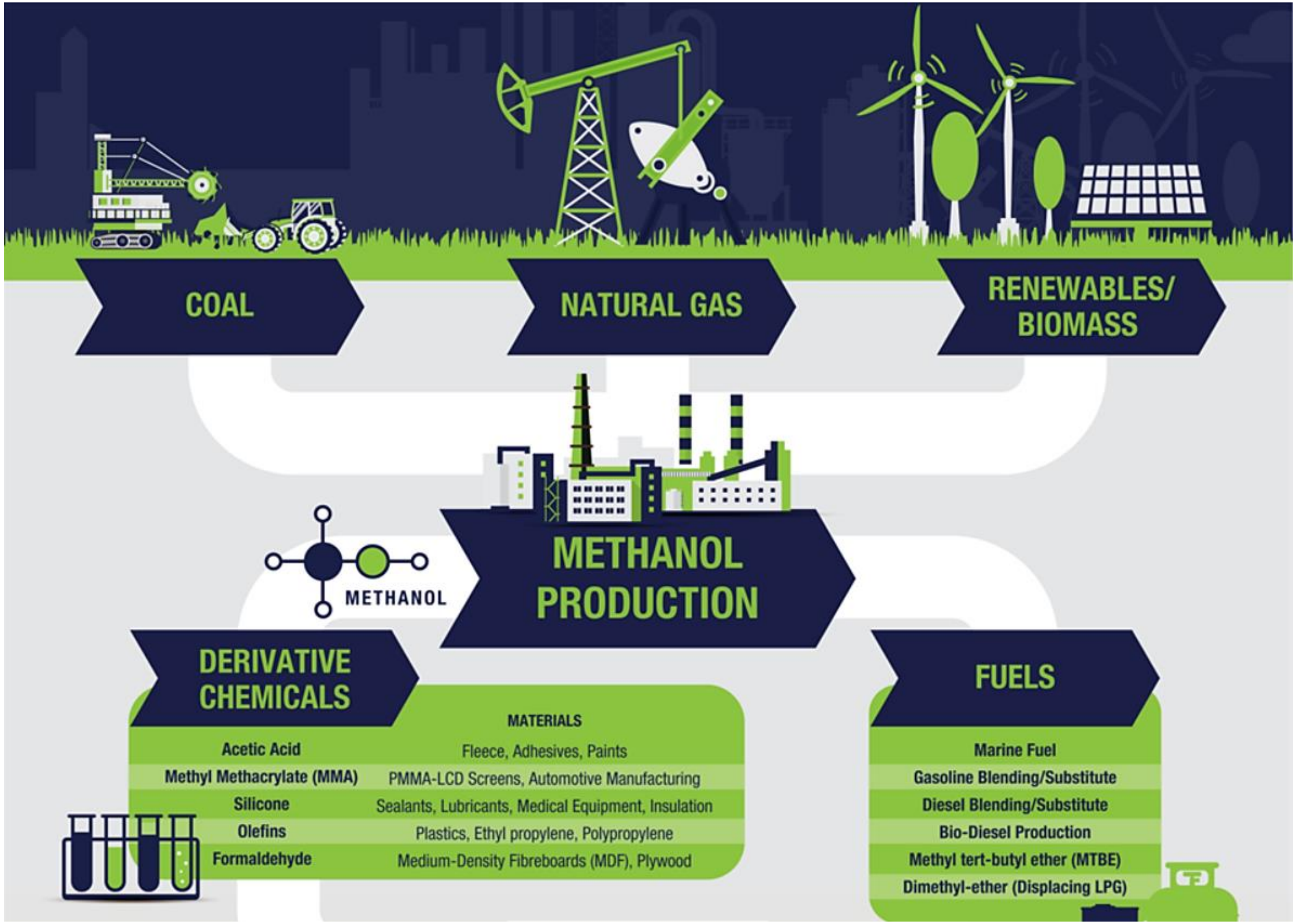
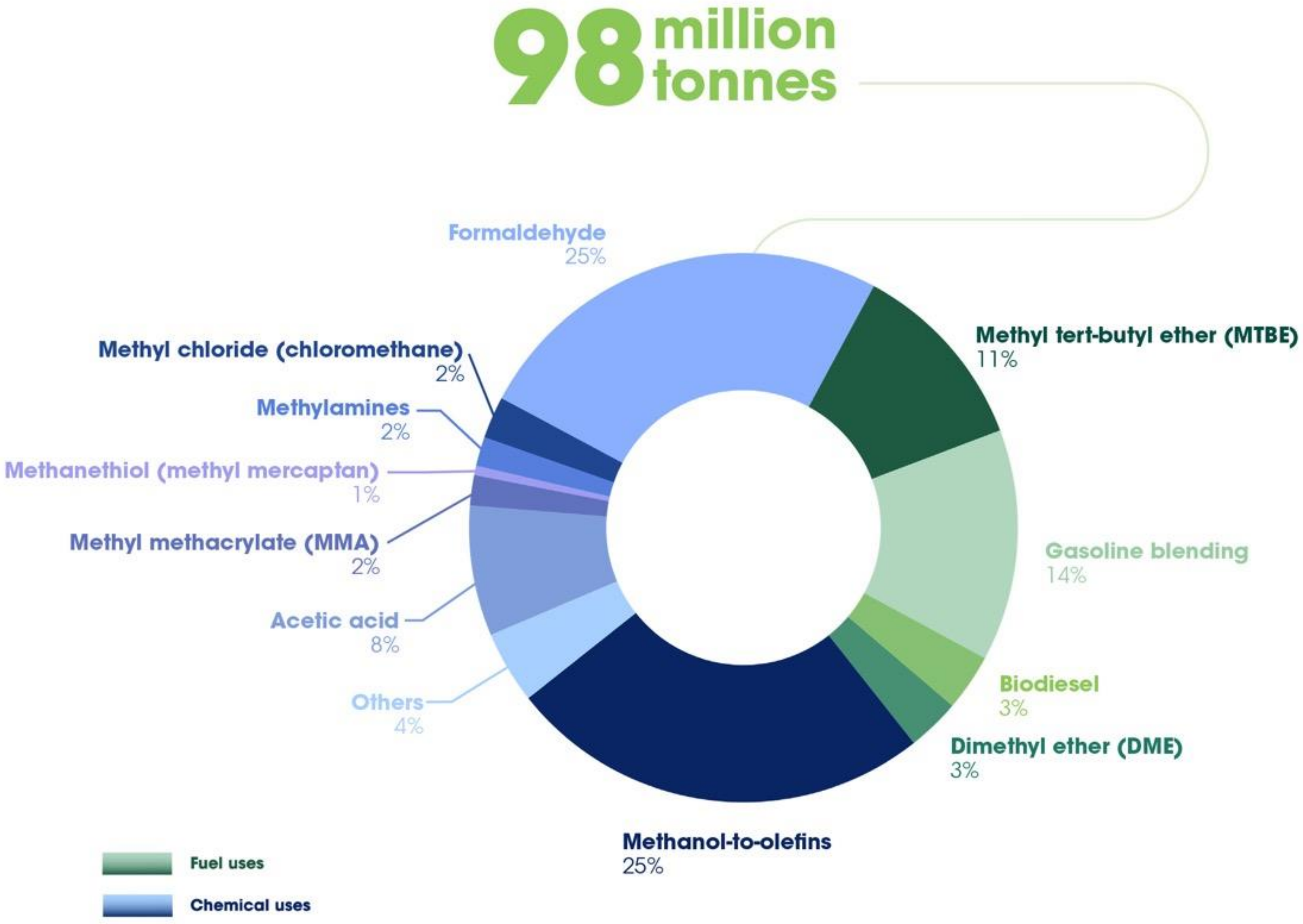
Singapore | Washington | Brussels | Beijing | New Delhi

Feedstocks & Markets



- Natural gas is still the predominant feedstock for the methanol industry ex-China
- Increasing number of projects utilize sustainable feedstocks such as captured CO_2 from industrial emitters and green hydrogen produced from municipal solid waste (MSW), forestry residues or agricultural waste
- Conventionally methanol goes into the production of **downstream chemicals** (~55% of global consumption)
- Increasingly, the fastest growing segment is where it is consumed as a **fuel,** in numerous applications (~45%)

Demand



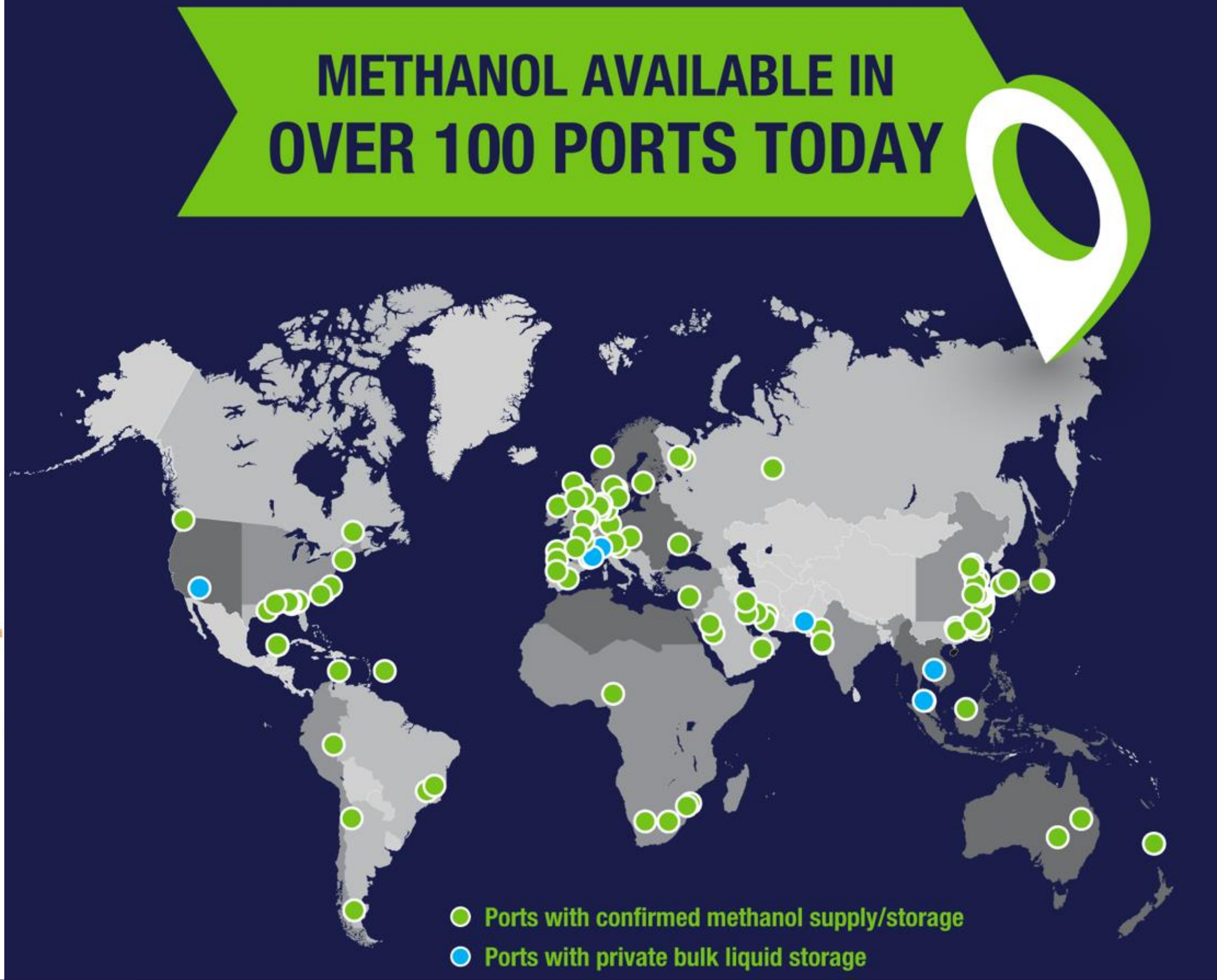
Source: *Based on data from MMSA (2020)*

- Demand and Supply have largely been in balance over the past 20 years
- ~32M mtpa traded internationally
  - China imports >10M mtpa
- Broad sub-vertical markets across both chemicals and fuel applications means
  - Less price volatility
  - Predictable supply
  - Consistent quality

Availability

ESTABLISHED TRADING HUBS

- Efficient break bulking, swaps, blending
- Transparent price assessments
- Standards and safe handling
- Lowers entry costs



Transitional benchmarking & scaling

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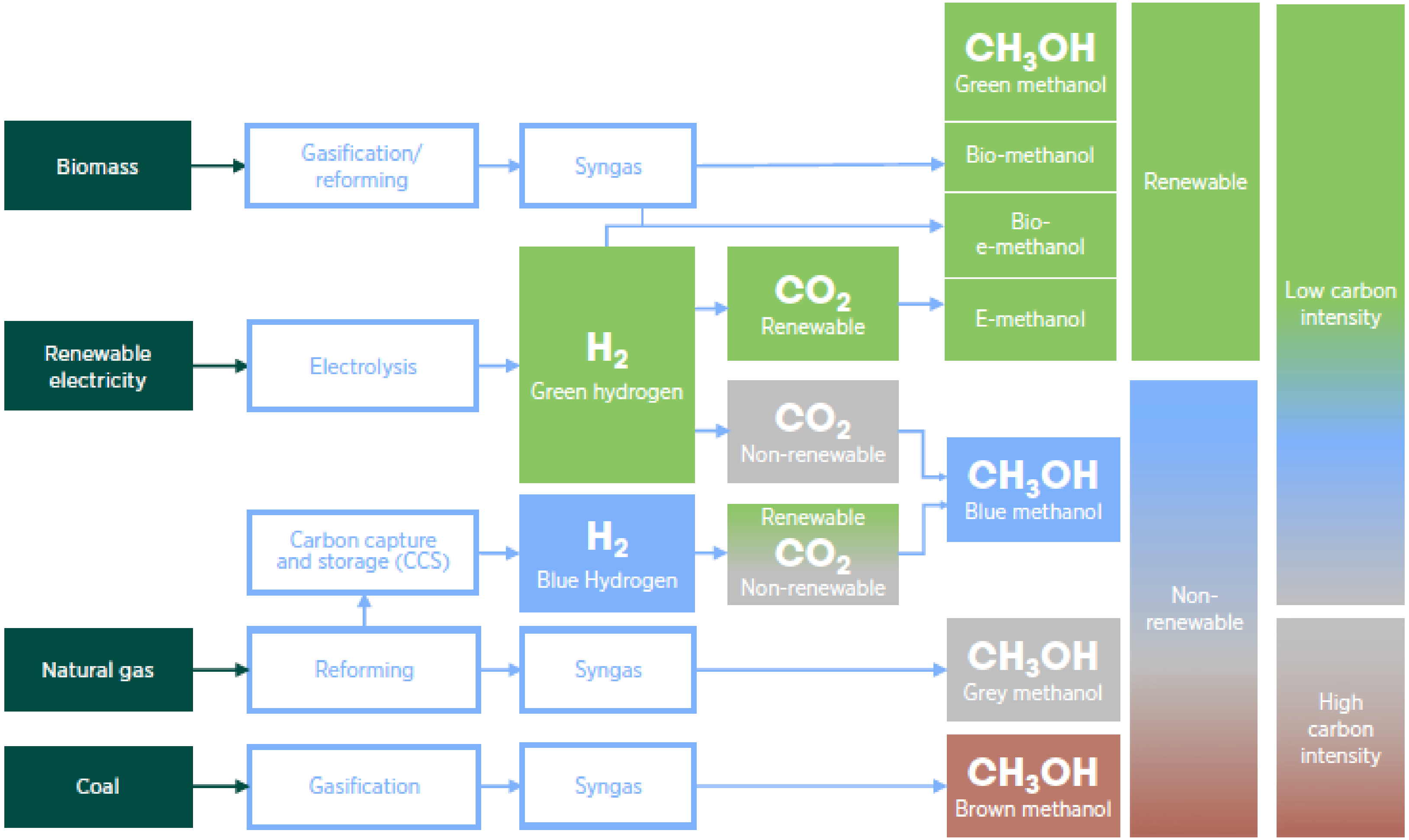
Year	Targeted reductions relative to reference year
2020	Reference year
2025	↓ 2%
2030	↓ 6%
2035	↓13%
2040	↓26%
2045	↓59%
2050	↓75%



Sources: IMO, IRENA

Renewable fuels play a critical role

A 1.5° C Scenario featuring 80% decarbonisation is based on four key measures

Renewable Fuels

1. Indirect electrification via e-fuels
   - **60% decarbonization**

2. Direct employment of advanced biofuels
   - **3% decarbonization**

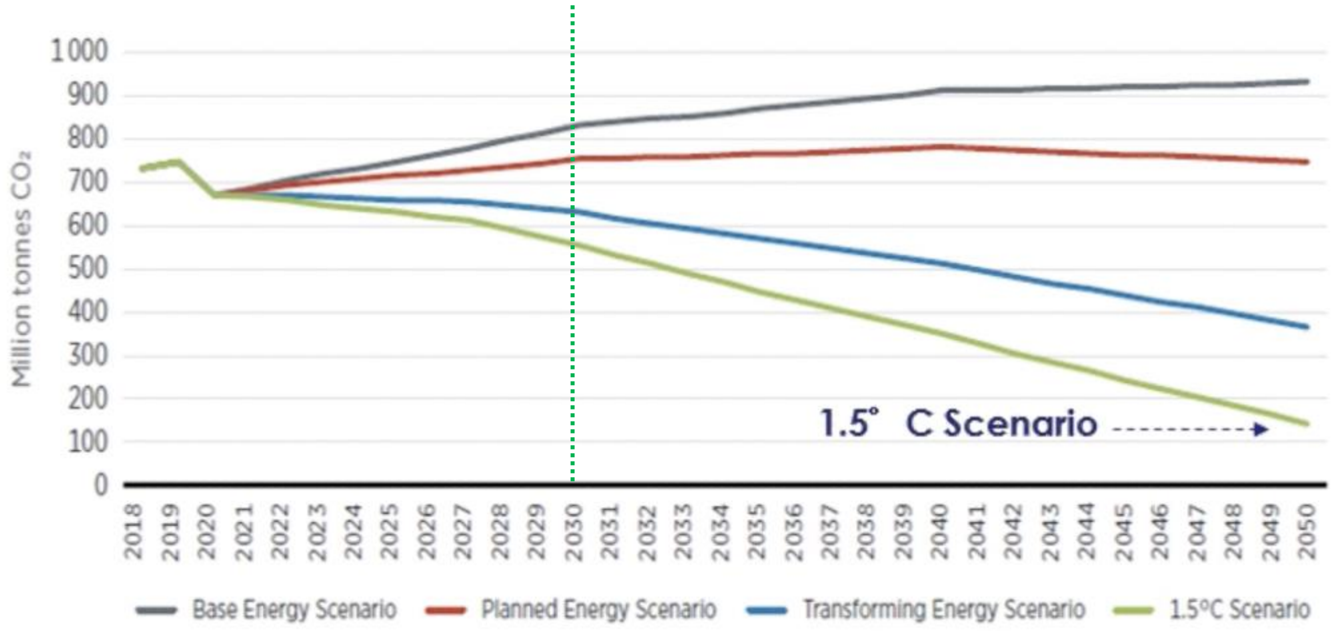
Energy Efficiency

3. Improvement of vessels' energy efficiency
   - **20% decarbonization**

Systemic changes in global trade dynamics

4. Reduction in final energy due to sectoral activity changes (reduced oil demand, circular economy)
   - **17% decarbonisatipon**

Comparison of CO_2 emissions associated with each scenario, 2018-2050



IRENA 2022

Options: Compliancy vs Competitiveness

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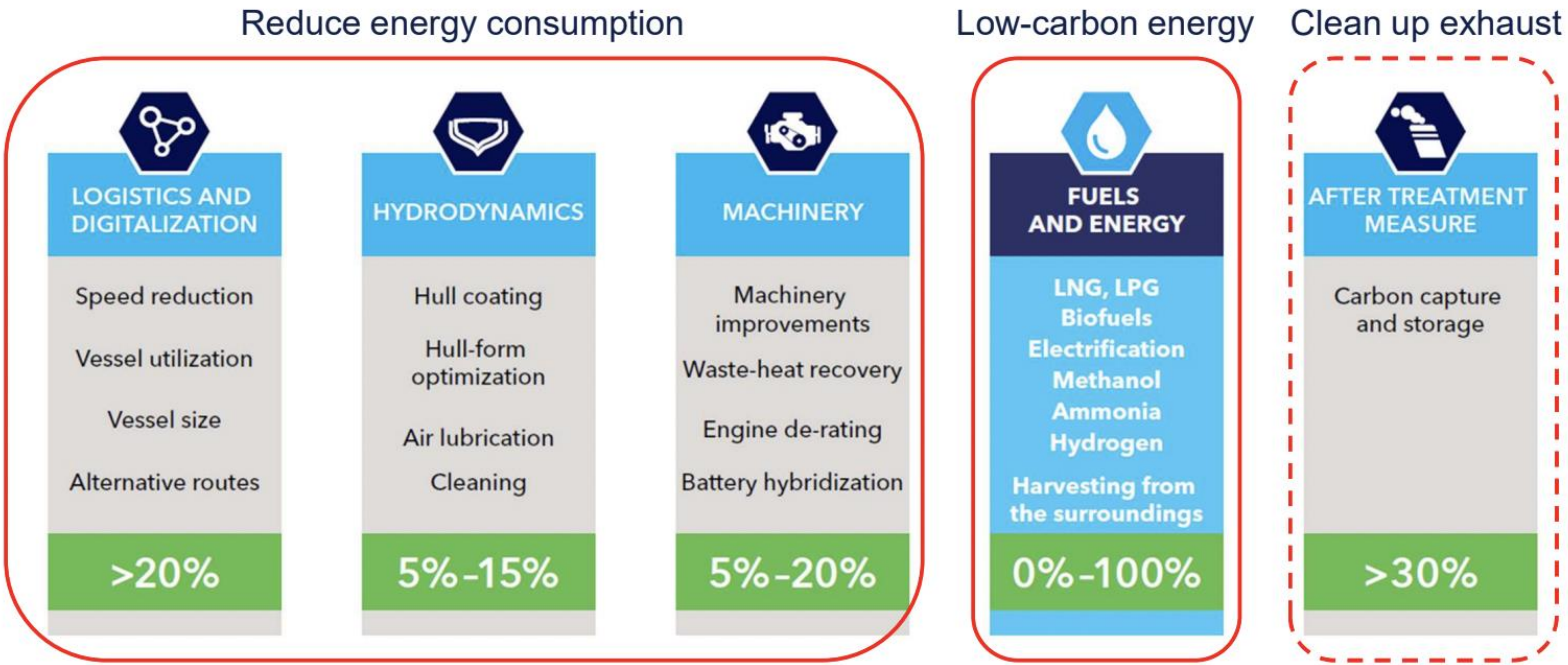
EVOLVING POLICY



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Source: DNV

Potential pathway ahead

Focus: Present
Energy Efficiency

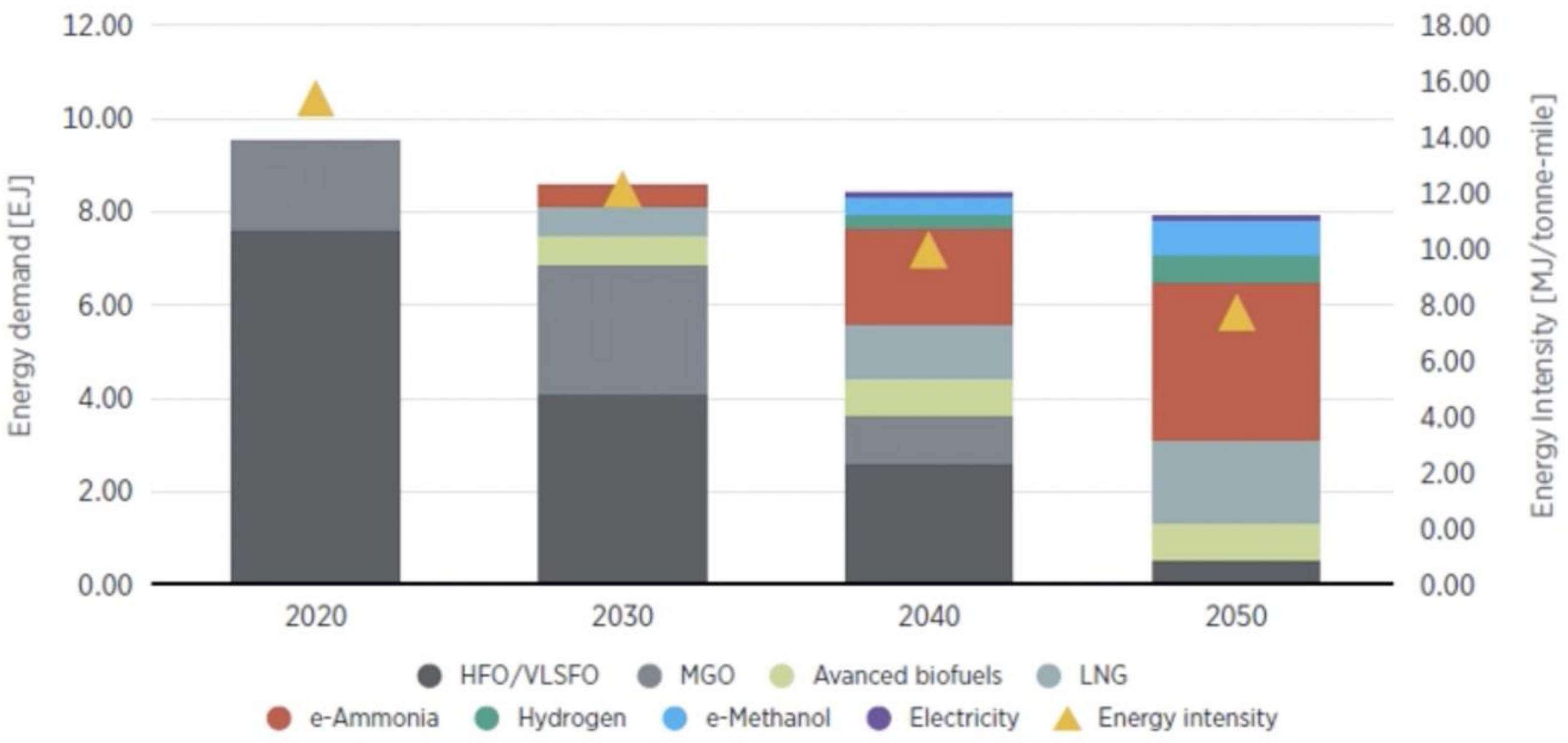
Focus: Short-Term
Biofuels

Focus: Mid- to Long-Term
Carbon neutral, “hydrogen dense” fuels are pivotal to maritime decarbonisation

By 2050, shipping will require a total of **46 MMT of carbon neutral hydrogen** for e-fuels production

- 73% e-ammonia
- 17% e-methanol
- 10% liquid H_2

1.5° C scenario energy pathway, 2018-2050



Based on current technology, this equates to **500GW of electrolyser and 1,000 GW* of renewable electricity** capacity

IRENA 2022

***1GW** = *3.125 million PV panels (based on a silicon model panel size of 320 watts) or;*
333 Utility-Scale Wind Turbines (based on the average utility-scale wind turbine size of 3MW installed)

Cost scenario

		Estimated Costs in USD		
		2015 – 2018	2030	2050
Cost of green H_2 (\$/t H_2) [(a)]		4000 – 8000	1800 – 3200	900 – 2000
Cost of CO_2 (\$/t CO_2) [(c)]		50 – 100	50 – 100	50 – 100
Cost of Methanol (\$/t MeOH) [(b)]	No Carbon Credit	870 – 1690	460 – 790	290 – 560
	Carbon Credit of \$50/t CO_2 [(d)]	780 – 1610	370 – 700	200 – 480
	Carbon Credit of \$100/t CO_2 [(d)]	700 – 1520	290 – 620	120 – 390

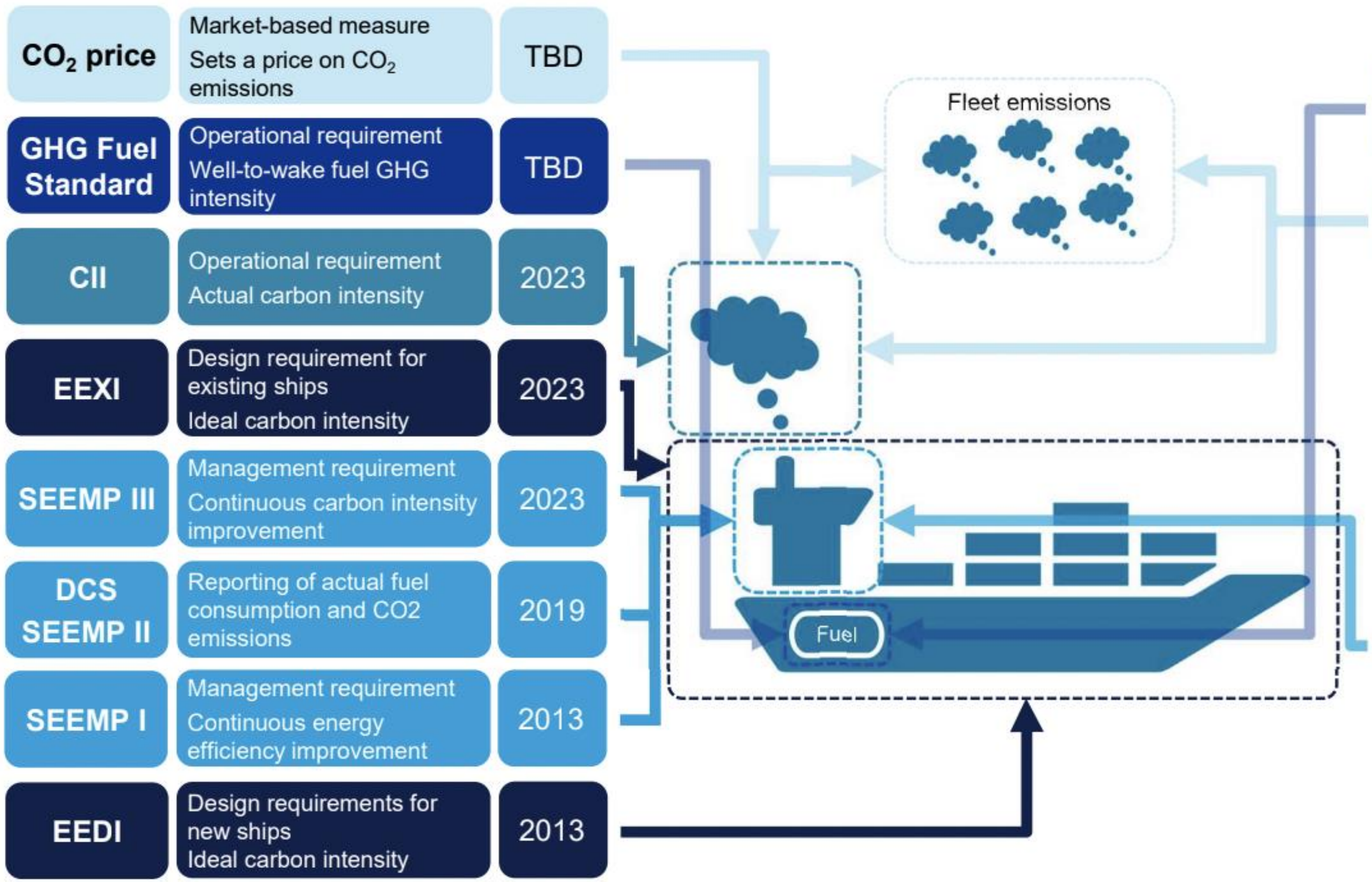
(a) Source: (IRENA, 2020)

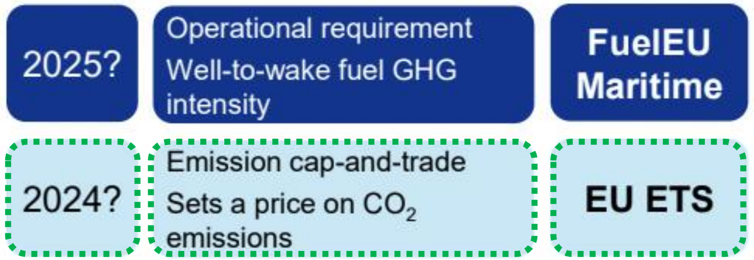
(b) assuming \$50 per ton synthesis cost for e-methanol once the raw material, H_2 and CO_2 are provided

(c) Origin of the CO_2 will change over time as volumes increase

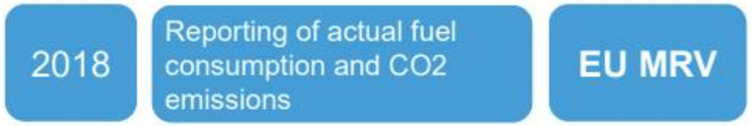
(d) The carbon credit per ton of e-methanol is based on the difference between the average CO_2eq emissions from methanol production from natural gas (95.2 gCO_2eq/MJ) and average CO_2eq emissions from e-methanol production from renewable CO_2 and H_2 (8.645 gCO_2eq/MJ). Considering a LHV of 19.9 MJ/kg for methanol, this corresponds to a 1.72 tCO_2eq of emission avoided per ton of e-methanol, compared to traditional natural gas based methanol.

Policy & Timing





- **Establishes clear guidance**
- **Creates initial benchmark**
- **Reduces 'gap'**
- **Improves investment outlook**
- **Enables creation of critical ecosystems**



- **Avoids sacrificing 'GOOD' for 'EXCELLENT'**

Source: DNV