Latest Trends and Outlook for Maritime Industry in Europe

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Preliminary

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Content

Preliminary

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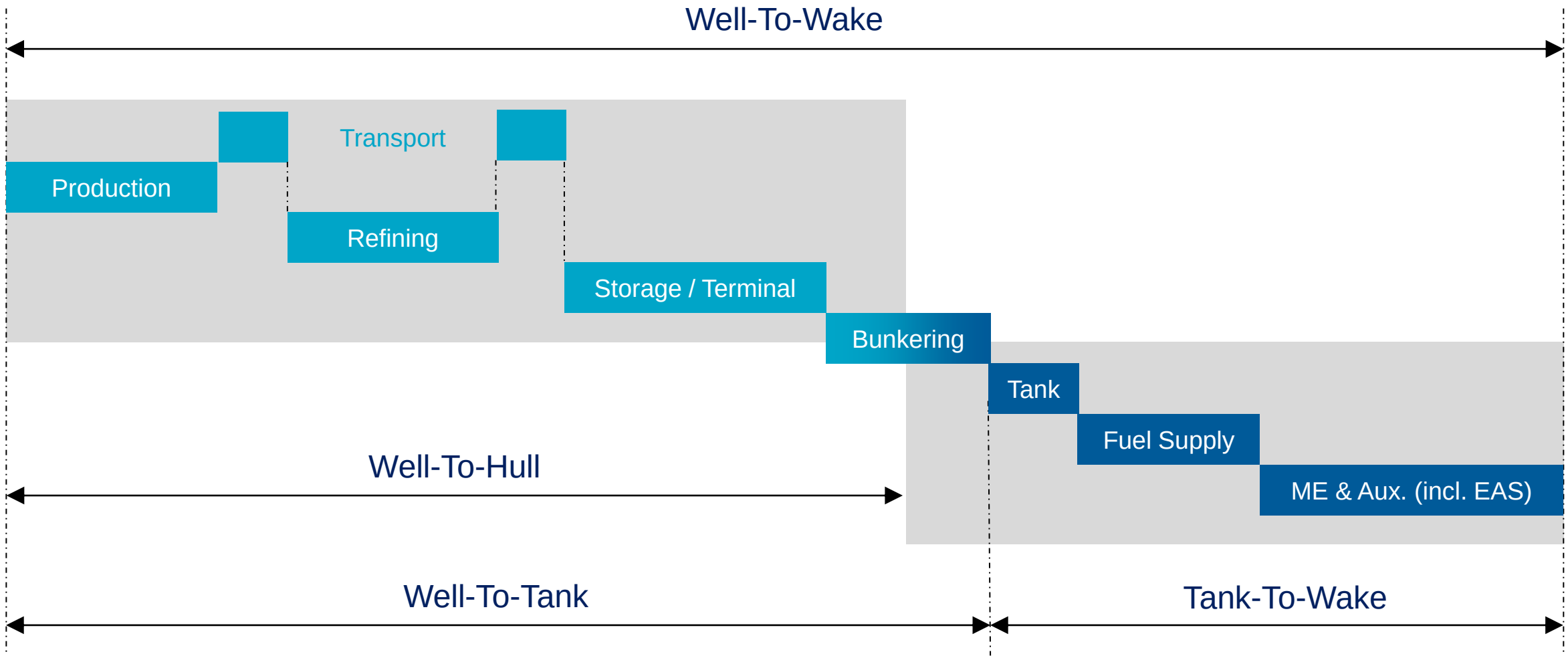
Green Shipping Corridor → Sustainable Port Policy

Source: Busan Port Authority


Ambitious Target vs Reality
Gap → Sustainability/LCA
Strategy of
GHG vs CO_2

Emissions Well to Wake (Shipping)

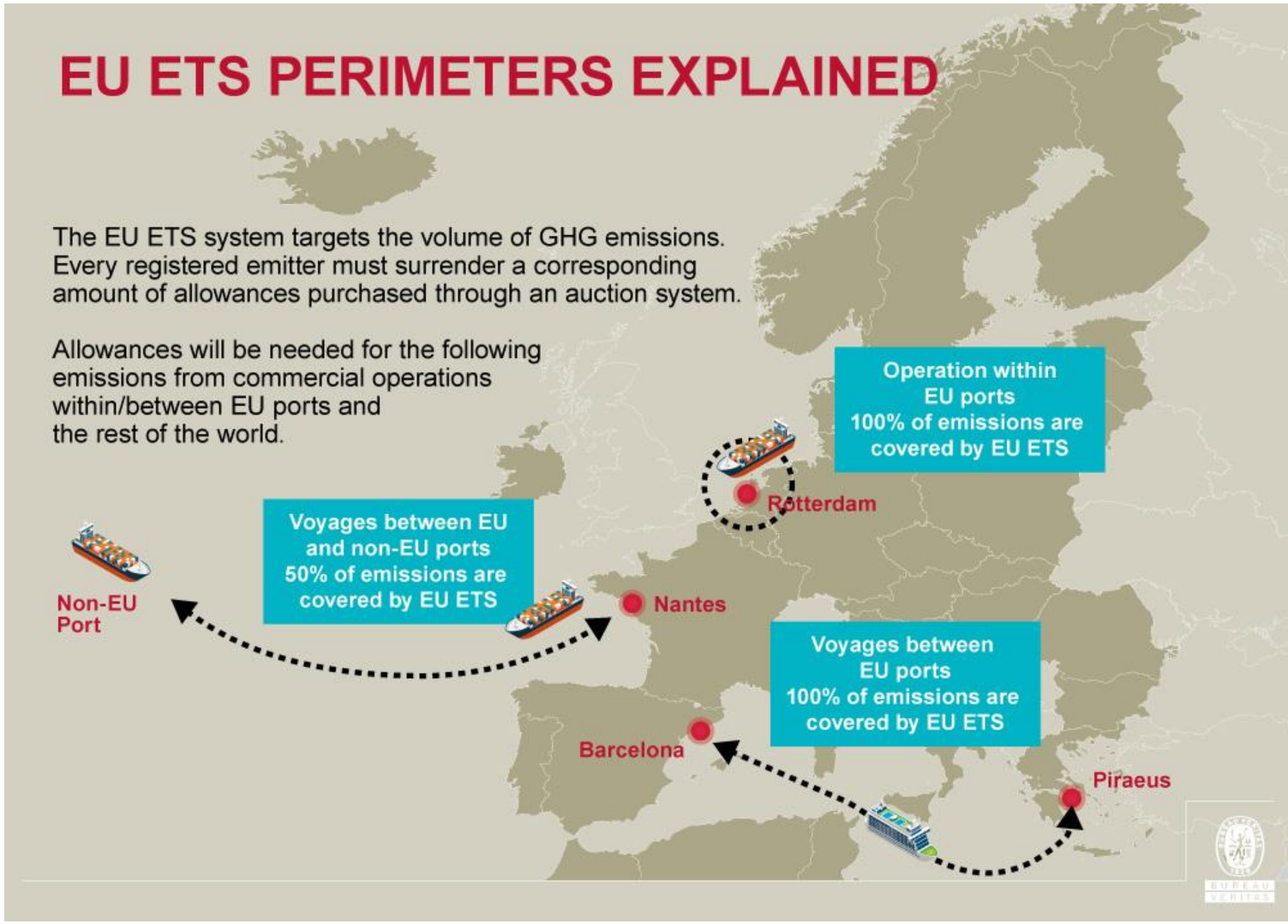


Source: AVL List GmbH

EU Emission Trading System (ETS) 2024

The EU Emissions Trading System (EU ETS) requires polluters to pay for their greenhouse gas (GHG) emissions; launched in 2005, started covering emissions from maritime transport in 2024.

Source: European Commission, https://climate.ec.europa.eu/eu-action/eu-emissions-trading-system-eu-ets/what-eu-ets_en



Source: Bureau Veritas

Fuel Sustainability
Evolution of Maritime Fuels

Price-Competitiveness, Safety and Availability + Environment

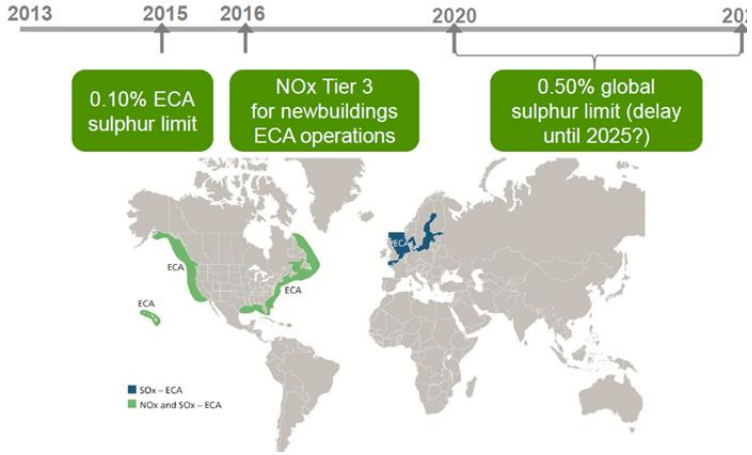
Coal
Solid Fuel

Diesel Oil / HFO
Liquid Fuel

LNG
Gaseous Fuel

1912 2012

Solid → **Liquid** → **Gas** → **(Net)Zero C.**



- 7,000DWT Cargo & Passengership (M/V Selandia)
  - 2 x 8cyl., 4cycle, 1,250hp

2 TOTE 3,100teu Container ship by 8L70ME-C8.2-GI
2 Teekay 173K LNG Carrier
Powered by 2 x 5G70ME-C9.2-GI

- Only 1 Oil Station
- Ship Dieselization: ~20years

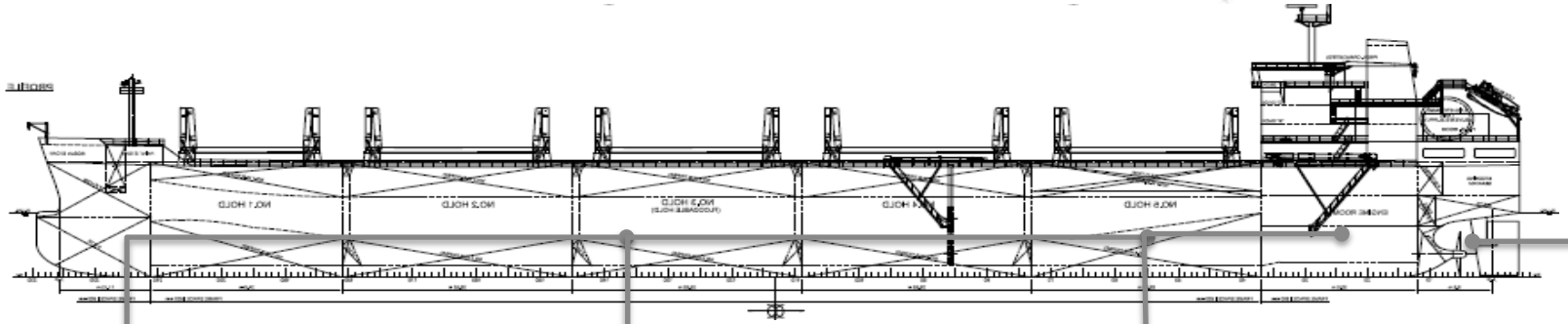
1812 – steam (reciprocating) engine
(cf : 1894- World first steam turbine-powered steamship: Turbine)

World first diesel engine ship : M/S Selandia

- Several Gas Stations
- Innovative Technology on S, T, L & E
- Electronic Engine
- Scale Economy on Ships in Number.

World first LNG fuelled container ship designed by DSEC

Green Way on Ocean Going ships
Progression of Complexity: Still depends on the key role of ICE



	Bunker Fuel	Power Generation	Prime Mover	Propulsion System
Today	▪ HFO (dominantly) ▪ MDO/MGO	▪ Aux. Diesel Gensets ▪ DF Gensets	▪ 2-St, 4-St Diesel (HFO) ▪ DF Engines	▪ Mechanical Propulsion ▪ Electric Propulsion
2030-2050	▪ Hydrogen ▪ Ammonia ▪ Methanol ▪ LNG ▪ SNG (Syn. Methane) ▪ LPG ▪ Biofuel, HVO, etc.	▪ LNG, H2, Gensets ▪ Hybrid Power System ▪ Fuel Cell System ▪ Alternate Marine Power (AMP) – „Cold Ironing“	▪ DF Engines ▪ **Multi Fuel Capability** ▪ **Wind Power** ▪ SCR, EGR, Scrubber ▪ WHR Systems - **CCUS/ORC** ▪ **Fuel Cell/Electrolysis** ▪ **Hybrid** PTI/PTO	▪ Electric propulsion-Battery ▪ Hybrid Propulsion Syst. (w/shaft generator) – PTO (Transit, parallel, shore connection mode) – PTI (Diesel electric, fully electric, boost mode) ▪ **Hybrid/Electrification**

Fit to rules but go for H_2 | Integration of Energy systems & LCA – **ICE+FC/Electrolizer+CCUS+Wind+Nuclear**

Source: AVL List GmbH

Future Fuels for Sustainability

Production | Properties | Applications

Source: AVL List GmbH

Carbon-free Fuels

Hydrogen H_2

+

- Production Efficiency
- Flexibility: Engine; PEM FC
- Future Availability (Industry)
- Good Fuel Properties

-

- Storage Density
- Safety due to high Reactivity

Electrolysis

Electricity

$\rightarrow H_2$

Ammonia NH_3

+

- Storage as Liquid Gas
- Best Carbon free H_2 Carrier

-

- Toxic
- Corrosive
- Poor Fuel Properties

Haber-Bosch Process

Carbon-neutral Fuels

Methane CH_4

+

- Available Technologies and Infrastructure

-

- Upstream Emissions (CH_4)
- Energy Demand in case of Liquification (LNG)

RNG: Methanation

BNG: Bio-Fuel Production

Alcohols CH_3-(CH_2)-OH

+

- Liquid → Acceptable Storage Density

-

- Ethanol: Dependance from Bio-Source

Bio Alcohol / Synthesis

Methanol: Gasification of biomateria + Synthesis or Methanol synthesis

Ethanol: Sugar Fermentation

Paraffins C_nH_{2n+2}

+

- Available Technologies and Infrastructure
- Best Storage Density
- Highest Engine Efficiencies

-

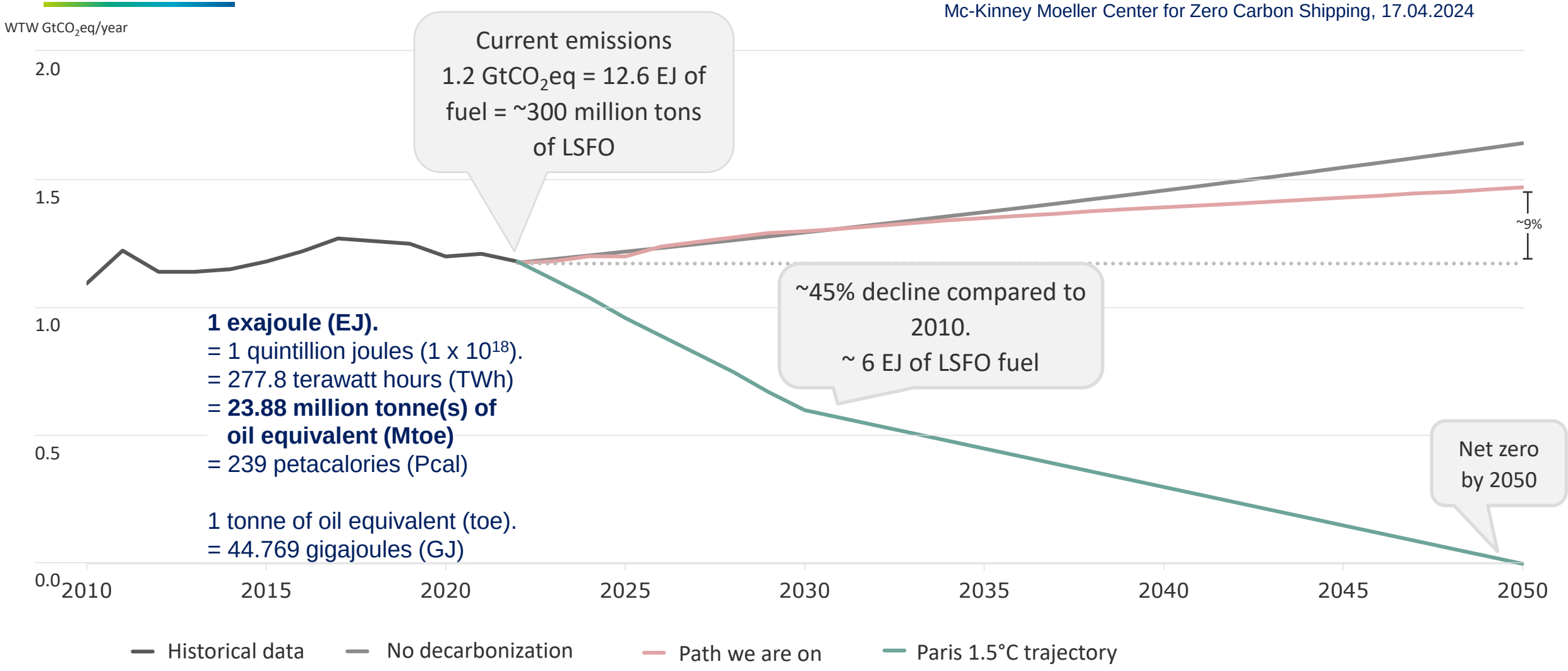
- Poor Production Efficiency

E-Fuel (e.g. Fischer Tropsch)

HVO: Isomerization

The challenges remain – **we are not on track**. Collaborative action is needed!

Source: HPSC 2024 Graz, Keynote Speech by Mr. Claus Graugaard, Maersk Mc-Kinney Moeller Center for Zero Carbon Shipping, 17.04.2024



Brainstorming
Maritime Cooperation

Europe - Owning

- Financial Investment
- Legislation, Rule Making
- Shipping/Offshore Plants – Owners, Charterers
- Shipbuilding – High Value (Cruise), Inland, Special Purpose Ships
- Equipment – Hi-Tech
- Engine OEM – HS with New Fuels
- Technology Providers

Korea - Building

- Shipping/Offshore Plants – Owners, Charterers
- Shipbuilding – High Value (LNG)
- Equipment – Hi-Quality, Cost benefit, Short Delivery
- Engine OEM – LS, MS with New Fuels
- Design
- Etc.

Cooperation

Example of Cooperation
Participants of Open Simulation Platform

Source: DNV