ENERGY TRANSITION

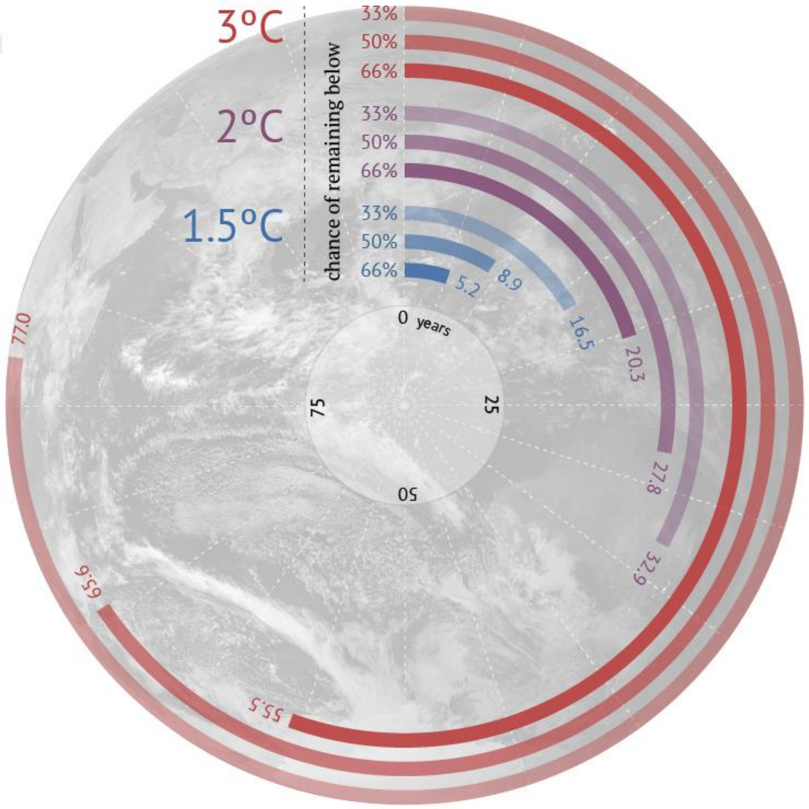
New Insights and Initiatives |

Richard Smokers & Jorrit Harmsen

TNO innovation for life

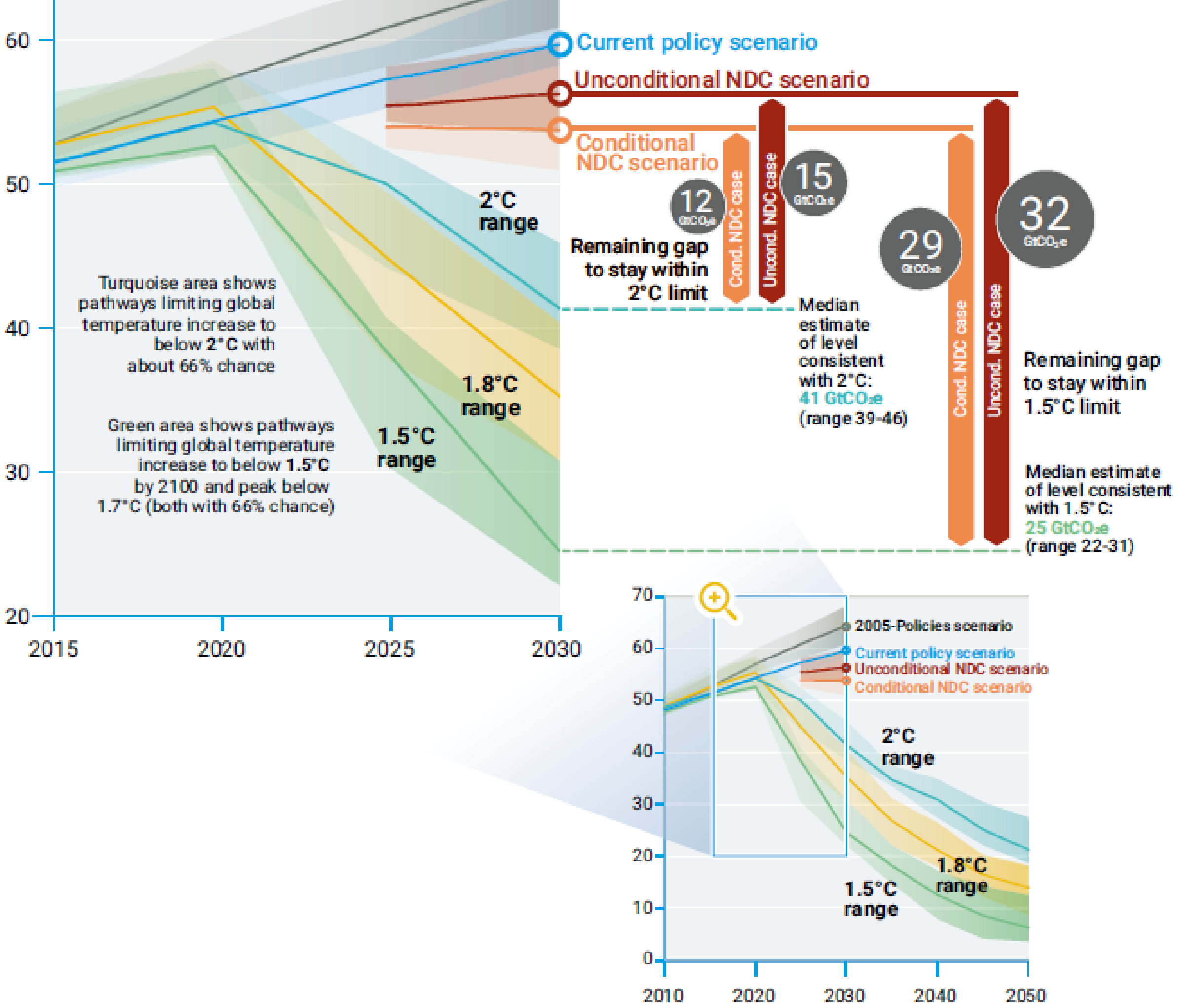
PARIS AGREEMENT

- **Limit global warming to max. 2˚C in 2100**
  - requires 80% CO_2 reduction in 2050 relative to 1990
    - 60% target for transport sector according to 2011 EU whitepaper
- **Strive for 1.5˚C in 2100**
  - requires 95% or more CO_2 reduction in 2050 relative to 1990
  - calls for quick reductions due to finite “carbon budget”
  - offers little room for lower reduction in transport sector
    - also transport sector should strive for 80 - 95% reduction



bron: www.carbonbrief.org

HOW ARE WE PROGRESSING?



IMO AGREEMENT

- Decrease absolute CO_2 emissions: $2008 \xrightarrow{-50\%} 2050$

  1. Design: EEDI framework

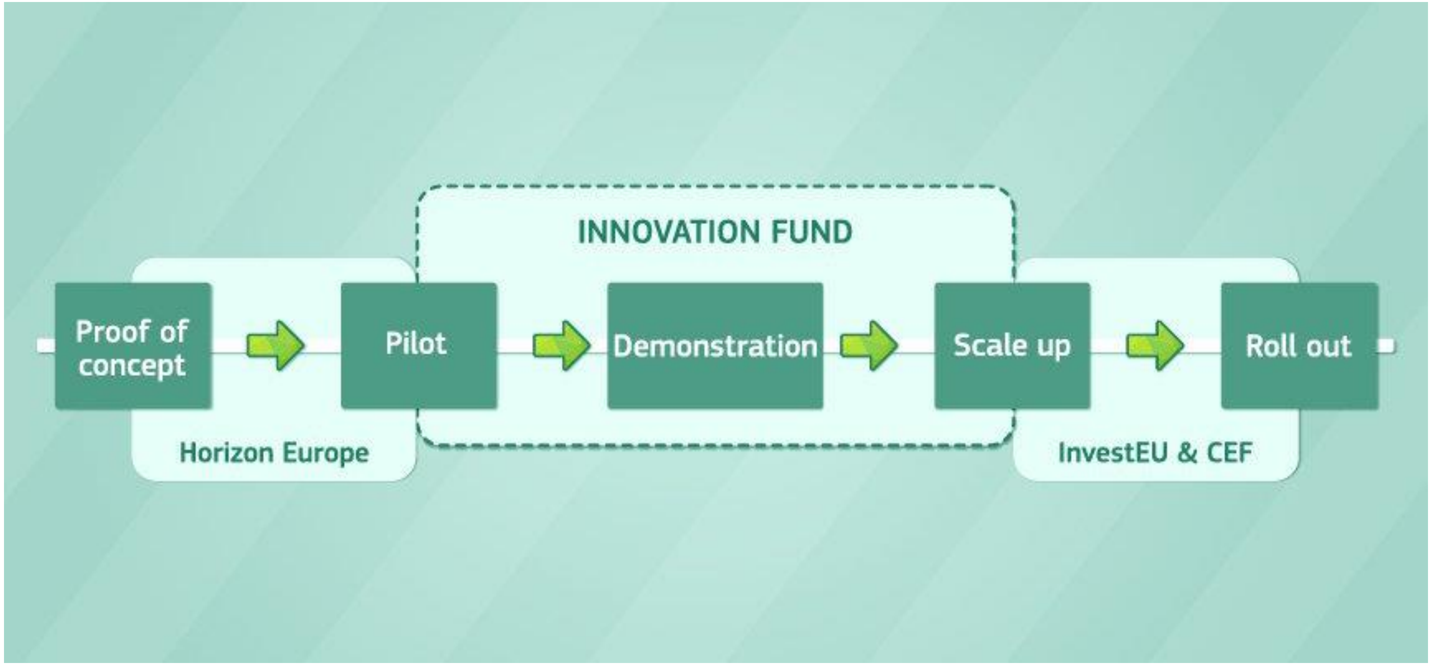
  2. Operation: efficiency $\frac{gCO_2}{ton \cdot nm}\ 2008 \begin{cases} \xrightarrow{-40\%} 2030 \\ \xrightarrow{-70\%} 2050 \end{cases}$

- Focus up to 2030 - 2035:
  - Incremental technological improvements
  - Operational measures & slow steaming
- Focus long term:
  - Zero or low emission fuels
  - Transition in transport flows

EUROPEAN GREEN DEAL

- Europe strives to be the first climate-neutral continent and a European Green Deal will be proposed in the coming months.
- European Union’s target for 2030 is to increased from 40% towards 55%.
  - Emissions Trading System is to be extended to include the maritime sector and also towards other modalities.
  - Introduction of a Carbon Border Tax
  - Sustainable Europe Investment Plan to support €1 trillion of investment over the next decade

EUROPEAN FUNDING POSSIBILITIES FOR THE MARITIME SECTOR



MISSIEGEDREVEN INNOVATIE VOOR MOBILITEIT

- IKIA Klimaat & Energie is bijlage bij het Klimaatakkoord
  - Missie mobiliteit
    - MMIP 9 - *Innovatieve aandrijving en gebruik van duurzame energiedragers voor mobiliteit*
    - MMIP 10 - *Doelmatige vervoersbewegingen voor mensen en goederen*

Uitvoering samengevoegd in **Meerjarige Missiegedreven Innovatieprogramma Duurzame Mobiliteit**

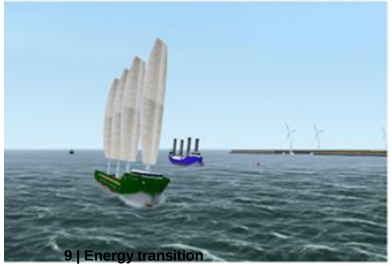
- Deel-KIA Toekomstbestendige Mobiliteitssystemen
  - uitvraag van IenW aan Topsector Logistiek (i.s.m. HTSM en Water & Maritiem)
  - focus op:
    - bereikbaarheid en veiligheid
    - niet-CO_2 gerelateerde milieu-impacts en hinder van landgebonden transport
    - slimme, veilige en duurzame scheep- en luchtvaart (incl. CO_2)
    - integrale gebiedsontwikkeling en infrastructuur

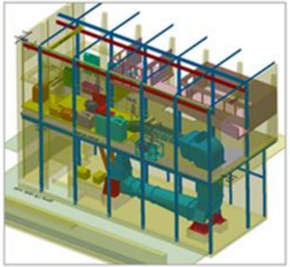
Missie D+

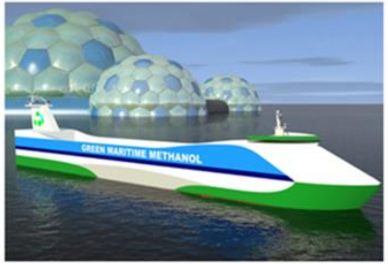
Thema “Towards Zero Emission” van TKI Maritiem

- Circulaire scheepsbouw en scheepvaart
- Innovatieve componenten voor het voortstuwingssysteem (aandrijflijn) en hun integratie
- Gebruik van alternatieve energiedragers aan boord van schepen
- Nieuwe business- en governancemodellen voor scheepvaart

- Aansluiting bij:
  - Blauwe route in de Nationale Wetenschaps Agenda
  - Green Deal Zeevaart, Binnenvaart en Havens







Green Deal

innovation for life

Zeevaart, Binnenvaart en Havens

- 1. Financiering
- 2. Gelijkwaardigheidserkenning en labelsysteem binnenvaart
- 3. Gecoördineerd overheidsbeleid
- 4. Duurzame alternatieve brandstoffen
- 5. Techniek en innovatie
- 6. Samenwerking in de keten
- 7. Mondiale CO2-heffing
- 8. Launching customership
- 9. Duurzame offshore werkzaamheden
- 10. GLEC-framework
- 11. Doeltreffendheid Green Deal instrumentarium

LEVERS FOR CO_2 REDUCTION

transport demand

$$gCO_2 = \frac{gCO_2}{MJ} \times \frac{MJ}{v.km} \times \frac{v.km}{ton.km} \times \frac{ton.km}{ton} \times \frac{ton}{product} \times \#products$$

carbon intensity of energy carrier

vehicle efficiency

load factor

transport distance

product properties and packaging

size of production

efficient vehicles / vessels on renewable energy

efficient logistics & supply chain

FUELS: PHASE OF DIVERGENCE

- Many fuel options available for the longer term future

Feedstock	Energy carrier
alternative fossil	CNG / LNG
	methanol
	MTBE
	GTL
	ULSFO
	DME
	electricity
	hydrogen (thermal / electrolysis)
wind/sun Power-to-X	Power-to-DME
	Power-to-methanol
	Power-to-kerosine
	ammonia
	formic acid
	green electricity
	Power-to-H2 (electrolysis)
nuclear	electricity from on-board plant

Feedstock	Energy carrier
biomass/biogas	PPO (pure plant oil)
	FAME 100%
	HVO-diesel
	HVO-kerosine
	bio-ethanol
	bio-methanol
	bio-MTBE
	bio-DME
	compressed bio-methane (CBG)
	liquid bio-methane (LBG)
	electricity (wood)
	bio-H2 (thermal, wood)
	bio-H2 (electrolysis, wood)
biomass/algae	biodiesel algae

SCORING SYSTEM

Technical status

Level 1: R&D

Level 2: Innovation

Level 3: Scale up

Level 4: Commercial

Environmental impact

CO_2 performance

Air quality

Score

Upstream supply chain

Availability feedstock

Availability bunkering infrastructure

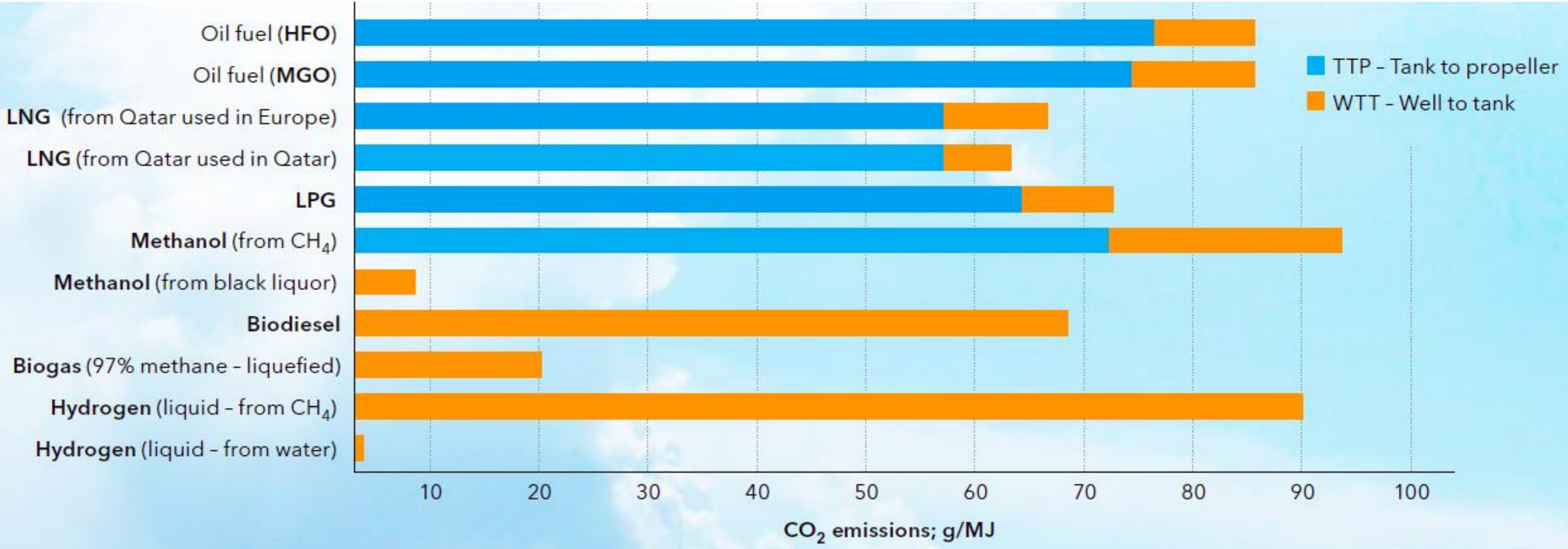
Use case

CAPEX, OPEX

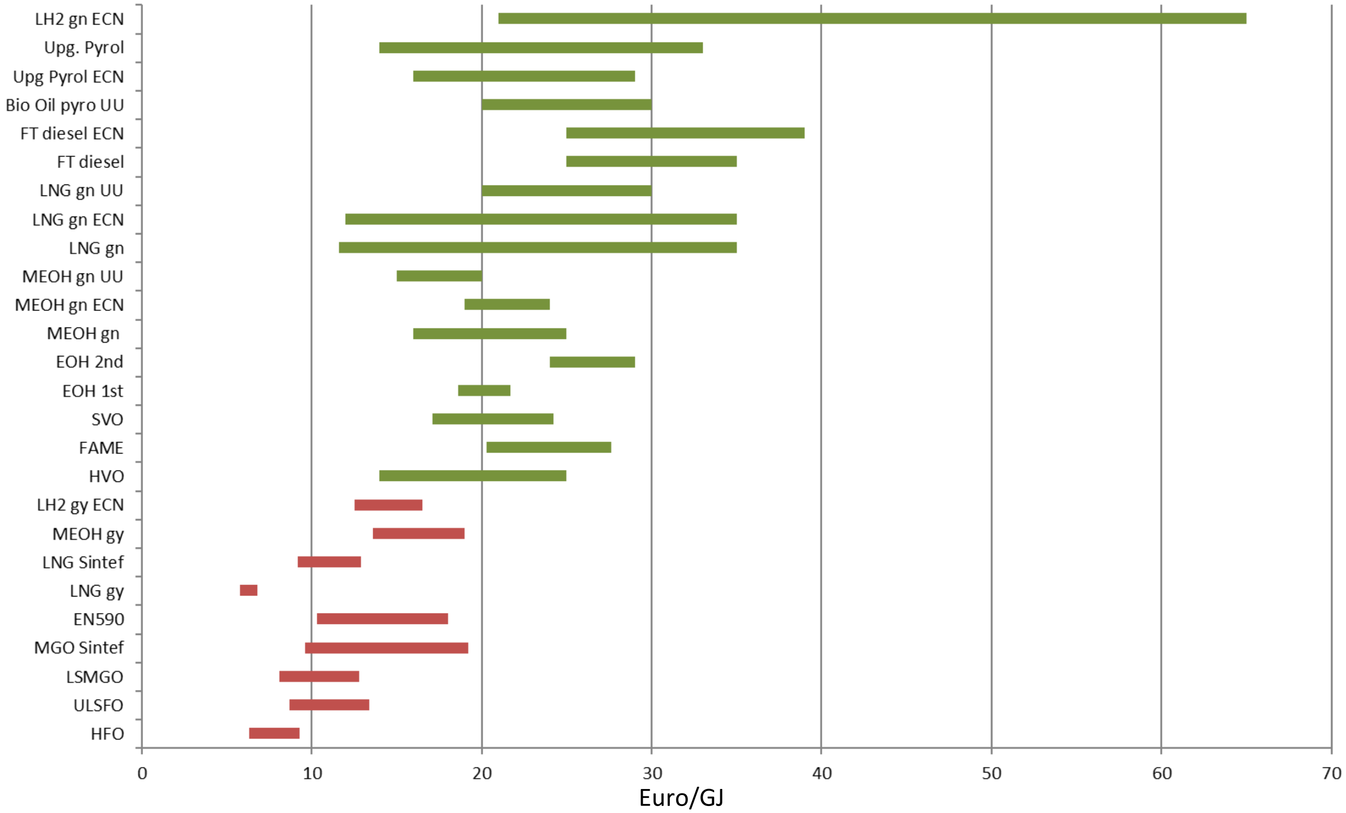
Impact on operation (range)

Robustness, safety, etc.

DIRECT & INDIRECT GHG EMISSIONS

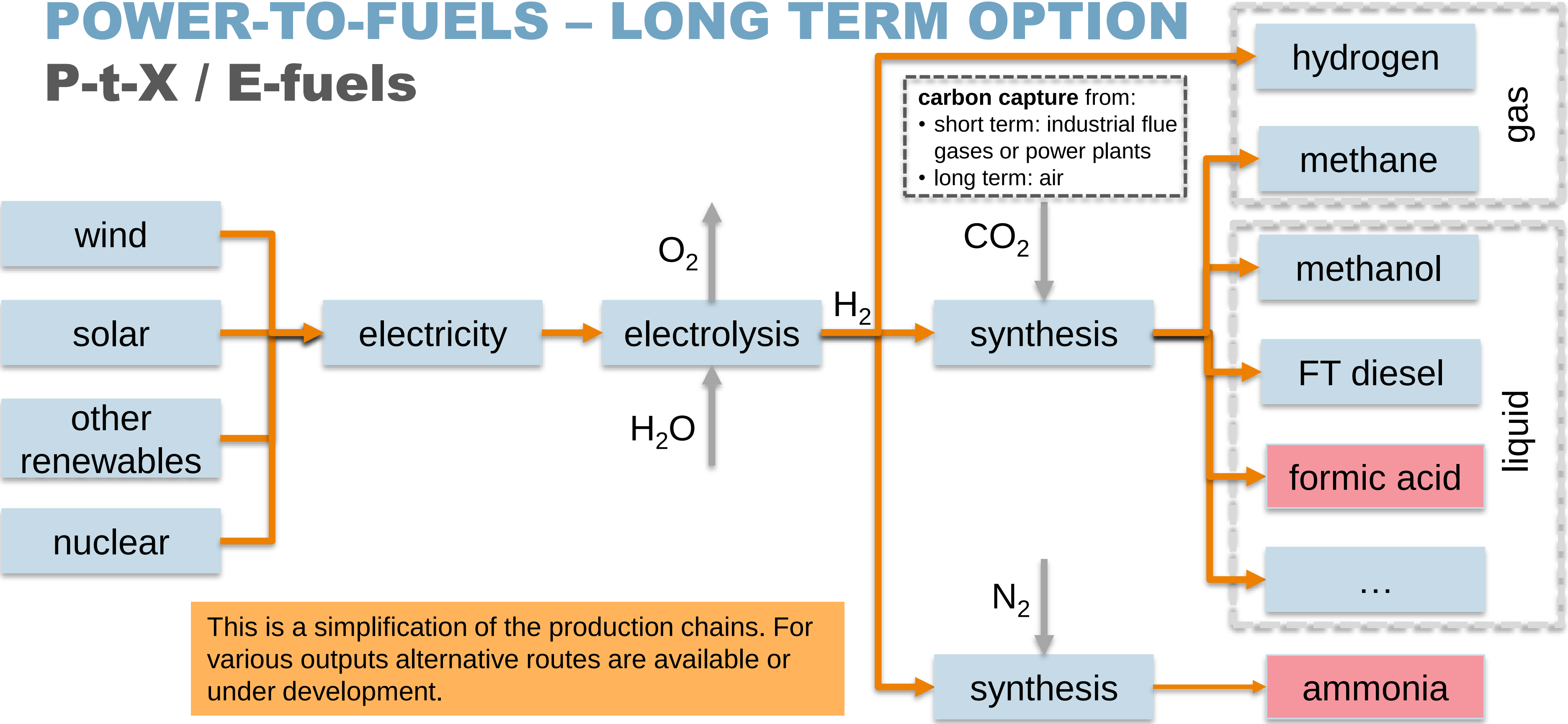


FOSSIL AND GREEN FUEL PRICES



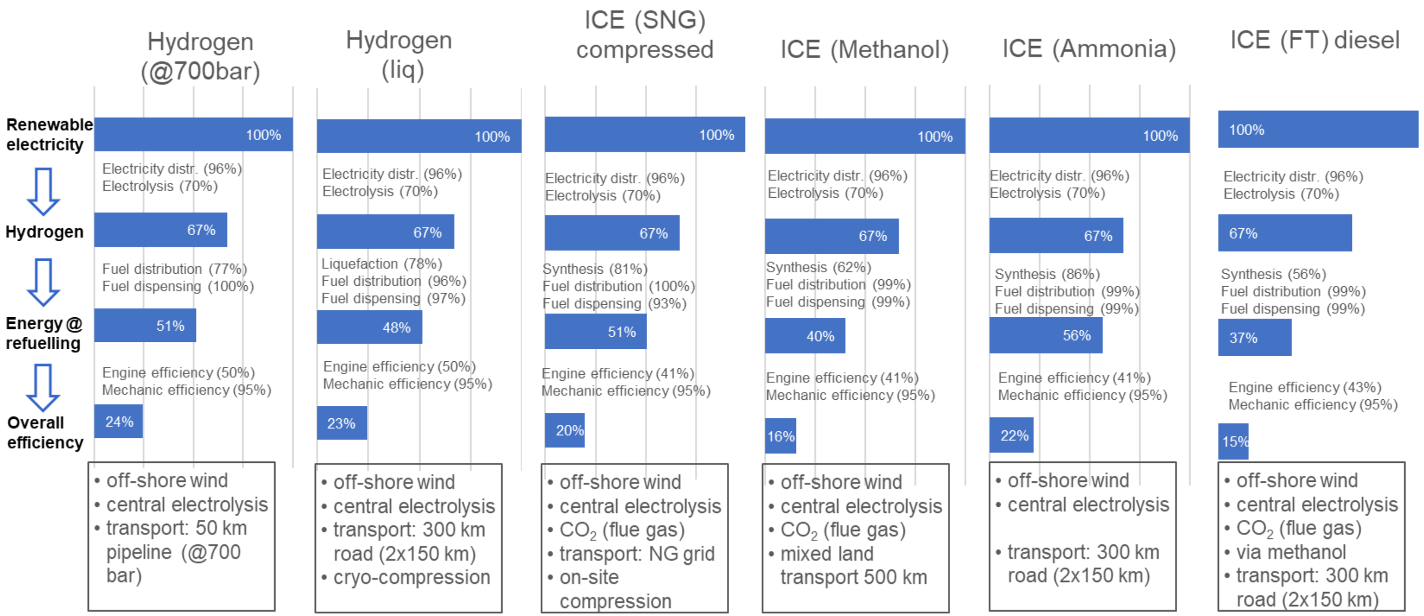
POWER-TO-FUELS – LONG TERM OPTION

P-t-X / E-fuels



This is a simplification of the production chains. For various outputs alternative routes are available or under development.

EFFICIENCY OF PRODUCTION PROCESS



KPI PRACTICAL APPLICATION AND SAFETY: FT FUELS AND METHANOL HAVE LEAST IMPACT

	Engine or energy convertor	Fuel storage in vehicle	Requires new infrastructure
Hydrogen	Large modification: fuel cell system or new engine type	Big impact due to low energy density	Yes – mostly new system
FT diesel	No modification (with drop in-quality)	Same as diesel	no
FT kerosine	No modification (with drop in-quality)	Same as kerosine	no
Methanol	Already proven engine modifications	Some impact due to lower energy density	Yes – new tank infra
Methane (cryogenic)	Already proven engine modifications	Substantial impact due to lower energy density and high pressure or cryogenic temperature	Yes – expansion of infra
Ammonia	Large modification: new engine type or new fuel cell system	Substantial impact due to low energy density and need for pressure or low temperature.	Yes – new tank infra

easy
Quite feasible
quite feasible
feasible
feasible
not impossible
not possible

STORAGE IN VEHICLE AND DISTRIBUTION

Storage in vehicle

Criteria:
- Space & weight
- Safety
- Costs (of tank)

Storage in vehicle	Hydrogen	Methanol	Ammonia	Synthetic kerosine	Methane
Distribution & longhaul trucks	compressed or cryogene	standard liquid	compressed (± 10 bar)	n.a.	compressed or cryogene
Inland shipping	compressed or cryogene	standard liquid	compressed (±10 bar) or cooled (ca -33°)	n.a.	cryogene
Short sea shipping	cryogene	standard liquid	cooled (ca -33°)	n.a.	cryogene
Deep sea shipping	-	standard liquid	cooled (ca -33°)	n.a.	cryogene
Aviation	-	-	-	standard	cryogene

Transport to fuel and bunker stations

Distribution / transport via	Hydrogen	Methanol	Ammonia	Synthetic kerosine	Methane
pipeline	compressed		compressed		compressed
tanker truck	compressed or cryogene	standard liquid	compressed (±10 bar)	-	cryogene
Inland ship	compressed or cryogene	standard liquid	cooled (ca -33°)	-	cryogene
Short sea ship	cryogene	standard liquid	cooled (ca -33°)		cryogene
Deep sea ship	cryogene	standard liquid	cooled (ca -33°)	-	cryogene

easy
Quite feasible
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CONCLUSIONS (1): METHANOL AND AMMONIA SEEM FEASIBLE OPTIONS FOR SHIPPING, AND KEROSENE FOR AVIATION

<table>
<tr><th></th><th>Hydrogen</th><th>FT diesel</th><th>FT kerosene</th><th>Methanol</th><th>Methane (cryogenic)</th><th>Ammonia</th></tr>
<tr><td>Long haul trucks</td><td rowspan="2">daily refueling, costly and spacious storage</td><td rowspan="3">too expensive</td><td rowspan="3">not practical</td><td rowspan="3">very feasible</td><td rowspan="3">feasible but costly storage & distibution</td><td rowspan="3">Feasible, but complex development for low NOx engines or fuel cells</td></tr>
<tr><td>Inland shipping</td></tr>
<tr><td>Maritime shipping</td><td>only short sea</td></tr>
<tr><td>Aviation</td><td>low energy density</td><td>not compatible</td><td>only viable option</td><td>low energy density</td><td>loss of cargo space</td><td>low energy density</td></tr>
</table>

CALL TO ACTION

generation → conversion → storage → distribution → application

generation
- biomass
- wind / solar
- what else?

conversion
- electrolysis
- CO_2-capture
- synthesis
- …

storage
- gaseous / liquid
- national reserves

distribution
- international / inland shipping/ pipelines / tanker trucks
- fuelling stations

application
- on-board storage
- conversion
  - combustion engine
  - reformer + fuel cell
- electric propulsion

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generation
- costs of renewable energy
- development supply / demand
- need for buffering
- …

conversion
- efficiency
- costs
- new processes
- central / local
- standardisation
- …

storage
- compatibility with existing assets
- safety
- …

distribution
- compatibility with existing fossil fuels
- compatibility with existing assets
- safety
- …

application
- density
- compatibility with engine
- efficiency
- emissions
- …

Successful implementation of a new fuel requires a system approach.
Close collaboration between stakeholders in concrete use cases is needed.

THANK YOU FOR YOUR ATTENTION

LNG en wat erbij komt kijken als je overstapt naar een andere brandstof

Sjaak Klap, Associate Maritime and Small-Scale LNG expert

Platform Schone Scheepvaart, 3 December 2019

CLEAN ENERGY JOURNEY

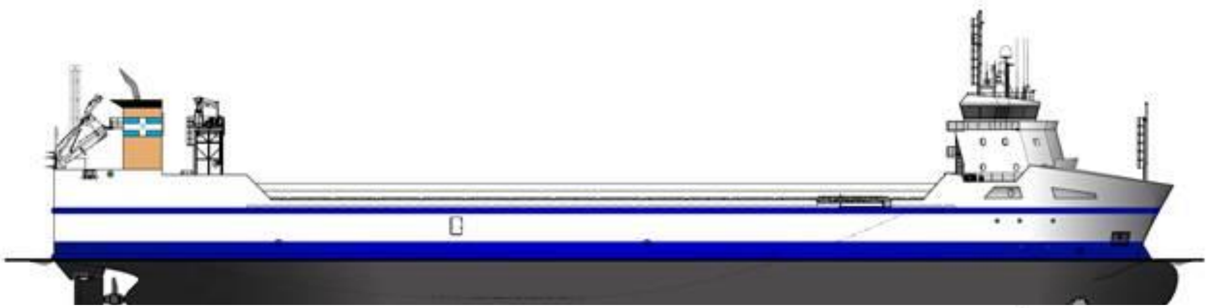
GLOWAKE

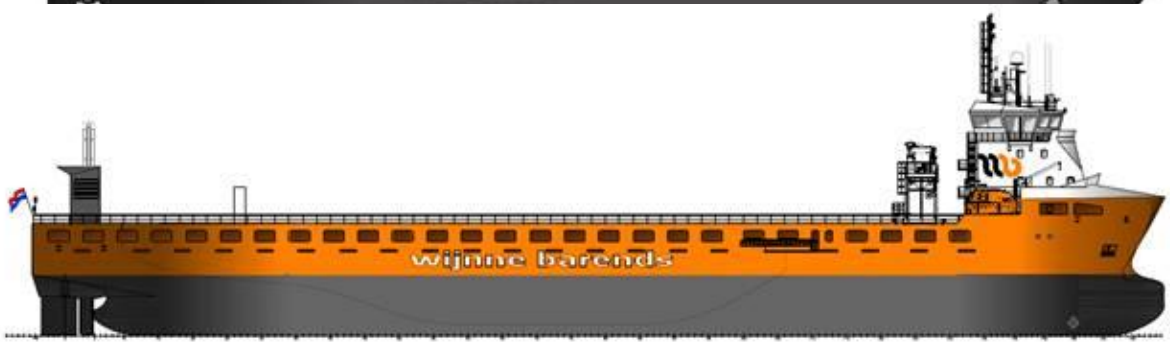
Agenda

- Introductie
- Waarom LNG als scheepsbrandstof ?
- Twijfels ?
- Wat zijn de alternatieven?
- LNG als scheepsbrandstof
  - Korte termijn / Lange termijn

Sjaak Klap - Introduction

- Spliethoff / 8 years of LNG > 7 LNG-fueled vessels for UPM

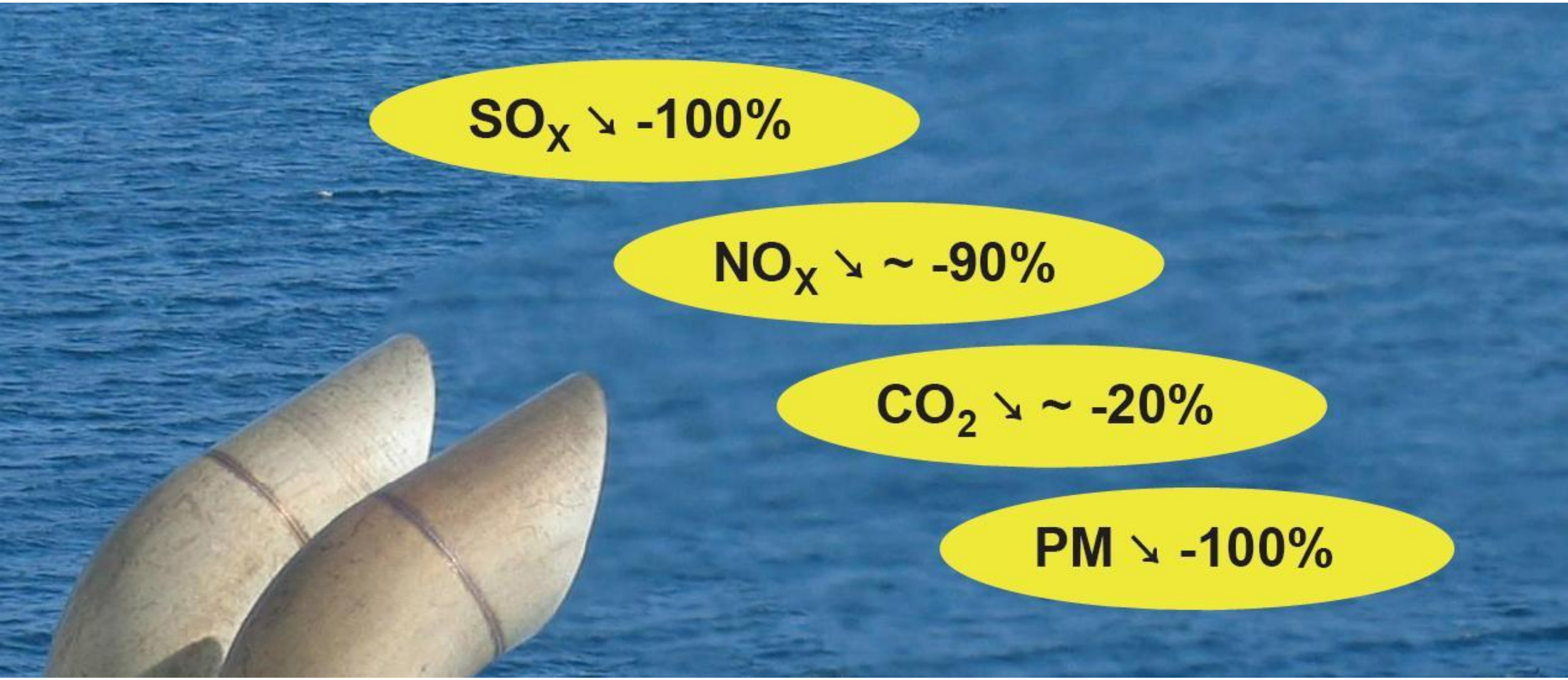




- Glowake / Maritime and Small-Scale LNG Expert

- The Society for Gas as a Marine Fuel (SGMF) / Principal Environmental Advisor

Waarom LNG als scheepsbrandstof?



Wat zijn de twijfels?

- Scheepsontwerp: LNG tank(s) gaan ten koste van ladingcapaciteit
- Beschikbaarheid
- Onbekendheid
- Veiligheid
- Training bemanning
- **Business Case**
- **LNG en CO_2 doelstellingen**

Business Case

- In principe eenvoudige rekensom
- Extra investering t.o.v. alternatief (MGO / LSFO / HSFO)
- Besparing op brandstofkosten
- Ieder project moet specifiek worden doorgerekend (kengetallen onbetrouwbaar)
- Geloofwaardige toekomstige brandstofprijzen scenario's essentieel
  - LNG is goed te voorspellen (onafhankelijk van Brent)
  - Vloeibare brandstoffen worden duidelijk na 2020; blijven afhankelijk van Brent

GHG emissie reductie

- Waar staat **35.000 ton CO_2** voor?

- Startpunt CO_2 reductie: COP 21 / Paris 2015
  - Uiteindelijke doelstelling: koolstof neutraal

- IMO - MEPC 72 “Preliminary Roadmap”
  - -/- 40 % (relatief) in 2030 Basis 2008
  - -/- 70 % (relatief) in 2050
  - -/- 50 % (absoluut) in 2050
  - Maatschappelijke druk om doelstellingen verder aan te scherpen

- 2050 doelstellingen onhaalbaar met huidige brandstoffen / technologie

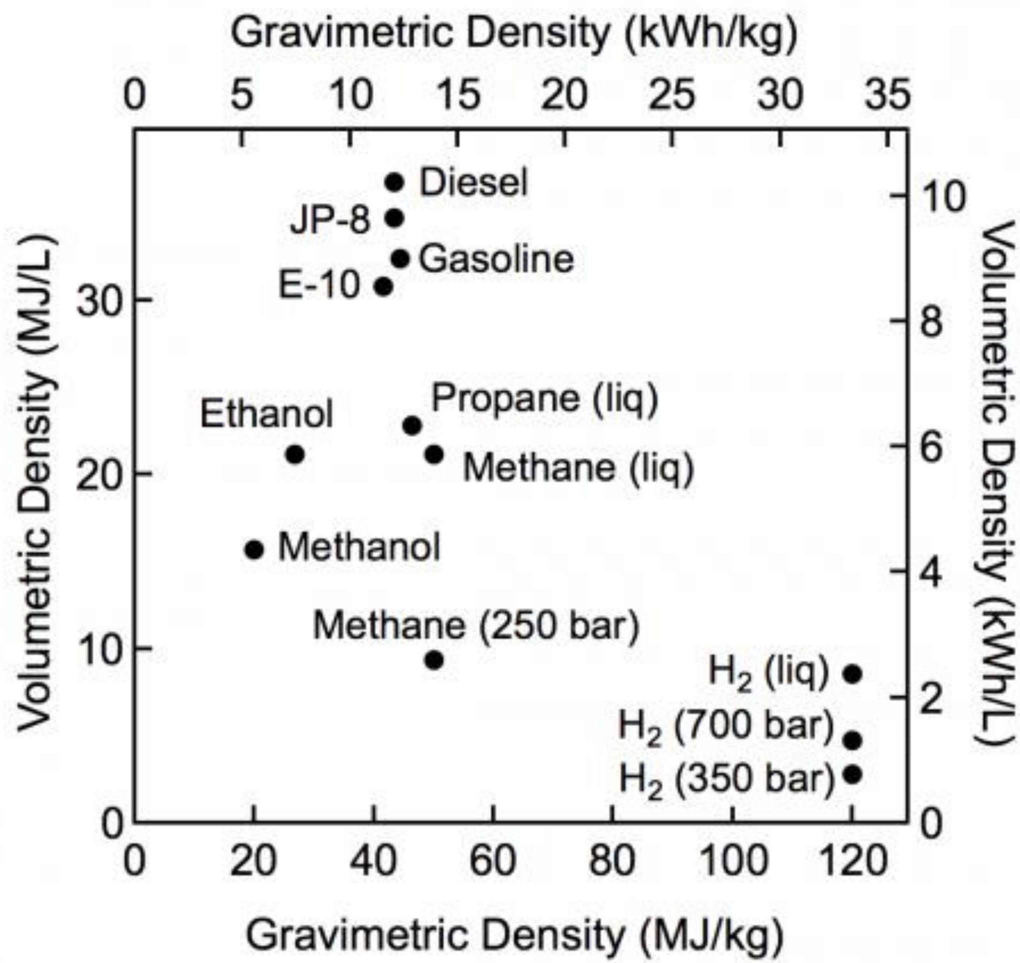
- Methaan slip

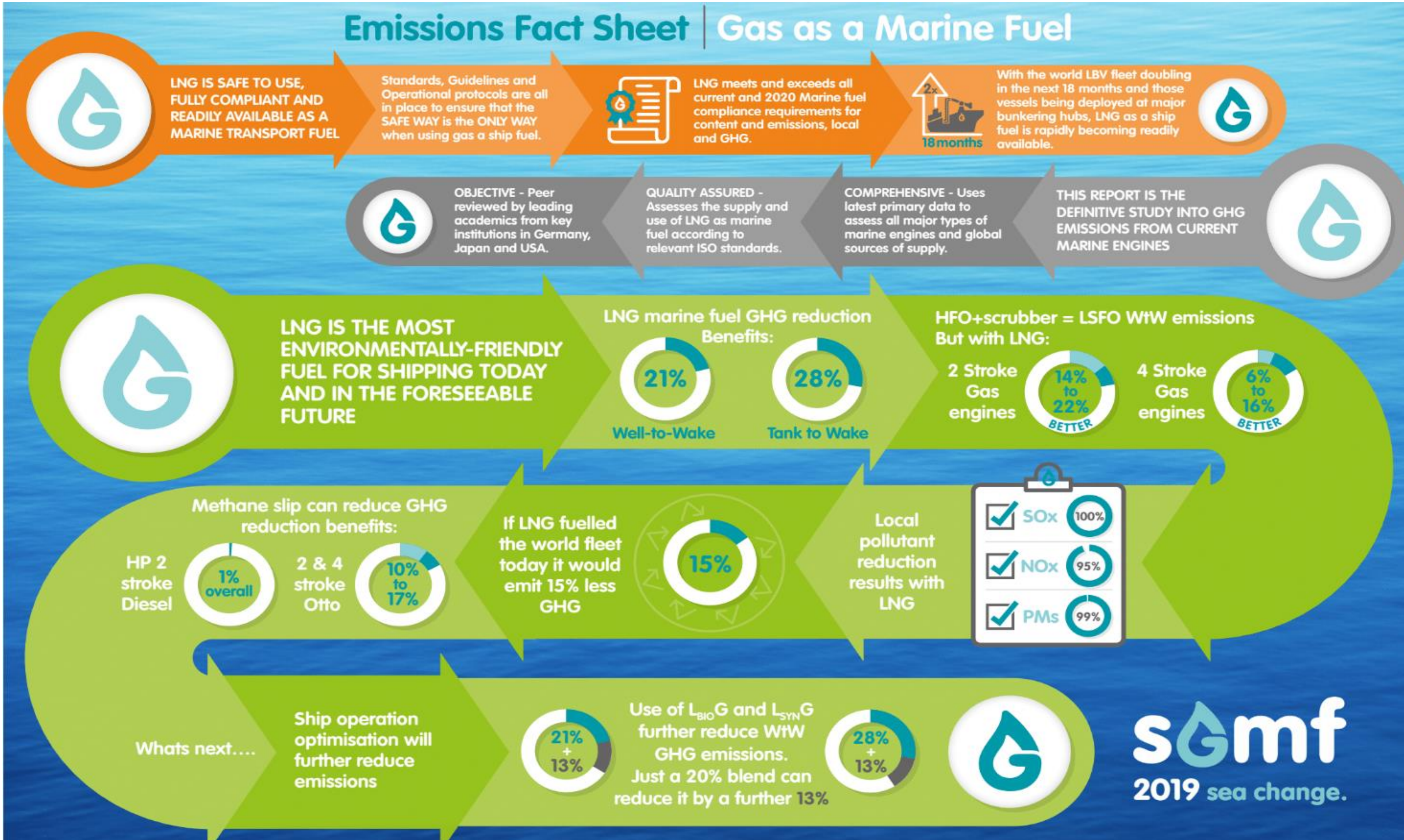
Alternatieve Brandstoffen (low / zero carbon)

- Beter: Energie dragers
- Duurzame productie essentieel (wind / zon / hydro)
- Opties:
  - Wind
  - Bio brandstoffen
  - Ethanol / Methanol
  - Waterstof
  - Ammonia
  - Batterijen
  - Synthetische brandstoffen (E-fuels / Power-to-X)
- En LNG?

Energie dichtheid

- Olie is de meest gunstige optie:





https://info.thinkstep.com/LNG-GHG-Study

Download the report: www.sgmf.info/posts

Alternatieven - hoe snel op te schalen?

- Scala aan studies gepresenteerd:
  - Verschillende studies > verschillende oplossingen
  - Kosten worden weinig meegenomen in deze studies
  - Trend: Geen enkele dominante brandstof / energiedrager

- Hoe ver in de ontwikkeling?
  - Methanol : plm. 10 schepen (meest methanol tankers)
  - Waterstof : Enkele testprojecten
  - Ammonia : Is er al concrete ervaring?

- LNG
  - 50 jaar ervaring met LNG carriers, 20 jaar met LNG-fueled vessels
  - 171 LNG-fueled schepen in bedrijf, bijna 200 in bestelling
  - Fossiel LNG vervangen door LBG (liquid biogas) of synthetische methaan
  - Methaan slip is punt van aandacht (SGMF / IMO)
  - **NU** beschikbaar voor een **competitieve** prijs

A recent short-sea project

- Local Emissions:
  - SO_x : practically nil
  - NO_x : -/- 90%
  - P.M. : practically nil

- Global Emissions:
  - CO_2 : Up to nett. -/- 20%

- CO_2 emission reduction when replacing older vessels:
  - More efficient design and machinery (fuel savings 20 – 25%)
  - Optimised operations (fuel savings say 5%)
  - MGO / ULSFO / HSFO > 25%
  - System CO_2 emission reduction in range of 45 – 50%.

LNG's position as a Marine Fuel today

Availability of Liquid Natural Gas for shipping:

- Rapid development in N.W. Europe (short sea trades)
- Accelerating development in other parts of the world (incl. deep sea trades)

Price level of LNG as marine fuel:

- Oil-related pricing declining; "hub-based gas" pricing gaining ground
- LNG's competitiveness improves at higher oil prices
- Price forecast post-2020: Between HSFO and LSFO/MGO

Reputation:

- Good concerning SOx - NOx - PM emissions
- Concern about GHG emissions:
  - Methane slip reduces effect of lower CO_2 emissions (25%)
  - LNG is a fossil fuel > LBG / synthetic methane

Conclusion:

- LNG is available today at competitive cost
- LNG will be one of the solutions in a future multi-fuel zero emission landscape
- Methane slip issue has to be solved

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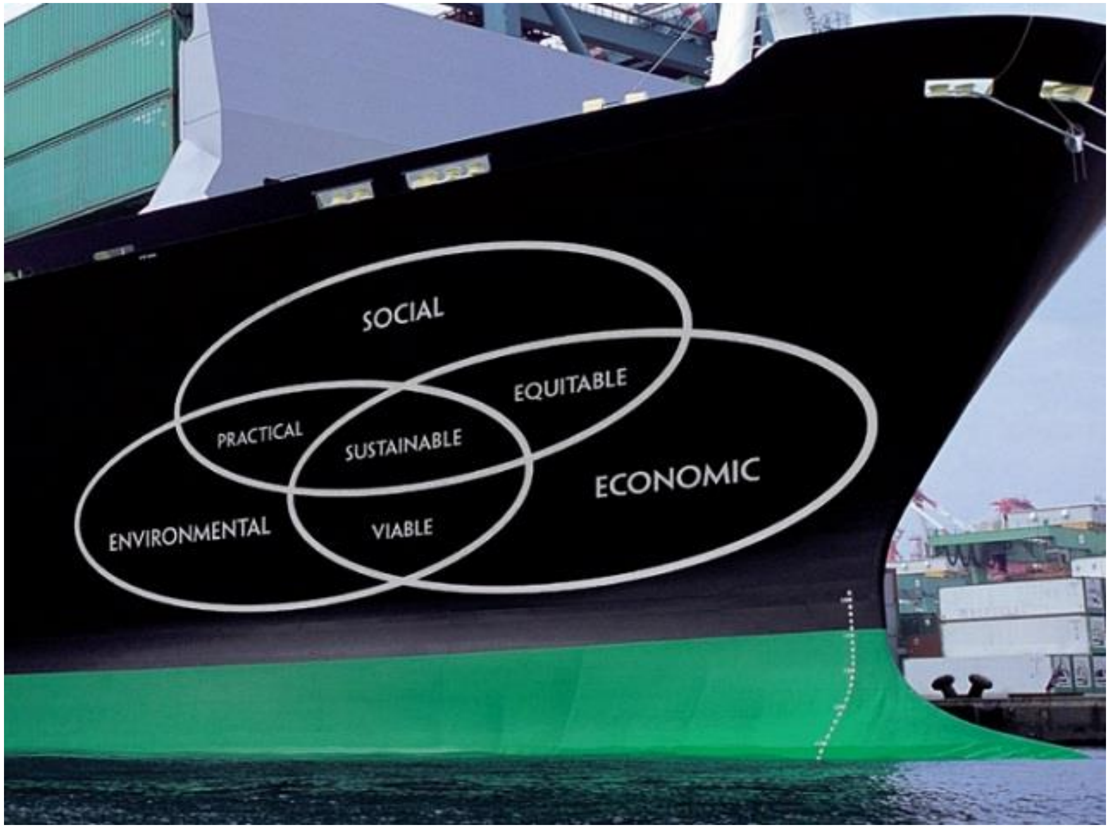


we sea change, do you?

sgmf

2019 sea change.

CLEAN MARITIME SHIPPING: COLLABORATIVE EFFORTS

Jarl Schoemaker, senior advisor Environmental Management

Seminar Platform Schone Scheepvaart – Energietransitie in de zeevaart, 3 December 2019

Port of Rotterdam

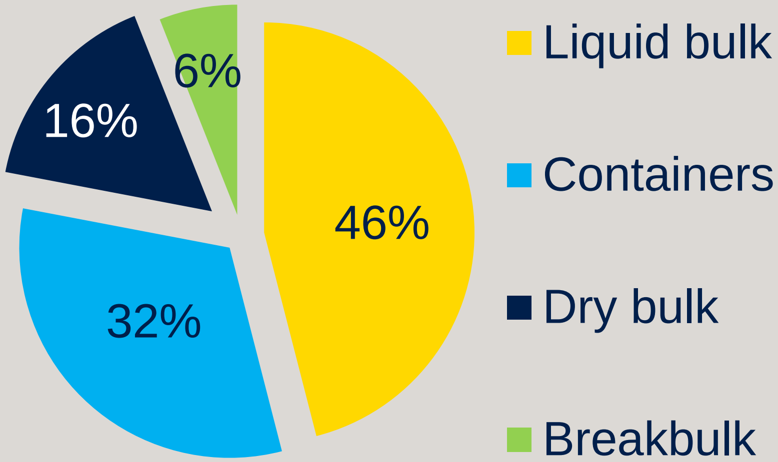
Shipping emissions

- EU port environmental priorities
  - Air Quality priority nr 1 for five years
  - Climate Change from nr. 10 to 3 in 2 years
- Rotterdam: industry in a climate neutral port
  - Energy efficiency and energy infrastructure
  - Transition to renewable energy and hydrogen
  - Circular feedstocks and fuels
- Transport: climate neutrality in 2050 for all modalities in port, <u>including shipping</u>
- IMO: 50% CO2-reduction between 2008 and 2050

	1996	2004	2009	2013	2016	2017	2018	2019
1	Port development (water)	Port waste	[illegible]	Air quality	Air quality	Air quality	Air quality	Air quality
2	Water quality	Dredging operations	Air quality	Garbage/ Port waste	Energy consumption	Energy consumption	Energy consumption	Energy consumption
3	Dredging disposal	Dredging disposal	Garbage/ Port waste	Energy consumption	Noise	Noise	Noise	Climate Change
4	Dredging operations	Dust	Dredging operations	Noise	Relationship with the local community	Water quality	Relationship with the local community	Noise
5	Dust	Noise	Dredging disposal	Ship waste	Garbage/ Port waste	Dredging operations	Ship waste	Relationship with the local community
6	Port development (land related)	Air quality	Relationship with the local community	Relationship with the local community	Ship waste	Garbage/ Port waste	Port development (land related)	Ship waste
7	Contaminated land	Hazardous cargo	Energy consumption	Dredging operations	Port development (land related)	Port development (land related)	Climate Change	Garbage/ Port waste
8	Habitat loss/ degradation	Bunkering	Dust	Dust	Water quality	Relationship with the local community	Water quality	Port development (land related)
9	Traffic volume	Port development (land related)	Port development (water)	Port development (land related)	Dust	Ship waste	Dredging: operations	Dredging: operations
10	Industrial effluent	Ship discharge (bilge)	Port development (land related)	Water quality	Dredging: operations	Climate Change	Garbage/ Port waste	Water quality

Source: European Sea Ports Organisation (ESPO)

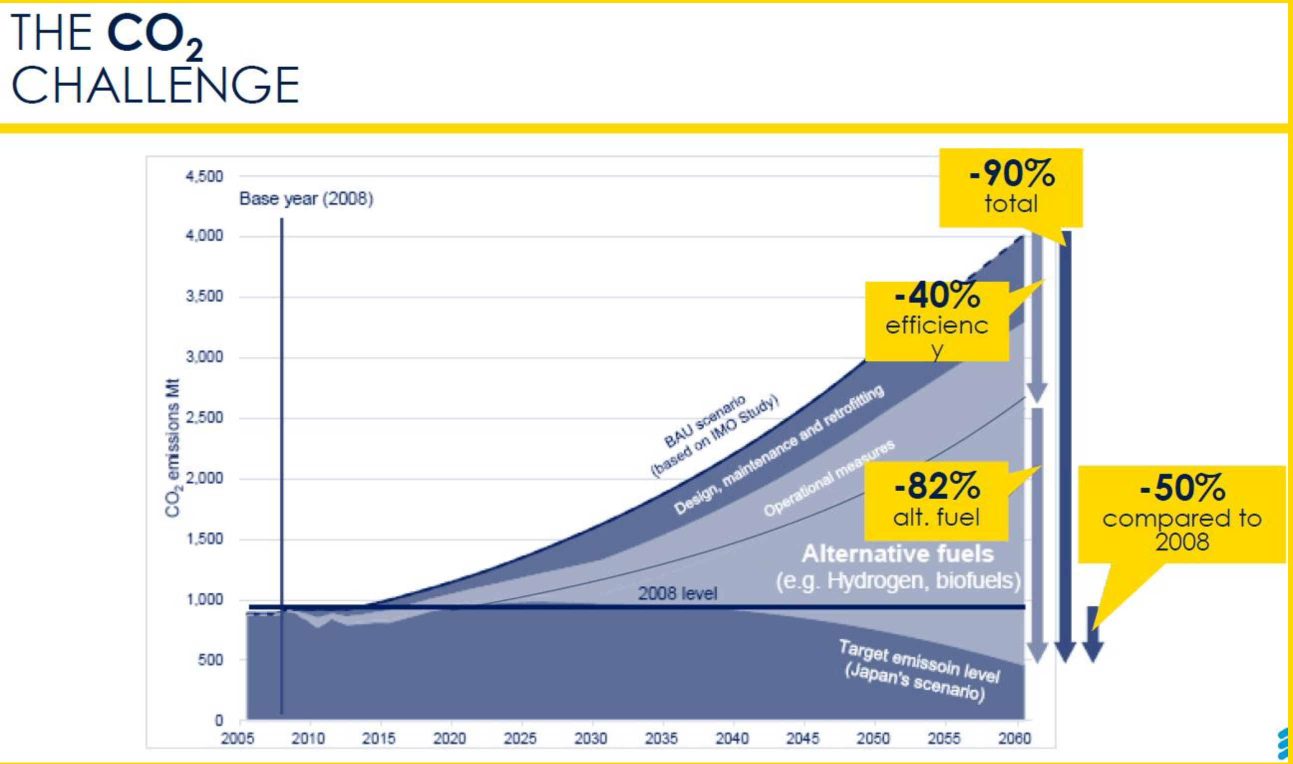
The Port is dominated by fossil energy and logistics



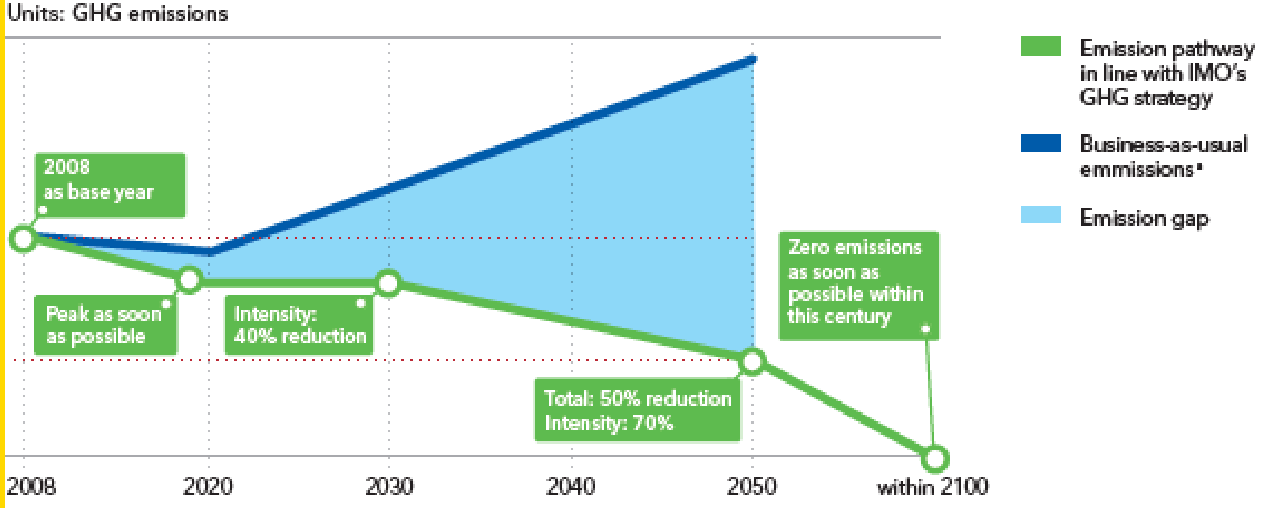
H1 2019

Port of Rotterdam

GHG challenge in shipping



IMO strategy for major reductions in GHG emissions from shipping



Total: Refers to the absolute amount of GHG emissions from international shipping.
Intensity: Carbon dioxide (CO_2) emitted per tonne-mile.
*Note that the the bussiness-as-usual emissions are illustrative, and not consistent with the emissions baseline used in our modelling (Chapter 6).

Source: DNV GL (2018a)

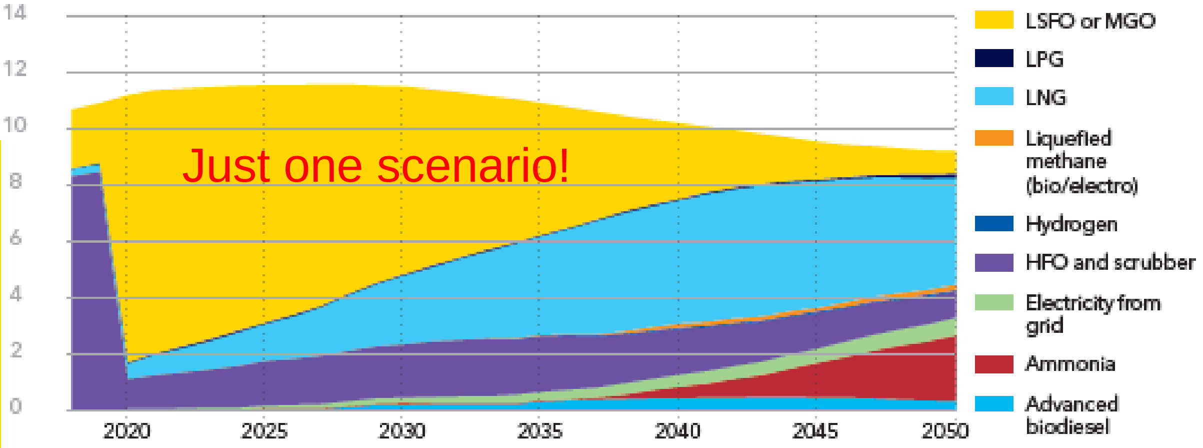
Port of Rotterdam

GHG challenge in shipping

- Efficiency measures and LNG are not enough
- Alternative fuels are crucial to achieve IMO GHG-reduction targets
- Slowly emerging insight in the future fuel mix
- First zero-emission ships have to be in service from 2030 onwards

Energy use and projected fuel mix 2018-2050 for the simulated IMO ambitions pathway with main focus on design requirements

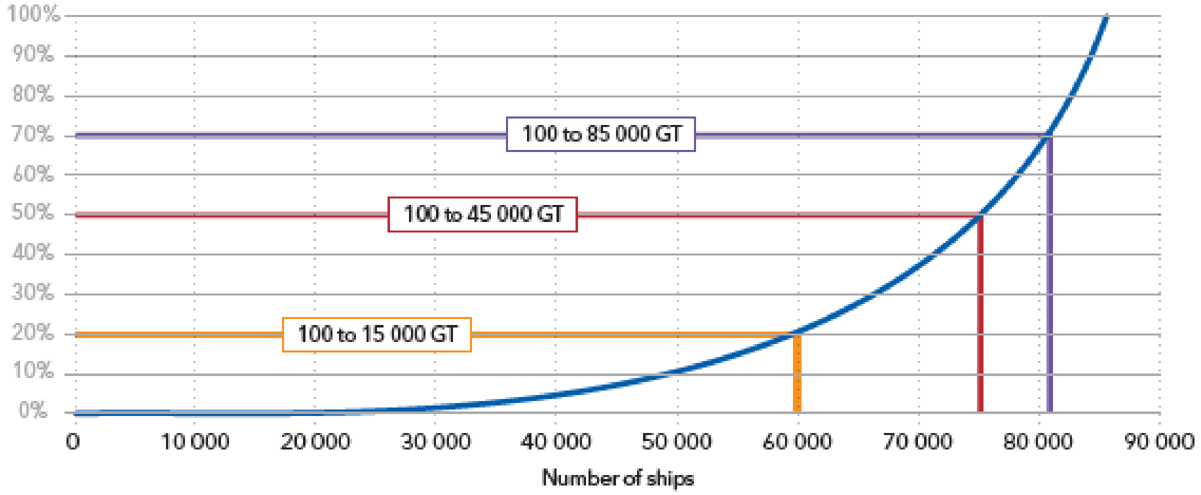
Units: EJ/yr



LSFO, low-sulphur fuel oil; MGO, marine gas oil; LPG, liquefied petroleum gas; LNG, liquefied natural gas; HFO, heavy fuel oil; Advanced biodiesel, produced by advanced processes from non-food feedstocks

CO_2 emissions from 86 000 ships in 2018 analysed by ship size[a]

Units: Share of CO_2 emissions

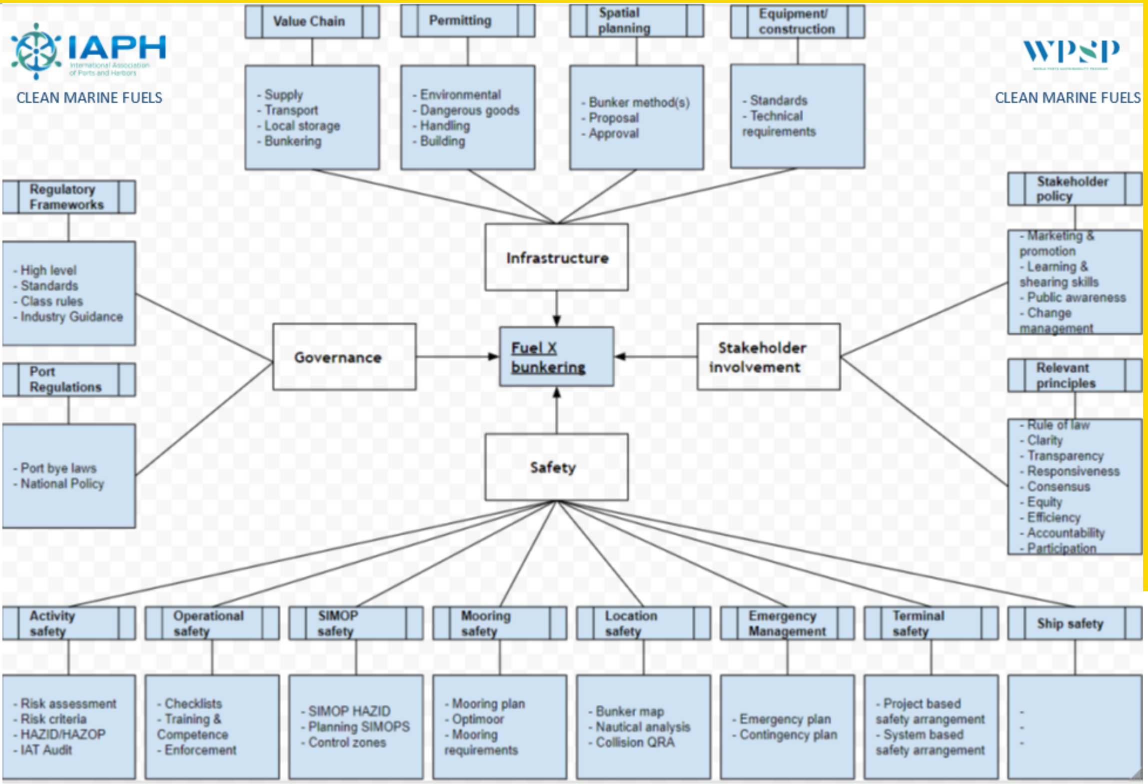


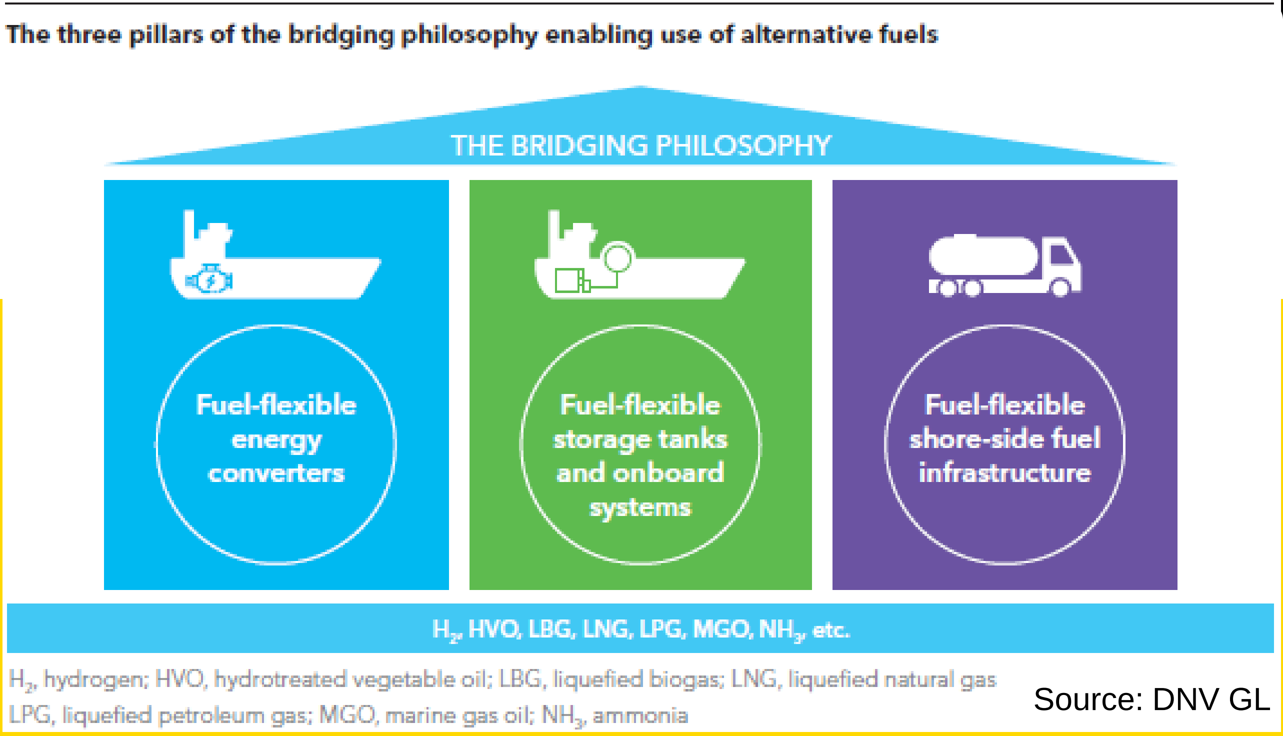
[a] Data for this analysis are accumulated CO_2 emissions for 86 000 ships observed in the AIS system in 2018 as a function of ship size in gross tonnage (GT), as calculated in our study.

Source: DNV GL

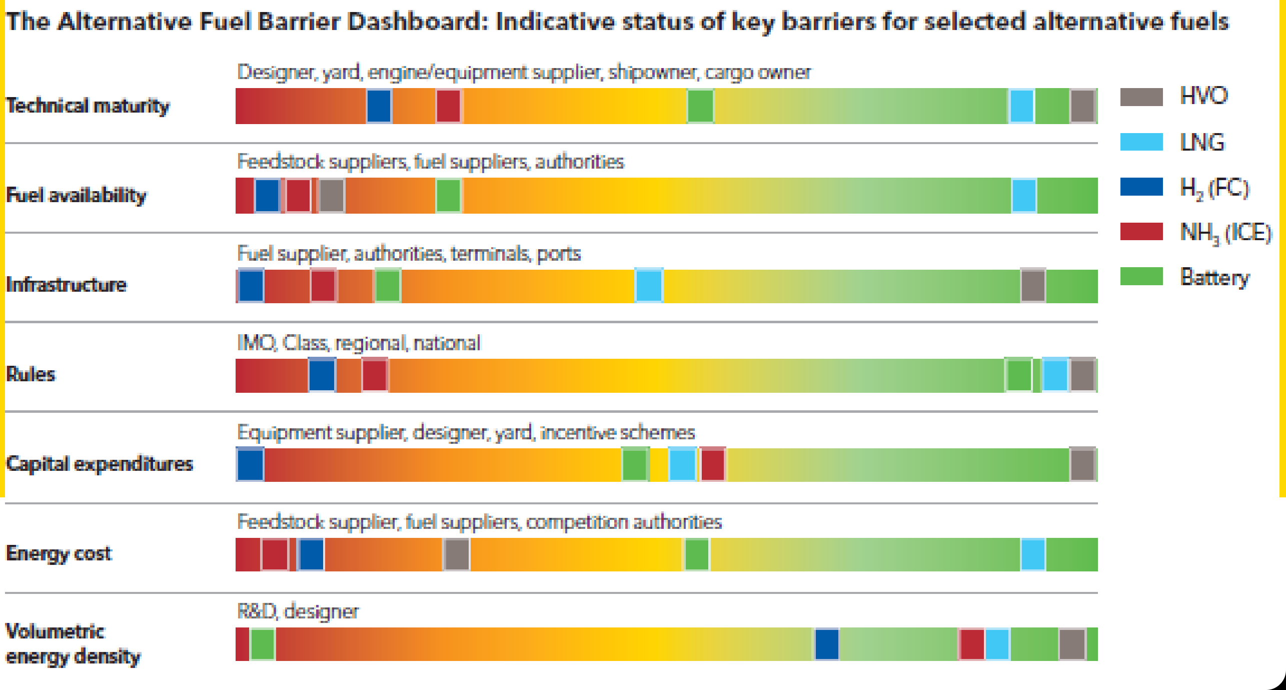
The future fuel mix

- Emerging consensus: fuel flexibility is the new keyword
- Feasibility depends on vessel type and route
- Changes in bunker mix and cargo flows
- Clean Marime Fuels working group





Source: DNV GL



How to tackle shipping emissions? IMO

Global regulation by the International Maritime Organisation

Air quality measures

- IMO 2020 SOx; NECA North Sea and Baltic
- *But*: local pressure e.g. on scrubbers, NOx Tier III for existing vessels, noise

Initial GHG-emission reduction strategy

- Vessel design requirements, operational improvements, alternative fuels and propulsion systems
- *But*: urgent action needed on a global market-based measure for GHG (fuel tax, ETS, GHG fund, …)
  - No progress expected unless price differential with cheap fossil fuels is tackled
  - Slow progress at IMO could lead to suboptimal regional measures (plan B)
  - Boundary conditions: no carbon leakage, low administrative burden, …

Increased collaboration with partners in the value chain, including ports

How to tackle shipping emissions? IMO and ports

MEPC resolution that invites Member States to encourage voluntary cooperation between the port and shipping sectors to reduce GHG emissions from ships:

- Clean Marine Fuels
- Port call optimization (just-in-time, digitalisation, data exchange)
- Onshore Power Supply
- Voluntary incentive schemes for ships that go beyond IMO requirements

IMO INTERNATIONAL MARITIME ORGANIZATION

E

MARITIME ENVIRONMENT PROTECTION COMMITTEE
74th session
Agenda item 7

MEPC 74/7/10
8 March 2019
Original: ENGLISH

REDUCTION OF GHG EMISSIONS FROM SHIPS

Draft MEPC resolution that invites Member States to encourage voluntary cooperation between the port and shipping sectors to reduce GHG emissions from ships

Submitted by Argentina, Canada, Cook Islands, Islamic Republic of Iran, New Zealand, Panama, Singapore, ICS, IAPH, IMPA, WWF, RINA, IHMA and FONASBA

SUMMARY	
Executive summary:	MEPC 73 invited Member States and international organizations to work with Canada and the International Association of Ports and Harbors (IAPH) on a draft MEPC resolution that encourages port developments and activities to facilitate the reduction of GHG emissions from ships, for submission to MEPC 74. This document proposes a draft resolution for adoption by the Committee at MEPC 74.
Strategic direction, if applicable:	3
Output:	3.2
Action to be taken:	Paragraph 20
Related documents:	Resolution MEPC.304(72); MEPC 73/7/1, MEPC 73/7/5, MEPC 73/13/4, MEPC 73/19 and ISWG-GHG 4/2/1

Introduction

1 The *Initial IMO Strategy on reduction of GHG emissions from ships* (the Initial Strategy) sets out clear objectives, vision and levels of ambition. The Initial Strategy also lists candidate short-term measures that could be finalized and agreed by the Committee between 2018 and 2023, including measure 4.7.8 to encourage relevant port developments and activities.

2 Ports contribute to mitigating land-based emission sources. They are subject to local, regional or national GHG emission reduction plans under Nationally Determined Contributions (NDCs) under the Paris Agreement. While the main responsibility to achieve the objectives of the Initial Strategy lies with the shipping sector and ports themselves fall outside IMO's jurisdiction, it is acknowledged that ports and shipping can cooperate to facilitate GHG

I:\MEPC\74\MEPC 74-7-10.docx

Port of Rotterdam

How to tackle shipping emissions? Europe and member states

- The European Union:
  - Stronger **strategic research agenda**, innovation and **deployment** of new technologies and fuels, including funding
  - Regulatory package based on impact assessment taking into account all relevant effects and competitiveness
- National:
  - IMO Delegation support for higher GHG-reduction ambition
  - NL Green Deal on waterborne transport (*including tax exemption on electricity for onshore power supply*)
  - Local initiatives to implement stricter local air quality measures
  - Urgent problem with NOx-deposition (shipping minor contributor)

How to tackle shipping emissions? Port of Rotterdam examples

- Support for IMO regulations (IMO 2020, NECA)
- Port of Rotterdam incentives:
  - Environmental Ship Index
  - Green Award
  - LNG bunker incentive
- *Effectiveness of incentives?*
  - *Port incentives stimulate use of cleaner fuels*
  - *Will not cover investment costs*
- Leading role in facilitating LNG as shipping fuel

- Energy Transition Program
- Support for production of low carbon fuels (e.g. bio-LNG)
- Support for studies, e.g. methanol
- Low-carbon fuel fund – 5 million Euro
- IAPH World Port Sustainability Program
- World Port Climate Action Plan
- Patrol vessels: biofuels and hybrid propulsion

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The Ultimate Goal

Port of Rotterdam

Leading the Energy Transition

CO_2 reduction: We follow the global ambitions of the Paris Agreement and we aim to meet the targets of the National Climate Agreement: -49% in 2030 and CO2 neutral in 2050.

New economic Developments:

- Twofold strategy: we help the existing industry to make drastic reductions in their CO2 emissions while also attracting new, sustainable industry.
- New opportunity's for a strong competitive position
- The energy transition kickstarts the new and sustainable economy of the future;

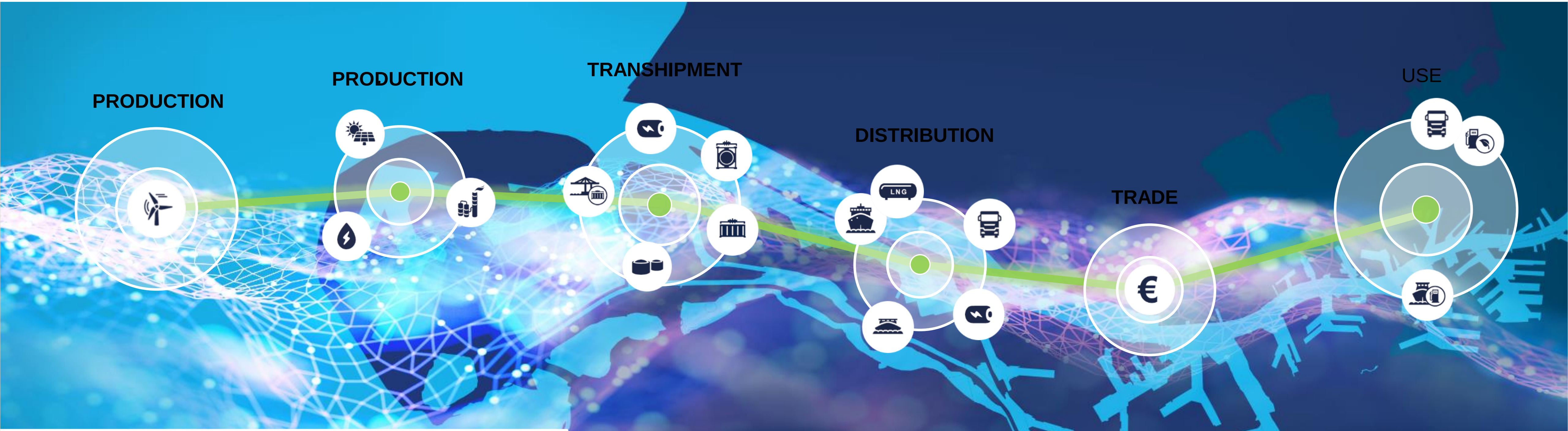
Energy Transition Program – Port of Rotterdam

Energy-Infrastructure	*Renewable Energy*	*Electrification*	*Circular Economy*	*Renewable fuels and chemicals*	*Alternative Fuels*	*Sustainable Supply Chains*
Carbon Capture Utilization and Storage (CCUS) – Porthos	North Sea Wind Power Hub	Electrolysis (Power 2 H2)	Pyrolyse	Waste to Chemicals	Containerized Batteries	Efficiency measures via digital supply chains
Heat Roundabout	Solar Program	Power 2 heat	Carbon Capture and Utilization	Biochemicals	LNG	Modal Shift
	Offshore Wind	Power 2 products	Ramlab	Biofuels	Shore Power	
	Geothermal Energy	Upgrade of e-infrastructure			Synfuels	
	Blocklab					

RIGHT HERE.

RIGHT NOW.

Ambition: develop the port as the production, logistic- and usercenter for alternative transport fuels with zero emission



New fuels

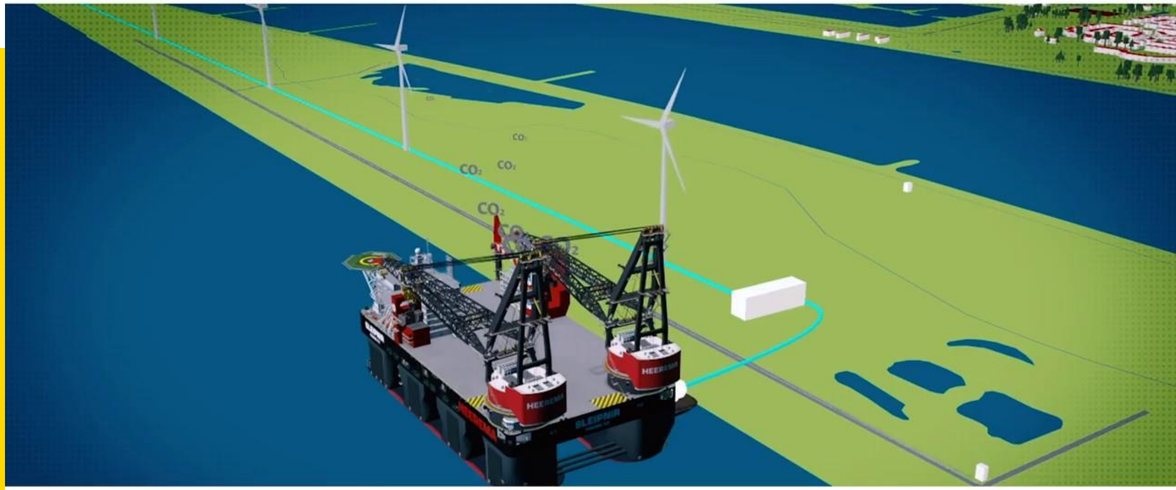
New Supply Chains
New Business models
New bunker infrastructure
New regulation& policies & incentives

Port of Rotterdam

Power-to-Ship demonstration projects

- Shore Power Project Calandkanaal
  - 20MW connection with electricity directly from nearby windpark – Heerema Marine Contractors as foundation customer
  - Electrical hub designed to supply more vessels in the area
  - Power-to-Ship as-a-service model (3rd party investors)
- Pilot project mobile Power-to-Ship solutions
  - Government and city funded project showcasing and testing mobile power units
  - First phase for small power users
  - Second phase larger power users (2020)
- Lesson learned: sector-specific treatment, public financing and equal fiscal treatment necessary

MARITIME KVNR SHIPPING AWARD NOMINEE 2019



Shore Power Caland Canal - Heerema Marine Contractors

Port of Rotterdam

Opportunity: modular battery-concept for the IWT- and energy markets

+

=

ING
HEINEKEN
WÄRTSILÄ
ENGIE
Port of Rotterdam
CCT Combined Cargo Terminals
Eneco
BCTN

Battery container storage systems, to be used for:
- Renewable energy storage
- Power grid balancing: frequency control reserve
- Peak shaving
- Events
- **<u>Propulsion for inland navigation</u>**

+

- Container Energy Storage Systems for inland vessel propulsion:
- No delays for loading batteries
- Pay-per-use only

=

- CO_2 neutral shipping
- Competitive prices compared to gasoil with NRMM stage V engines
- Shipowner is not the owner of the batteries
- New Energy Storage Company (ESC) invests on basis of multiple cashflows
- Scaling up to 600-800 barges possible

Port of Rotterdam

What is needed?
Collaboration throughout the value chain

- Collaboration throughout the value chain:
  - Required for both operational efficiency improvement and the introduction of alternative fuels
  - Shipping sector, maritime technology industry, shippers (cargo owners), logistics service providers, regulators, IT-industry, banks, finance institutes, energy companies and bunker industry,
- Focus on both local air quality and climate change: diverse challenges in different ports
- Supportive & stable political landscape with regulatory package, strategic research agenda and funding
- First priority: commercial availability of clean and low-carbon fuels (but LNG remains important)
- Development of alternative fuel (e-)bunkering infrastructure
- Urgent action on a global GHG market-based measure

Port of Rotterdam

Who joins us?

www.portofrotterdam.com

Port of
Rotterdam

Walstroom Calandkanaal

Platform Schone Scheepvaart
Energietransitie in de scheepvaart

Vincent Doedée (Heerema)
Stefan van Doorn (Eneco)

MARINE CONTRACTORS
Port of Rotterdam
Eneco

Walstroom Calandkanaal

Agenda

1. **Wat is walstroom Calandkanaal?**
2. **Waarom interessant?**
3. **Wat hebben we gedaan?**
4. **Ambities schone scheepvaart**
5. **Op weg naar een schone scheepvaart**

Sustainability
Electrification
Rotterdam
Infrastructure
Emission Reduction
Walstroom
Rozenburg

Wat is walstroom Calandkanaal?

Sustainability

Electrification

Rotterdam

Infrastructure

Emission Reduction

Walstroom

Rozenburg

Waarom interessant?

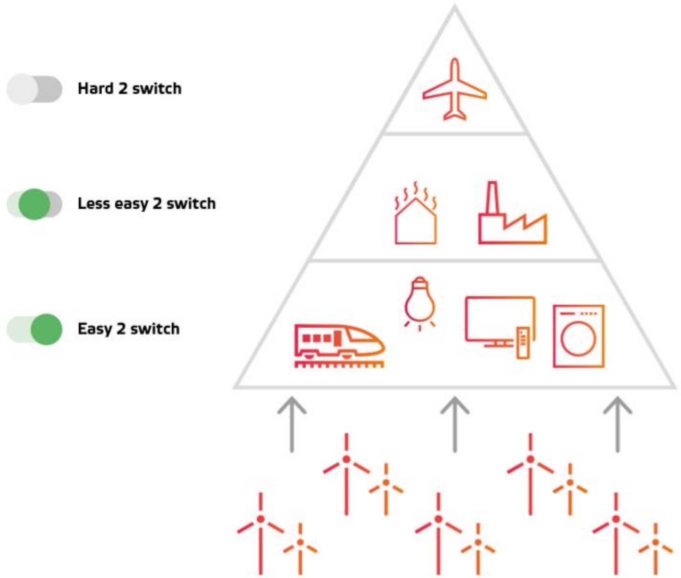
Heerema:

1. Verantwoordelijkheid nemen
2. Stakeholders
    1. Geluid
    2. Emissies
3. Besparing

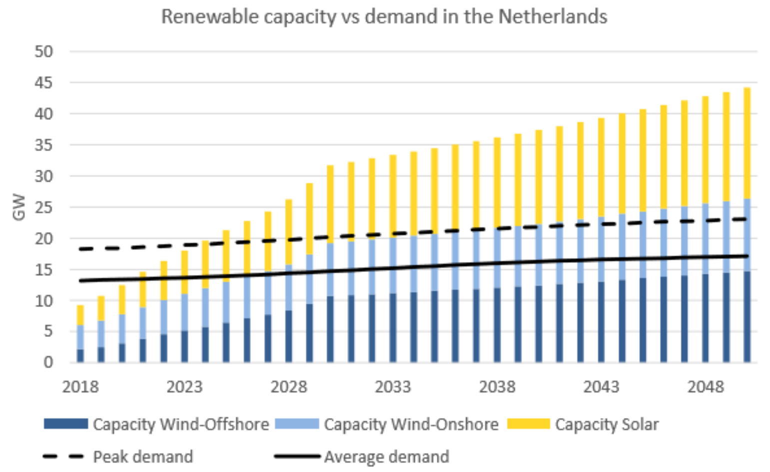
Waarom interessant?

Eneco:

1. Missie is 'duurzame energie van iedereen'
2. Eneco is koploper in het verduurzamen van bestaand elektriciteitsgebruik. De uitdaging ligt nu in het verduurzamen van andere fossiele stromen (mobiliteit en warmtevraag).
3. Om de energietransitie betaalbaar te maken zal de elektriciteitsvraag ook moeten toenemen en consumptie bij opwekking plaatsvinden (sterke aanwezigheid Eneco in de havens).



ainability
Electrification
Rotterdam
Infrastructure
mission Reduction



Wat hebben we gedaan?

Proces

1. Gestart met een haalbaarheidsstudie
   1. Aansluiten op windpark Eneco?
   2. Batterij voor peakshaving?
2. Conclusie haalbaar op alle vlakken behalve economisch
3. Geïdentificeerde kansen
   1. Gelijk speelveld met fossiel creëren
   2. Op zoek naar meer klanten
   3. Subsidie

Wat hebben we gedaan?

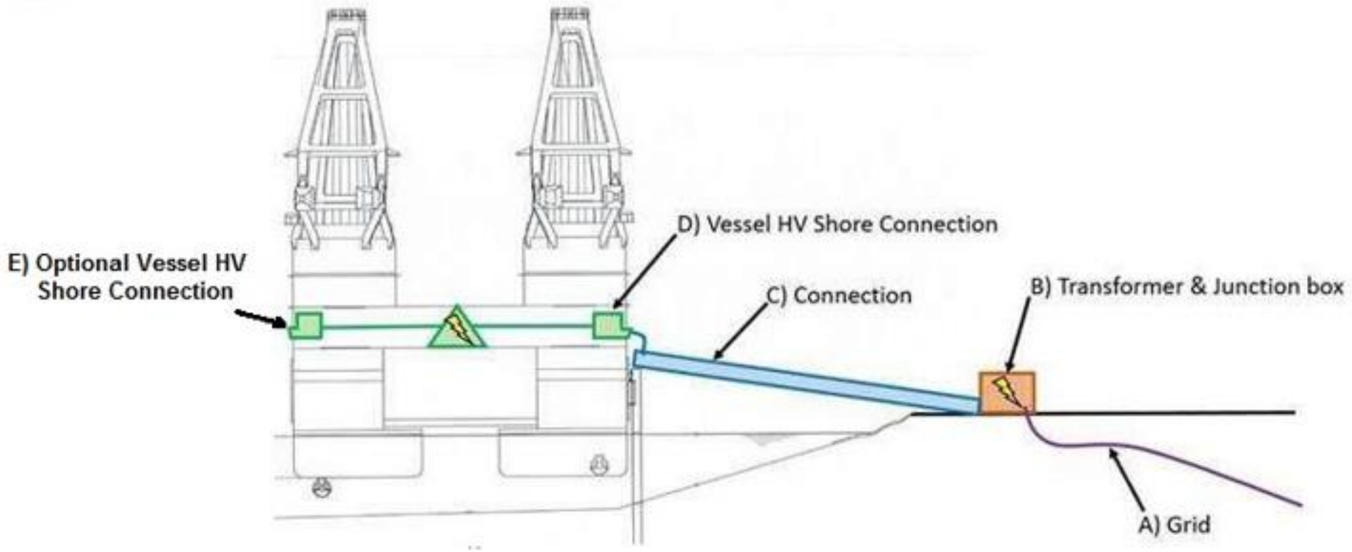
Gebiedsoplossing

Sustainability
Electrification
Rotterdam
Infrastructure
Emission Reduction
Walstroom
Rozenburg

Wat hebben we gedaan?

Scope of Work Vessel Conversion

- Physical connection SB/PS
- Breaker cabinet and fireproof housing
- Aanpassingen aan switchboard
- Cable routing through deck
- Possible pre-magnitization of Thialf transformers
- Lloyd's discussion with specifics on short circuiting ongoing



Ambities Schone Scheepvaart Heerema

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Rozenburg

Ambities Schone Scheepvaart Heerema

Sustainable Achievements		Sustainable Themes		Sustainable Ambitions		Sustainable Company
1st Sustainable Offshore Initiative (Our Oceans Challenge)	Main Office (A+++)	Offshore Excellence	Good Health and Well-Being	Smart Materials and 3D Printing	Fuel and Energy Efficiency	**Dare to Care** — Heerema Marine Contractors — Zero Incidents. Zero Waste. Carbon Neutral.
Sleipnir LNG	Support Local Communities	Sustainable Supply Chain Management	Reduce Footprint and Emissions (CO_2)	Automation	Shore Power	

NOW

Sustainability
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Infrastructure
Emission Reduction
Walstroom
Rozenburg

Ambities Schone Scheepvaart Heerema

Carbon neutral by 2025?

Prevent		Reduce		Compensate		Realized
Shore Power	Main Office √	Sleipnir LNG √	Economic Sailing √	Reforestation	BP Target Neutral	Prevent 0%
Power Management	Crane Utilization	GTL Fuel	Biofuels	Cook stoves	Solar Lamps	Reduce 10%
						Compensate 0%

Sustainability

Electrification

Rotterdam

Infrastructure

Emission Reduction

Walstroom

Rozenburg

Ambities schone scheepvaart Eneco

Eneco:

1. Meer walstroom voor de zeevaart
2. Batterijen
3. Groene waterstof

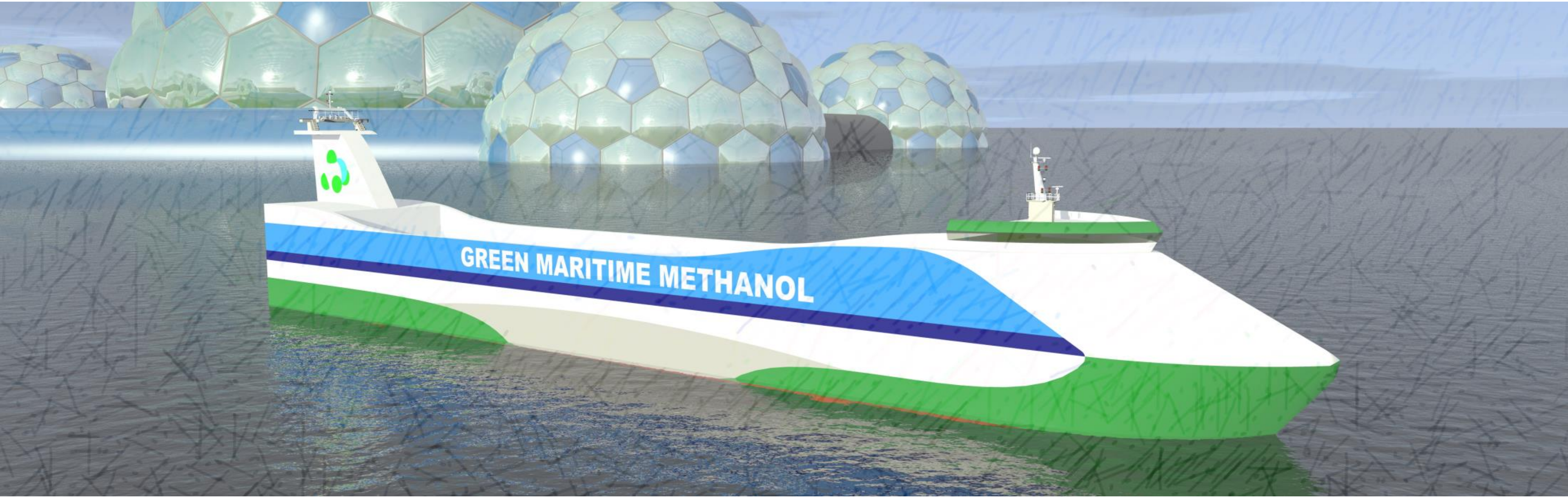
Sustainability
Electrification
Rotterdam
Infrastructure
Emission Reduction
Walstroom
Rozenburg

Op weg naar een schone scheepvaart

1. Open en transparante samenwerking
2. Kijk naar de maatschappelijke waarde
3. Klant die de strategische waarde van schone scheepvaart ziet

ity
Electrification
dam
frastructure
Reduction
alstroom
burg

GREEN MARITIME METHANOL



WP4 planning

Why Methanol?

- Promising options for implementation in the short to medium term:
  - Methanol production capacity is readily available worldwide.
  - Energy density of the fuel makes methanol optional for small and medium sized vessels
  - As an energy carrier fossil-based methanol can reduce CO2-emissions by up to 10% compared to MDO, and furthermore improve air quality emissions (SOx, NOx and PM).
  - Implementation of both biobased or synthetic feedstock is possible further reducing WTP CO_2-emissions.

GREEN MARITIME METHANOL

TNO
Maritiem Kennis Centrum
MARIN
Defensie Materieel Organisatie
Ministerie van Defensie
TU Delft

BioMCN
HELM
METHANOL INSTITUTE

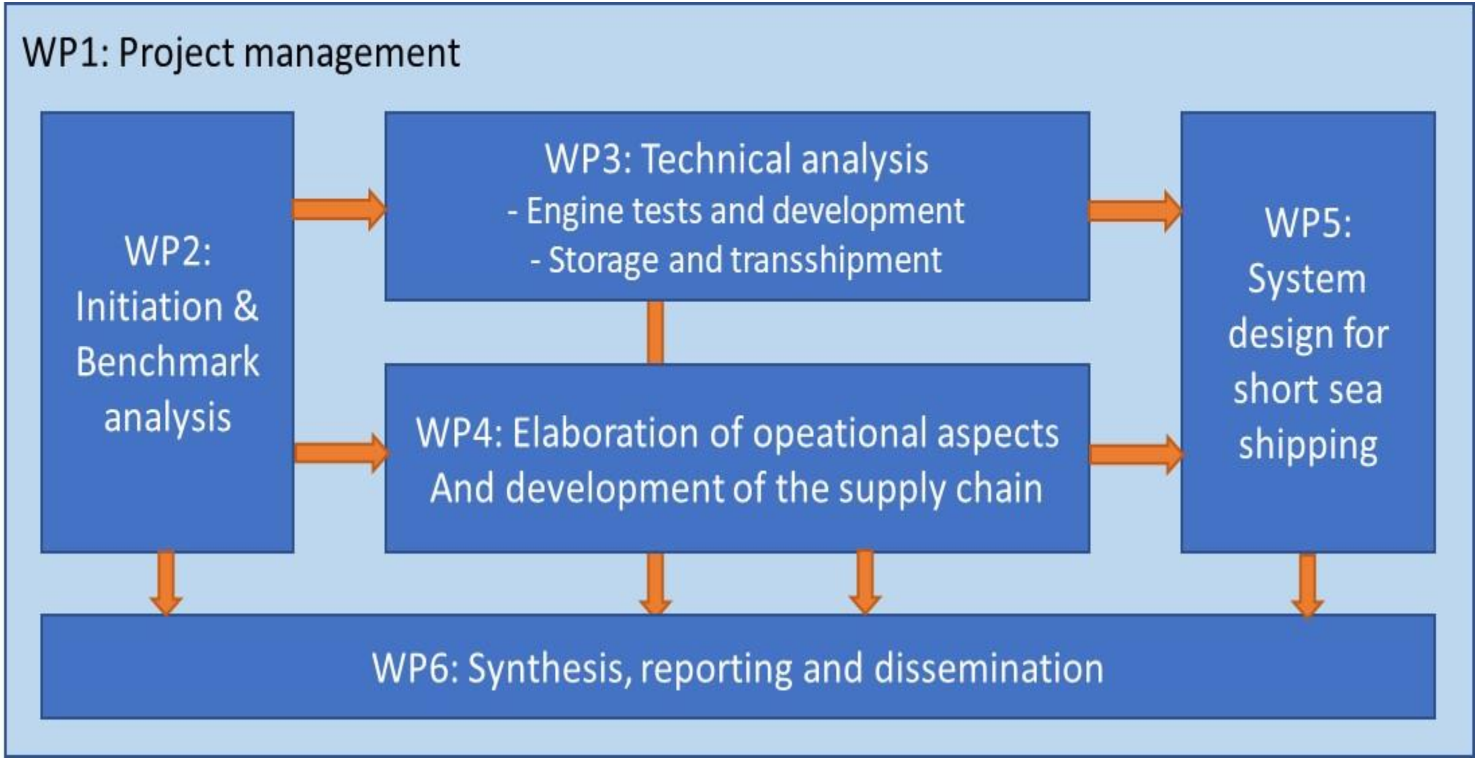
Van Oord
Ministerie van Defensie
Boskalis
ROYAL WAGENBORG
KONINKLIJKE VERENIGING VAN NEDERLANDSE REDERS

FEADSHIP
ROYAL DUTCH SHIPYARDS
C-JOB
DEDICATED NAVAL ARCHITECTS
IHC
DAMEN
Lloyd's Register
BUREAU VERITAS
1828

mtu
WÄRTSILÄ
MARINE SERVICE NOORD
pon
CAT
VIV

Port of Rotterdam
Port of Amsterdam

GREEN MARITIME METHANOL



GREEN MARITIME METHANOL

Example operational profile

- Long term contract
- Enough capacity to complete round trip on methanol
- A range of 1600nm is left at the time of bunkering
- Bunkering should take place every round trip
- All MGO tanks may be converted to methanol storage

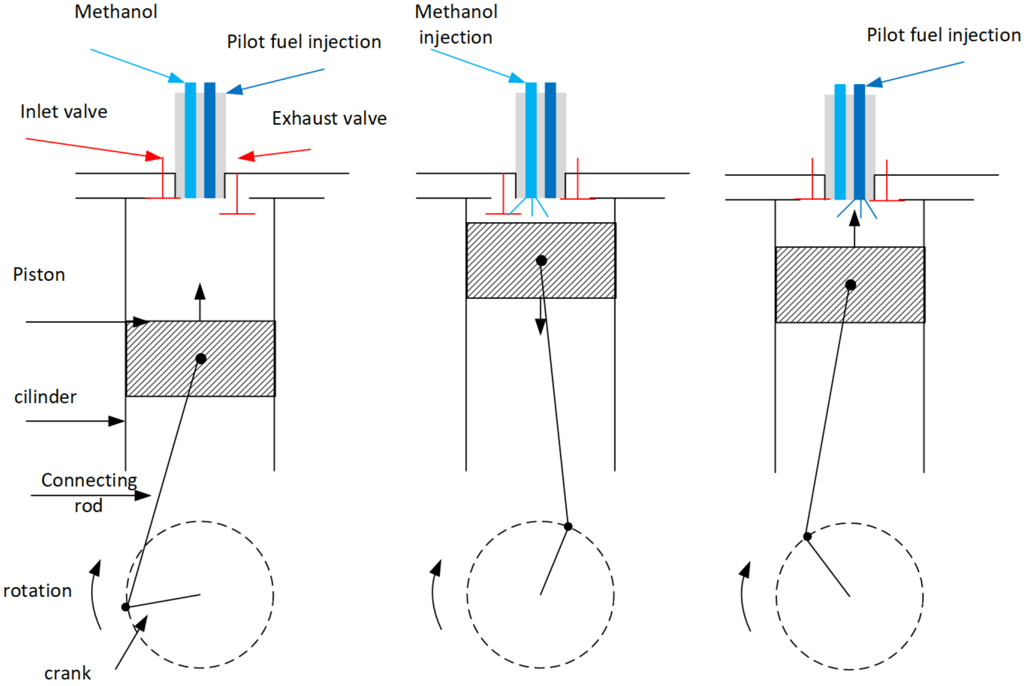
- The required bunker quantity does not allow for tank-to-ship bunkering. A local storage tank or a bunker ship would be required. Possibly source from local chemical plants.

MGO				**Methanol**		
Capacity	865	m3		Capacity	865	m3
Bunkering quantity	293	m3		Bunkering quantity	596	m3
Margin	572	m3		Margin	269	m3
% in tank	66%			% in tank	31%	
Total range MGO	10504	nm		Total range methanol	5167	nm
Range when bunkering	6946	nm		Range when bunkering	1609	nm

GREEN MARITIME METHANOL

Engine tests: different options to be considered

- Gas engine
- Retrofit diesel engine
- New engine pilot fuel



WP4 Operational and Supply Chain aspects

- Objective
  - Define the impact of use of methanol as a fuel on ***daily operation***
  - Define options for day-to-day ***bunkering procedures***.
  - Elaboration of the ***fuel chain*** including transshipment in the short and long term

- Results
  - Different ***scenarios for short sea shipping trades*** and insight in the various energy demands on board (TNO with ship owners).
  - Proposal for ***bunkering strategies*** in the short and long term (TNO with Port Authorities)
  - ***Upstream supply chain analysis*** including strategies for pricing (TNO with Methanol supply chain partners)

Three obvious tasks

- Operational aspects
- Bunkering strategies
- Upstream SC analysis

GREEN MARITIME METHANOL

System Design

Nedstack
PEM FUEL CELLS

Let’s Navigate towards Zero-Emission Shipping!

The path towards maritime fuel cell industrialization in the Netherlands

Seminar Platform Schone Scheepvaart – December 2019

Nedstack First

Name	**Nedstack Fuel Cell Technology BV**
Location	Westervoortsedijk 73-VB, Arnhem, the Netherlands
Founded	1999
Ownership	Privately

Website	www.nedstack.com
Industry	PEM Fuel Cells
Logo	Nedstack PEM FUEL CELLS

High lights

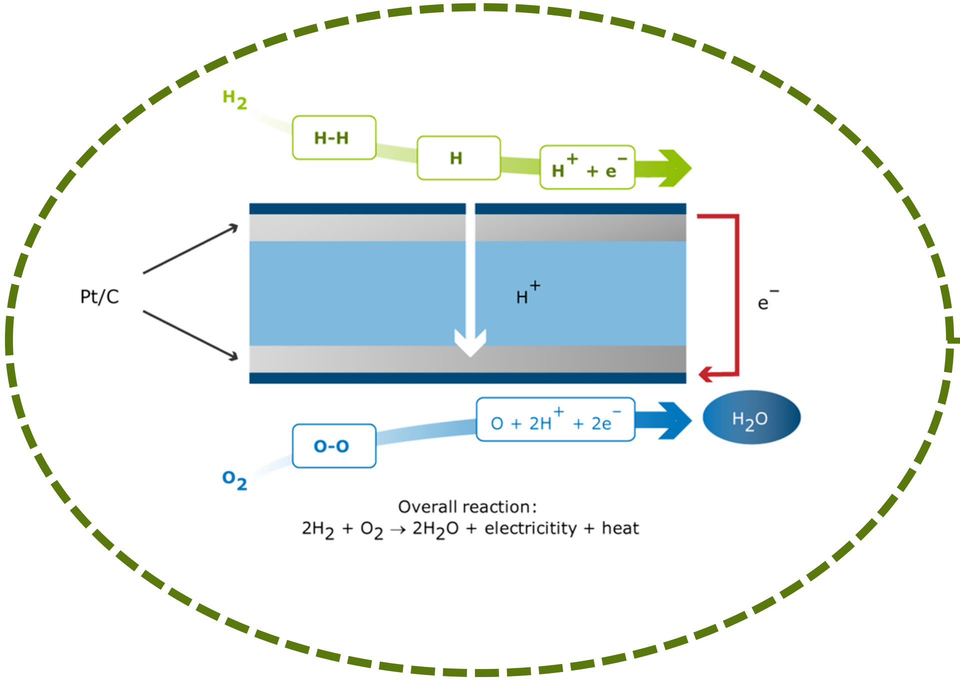
- Leading Global Player in High Power PEM-FC Technology;
  - Longest PEM Power Plant in Operation > 10 years;
  - First MW Sized PEM Power Plant (1MW);
  - Largest PEM Power Plant > 2 / 3.6 MW.
- > 700 FC Systems installed-base;
- > 23.000 Hours in-use FC Stack Lifetime demonstrated;
- In-house stack assembly – systems with co-makers on Nedstack IP;

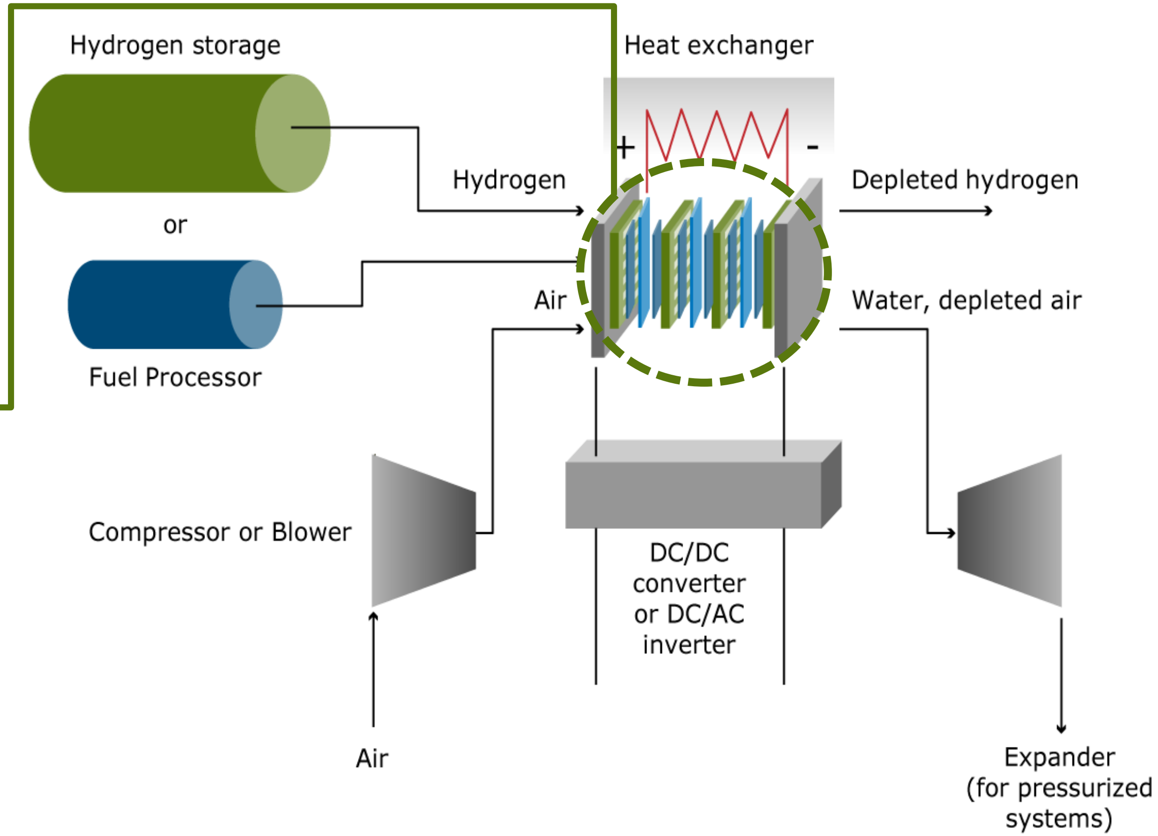
Specialized in Containerized Power Plants

Nedstack main location

PEM Fuel Cells and Fuel Cell Power Installations

From powder to power

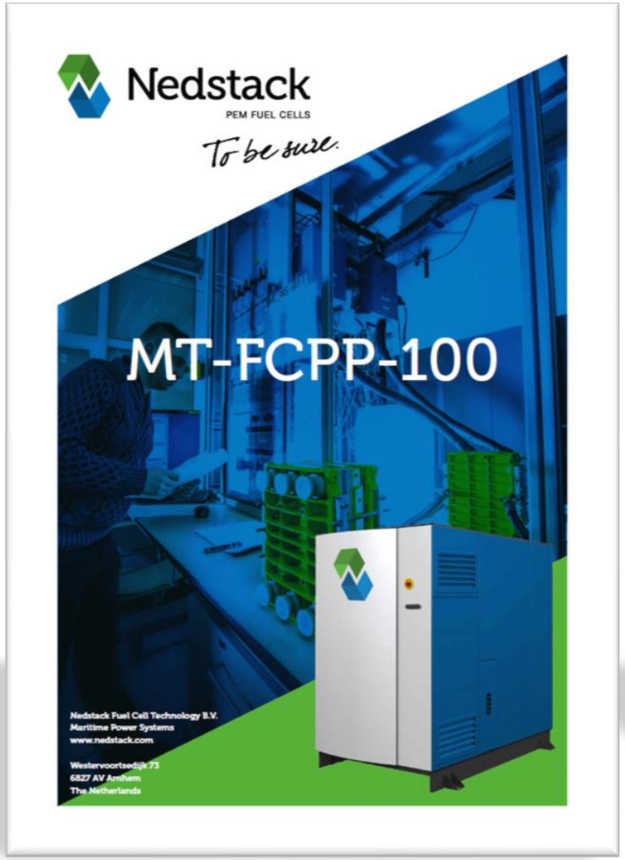




A Portfolio of Marine Fuel Cell Power Installations

NFCT MT-FCPP-40

NFCT MT-FCPP-100



NFCT MT-FCPP-500

Why Fuel Cells as a Maritime Power Solution?

Why Fuel Cells ?

HFO + ICE

Negative

- Climate impact;
- Air quality impact;
- Fuel Price Fluctuations;

HYDROGEN + PEM FUEL CELL

Positive

- Long range;
- Fast bunkering;
- Low weather sensitivity;

Positive

- Zero Emission;
- Efficient;
- Direct Torque;
- Quiet;

BATTERY

Negative

- Limited range;
- Long charging time;
- Low gravimetric power density;
- Weather sensitive.

PEM FC's the best option for the maritime domain?

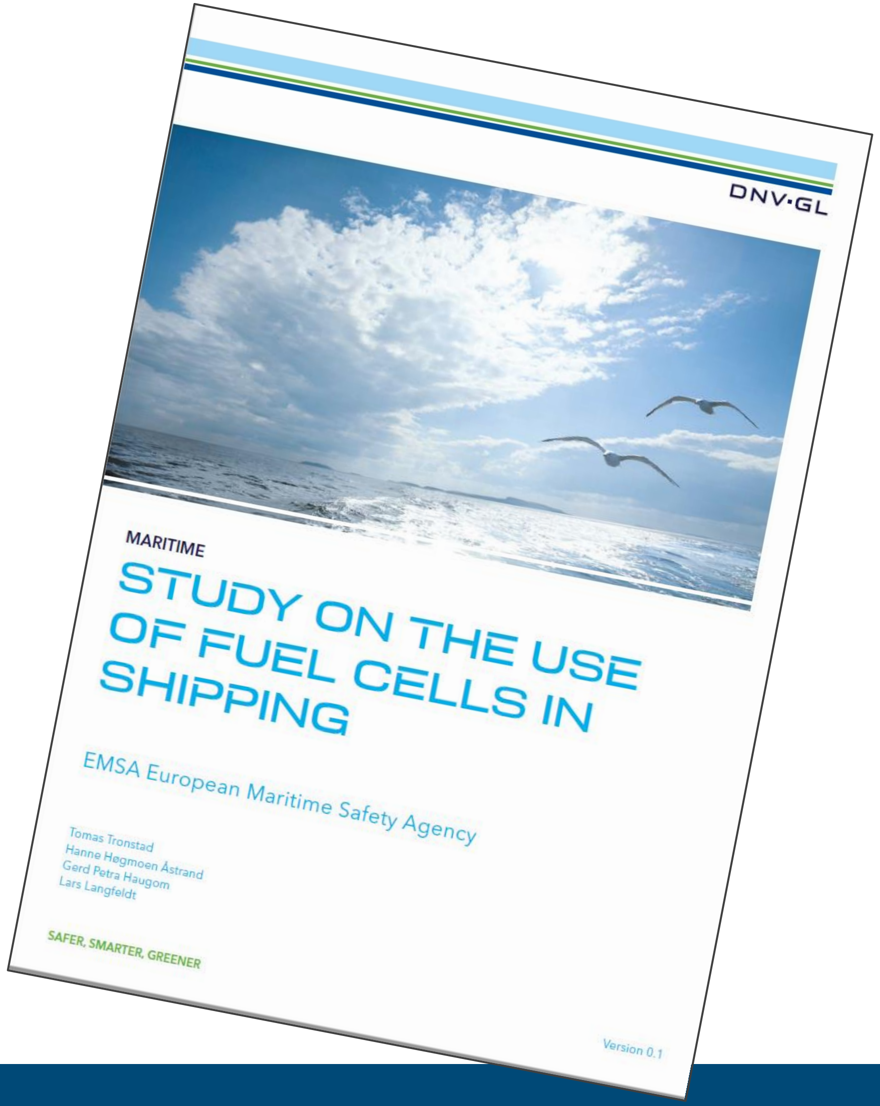
Nedstack PEM FUEL CELLS

LT-PEM FC's are the highest ranked Fuel Cell solution for shipping

Top ranked on:

- Maturity of Technology;
- Suitability;
- Safety;
- Environmental Performance;

EMSA


DNV·GL

MARITIME

STUDY ON THE USE OF FUEL CELLS IN SHIPPING

EMSA European Maritime Safety Agency

Tomas Tronstad
Hanne Høgmoen Åstrand
Gerd Petra Haugom
Lars Langfeldt

SAFER, SMARTER, GREENER

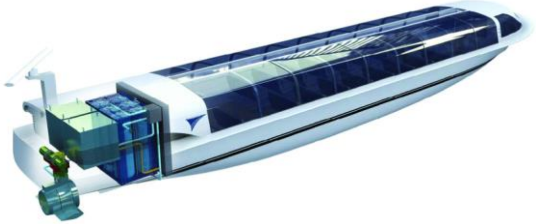
Version 0.1

Marine projects and current activities

Nedstack
PEM FUEL CELLS

PEM-FC Auxiliary Power for IHC Dredger

NEMO H2 (Lovers)

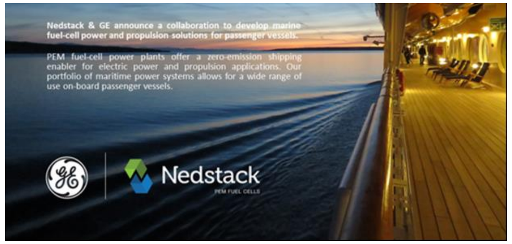


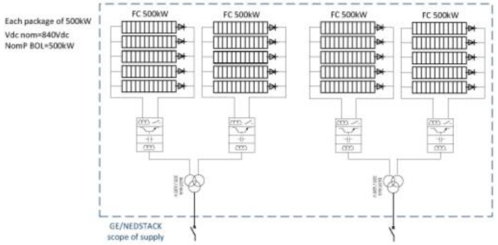
OSD-IMT / Nedstack: 65t BP Tug

Ulstein – Nedstack: SX190 Construction Support Vessel

FELMAR 40kW Power Unit

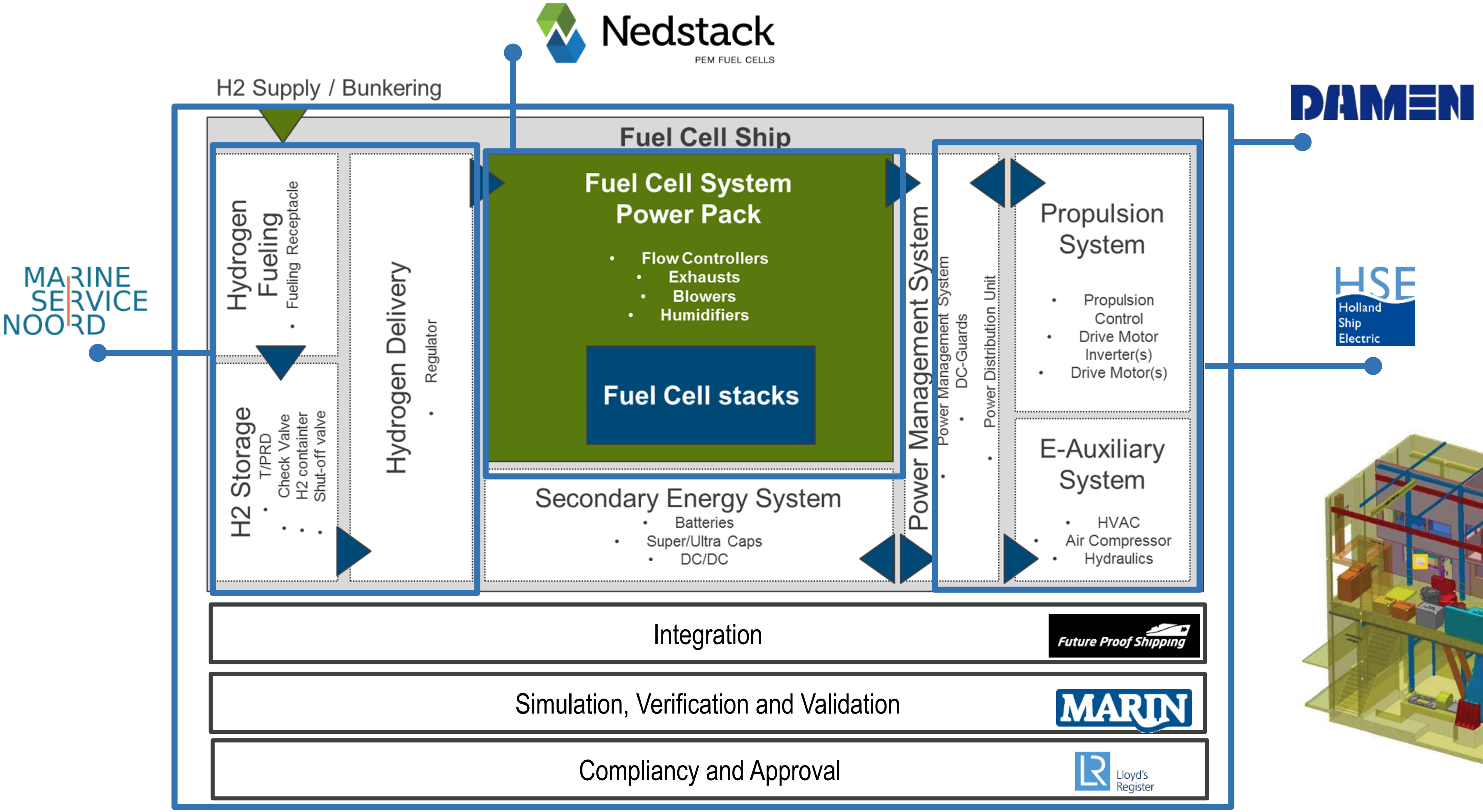
Nedstack/GE Partnership

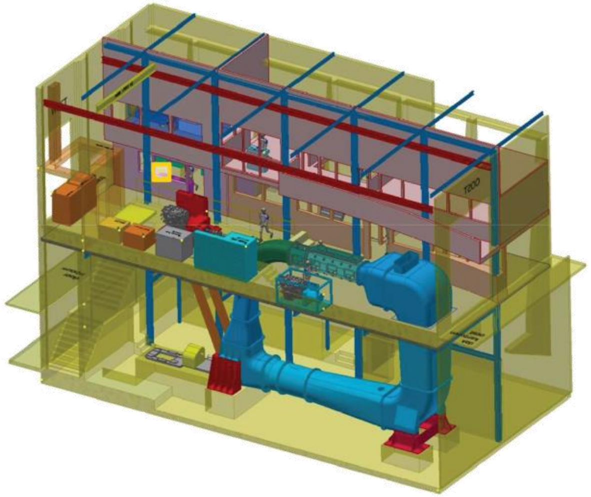




Marine projects and current activities

FELMAR consortium – "Engine Room of the Future"





Contributing to Regulations and Industrialization

- FELMAR – Dutch industry consortium
- Nedstack is project coordinator

FELMAR aims at industrializing and marinzing the current state of fuel cel ltechnology for inland navigation and short-sea applications.

- IEA-HIA Task 39;
- Nedstack is expert group member

IEA-HIA Task 39 consists of four subtasks: (i) Technology Overview, (ii) New Concepts, (iii) Safety and Regulations, and (iv) Demonstration.

- HE – Maritime Working Group;
- Nedstack is working group member

The HE-Maritime Working Group pursues to facilitate the adoption of hydrogen and fuel cell technologies in the maritime domain by industry-to-policy coordination.

Built & Class Approval

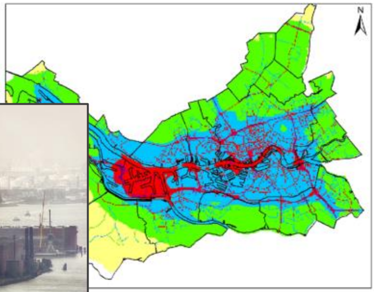
Nedstack
PEM FUEL CELLS

NEDSTACK MARINE MARKET TECHNOLOGY VERIFICATION PLAN

Basic Standardization & Class Approval		Fundamental Marine Verification & Improvement	
IEC Standardization	Class Approval	Vessel Profile Optimiz.	Marine Environment
kiwa	GL Germanischer Lloyd	MARIN	MARIN
			
COMPLETED	COMPLETED Initial	In Progress - Q4 2019	In Progress - Q4 2019

Navigating towards Zero-Emission

Nedstack
PEM FUEL CELLS



1

A NEED TO CHANGE

4

REALIZING THE CHANGE

2

A WILL TO CHANGE

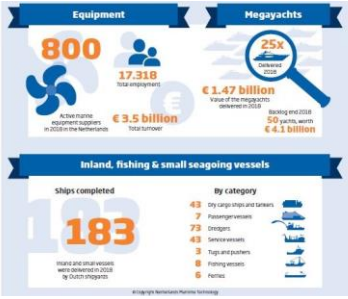
"IMO is at the UN climate change conference (COP 24) in Poland, highlighting key elements of the Initial IMO Strategy on reduction of GHG emissions from ships.

The strategy sets out a vision to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008, while, at the same time, pursuing efforts towards phasing them out entirely. This sets a pathway of CO2 emissions reduction consistent with the Paris Agreement temperature goals."

IMO INTERNATIONAL MARITIME ORGANIZATION — International Shipping News 07/12/2018

A CAPACITY TO CHANGE

3



Journey Summary

1

A NEED TO CHANGE

The Netherlands has a **unique ports & maritime industry** both on the supply and demand side.

By extension the Netherlands is **strongly subjected to related emissions**;

2

A WILL TO CHANGE

Supported by both global (IMO) and regional (CNRC) policies, the Netherlands has installed a unique public private partnership (**Green Deal Ports & Shipping**) to facilitate a change to zero-emission shipping.

3

A CAPACITY TO CHANGE

The Netherlands has a **supply chain with incredible innovation strength**.

MARIN is installing a **Zero-Emission-Lab** to facilitate the transition**.**

4

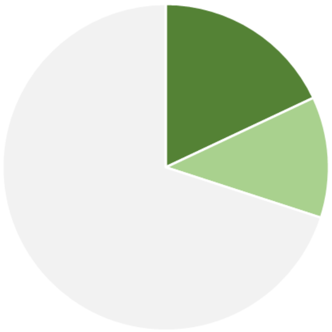
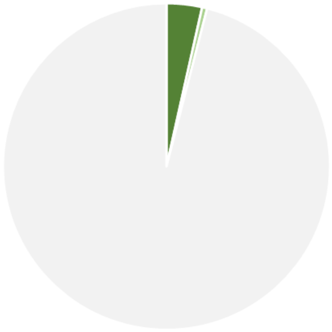
REALIZING THE CHANGE

The Netherlands has a system of subsidy policies in place to support the transition.

Nedstack has installed **a Maritime Application Group** to serve projects end-to-end.

The Global Perspective

Nedstack
PEM FUEL CELLS

18-30%	9%	70%	3.5% to 4%	85%
				
Of all the world's nitrogen oxide **(NOx)**	of the global sulphur oxide **(SOx)** pollution.	of all ship emissions are **within 400 km of land**.	of all **climate change emissions**	of all ship pollution is in the **northern hemisphere.**

1) *The Guardian, 2017*

Let’s Stay in Touch !

Nedstack
PEM FUEL CELLS
www.Nedstack.com

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Nedstack Fuel Cell Technology BV
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Phone: +31 615 027 073
E-Mail: VincentA.Schouten@Nedstack.com

MARINE NH3

NH3 (Ammonia) as Marine Fuel

Platform Schone Scheepvaart - Niels de Vries

3 December 2019

C-JOB
DEDICATED NAVAL ARCHITECTS

Renewable Fuels Motivation

- Reduction of greenhouse gas (GHG) emissions
- Circular economy

IMO Goals

- IMO: reducing overall carbon intensity of the cargo transported per kilometer by at least:
  - 40% by 2030
  - 70% by 2050

  (compared to 2008)

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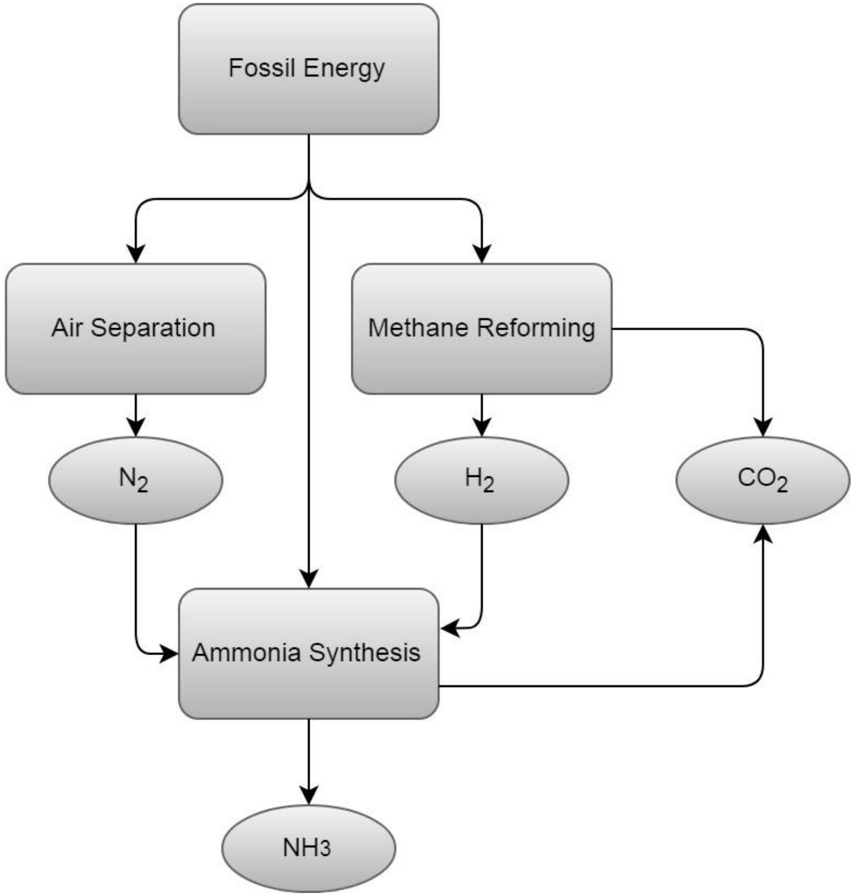
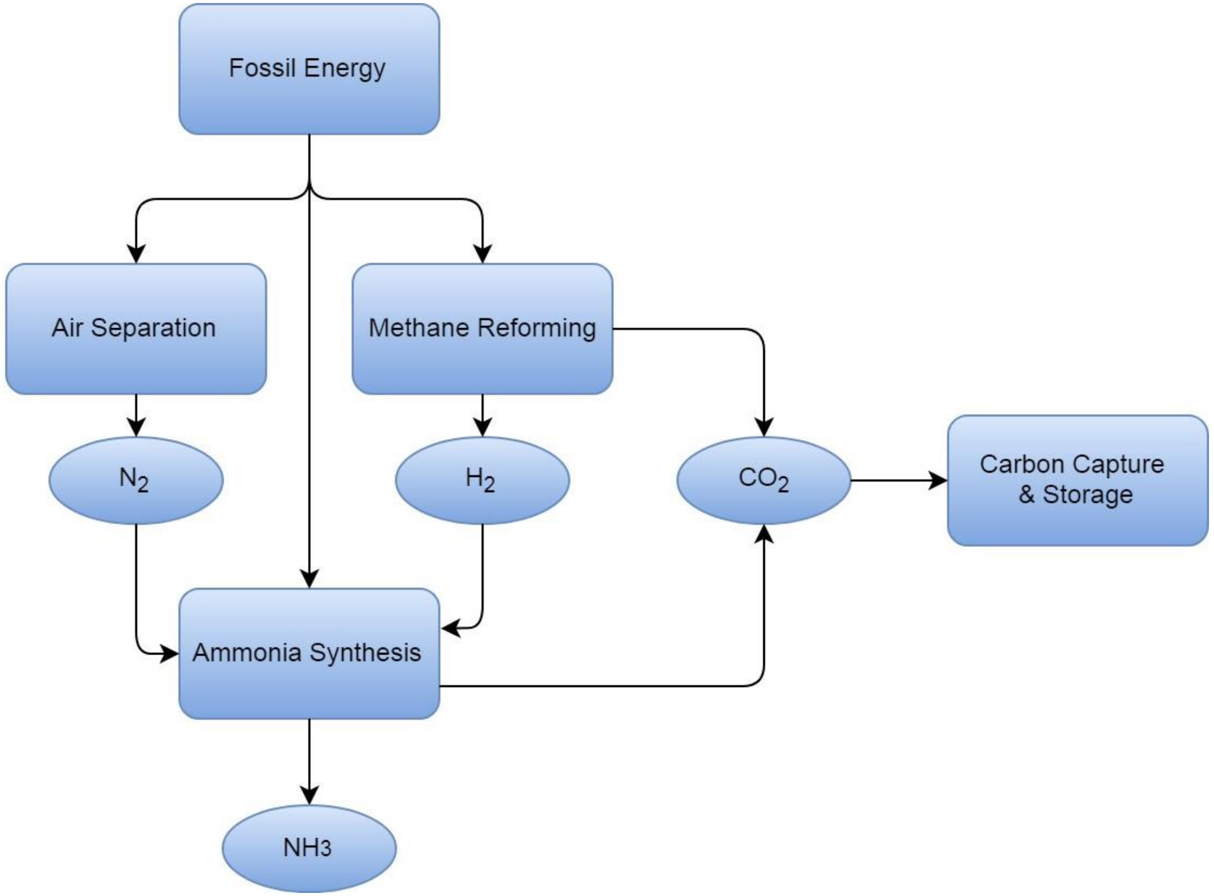
INTERNATIONAL MARITIME ORGANIZATION

Production: NH3 (Ammonia)





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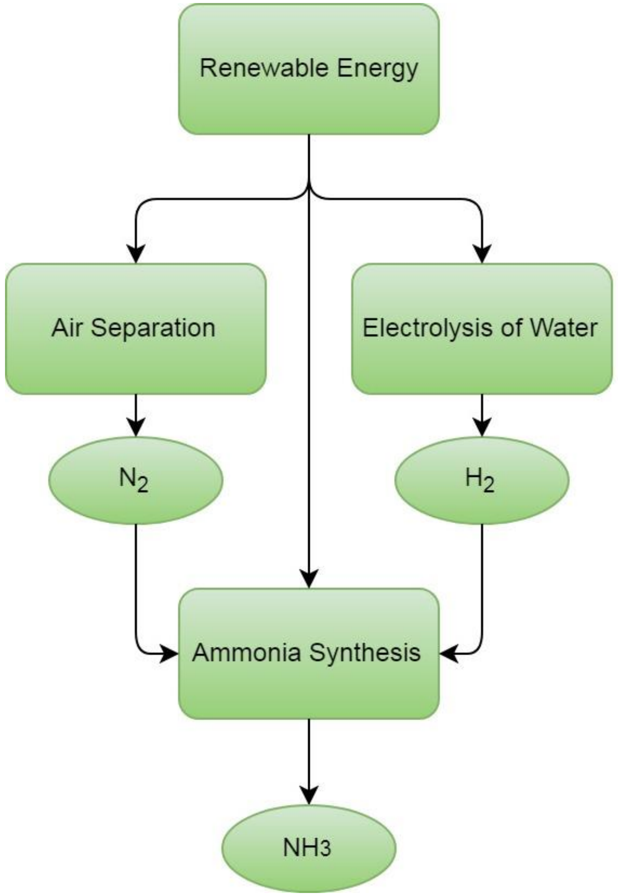

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    - Global production > 180 million tonnes
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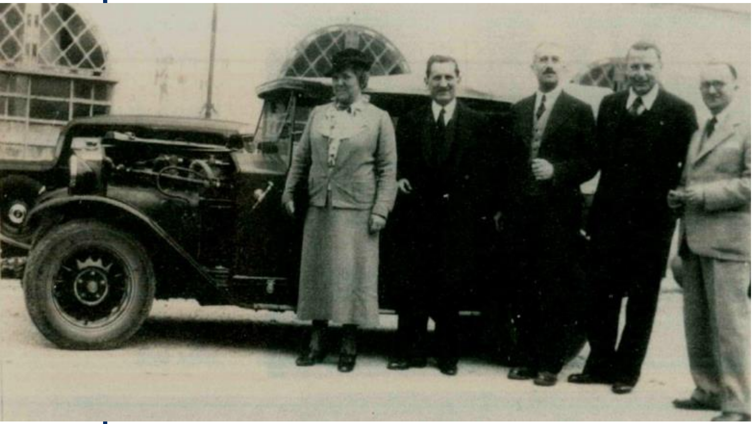
  - DeNOx (Ammonia in form of Urea)

History of Ammonia as Fuel

- Transportation methods



Renewable Fuel Options: Potential of Ammonia

Fuel type:	Energy density LHV [MJ/kg]	Volumetric energy density LHV [GJ/m3] ↓	Renewable synthetic production cost [MJ/MJ]	Storage pressure [bar]	Storage temperature [°C]
Marine Gas Oil (reference)	42.7	36.6	Not applicable	1	20
Liquid Methane	50.0	23.4	2.3	1	-162
Ethanol	26.7	21.1	3.6	1	20
Methanol	19.9	15.8	2.6	1	20
Liquid Ammonia	**18.6**	**12.7**	**1.8**	**1 or 10**	**-34 or 20**
Liquid Hydrogen	120.0	8.5	1.8	1	-253
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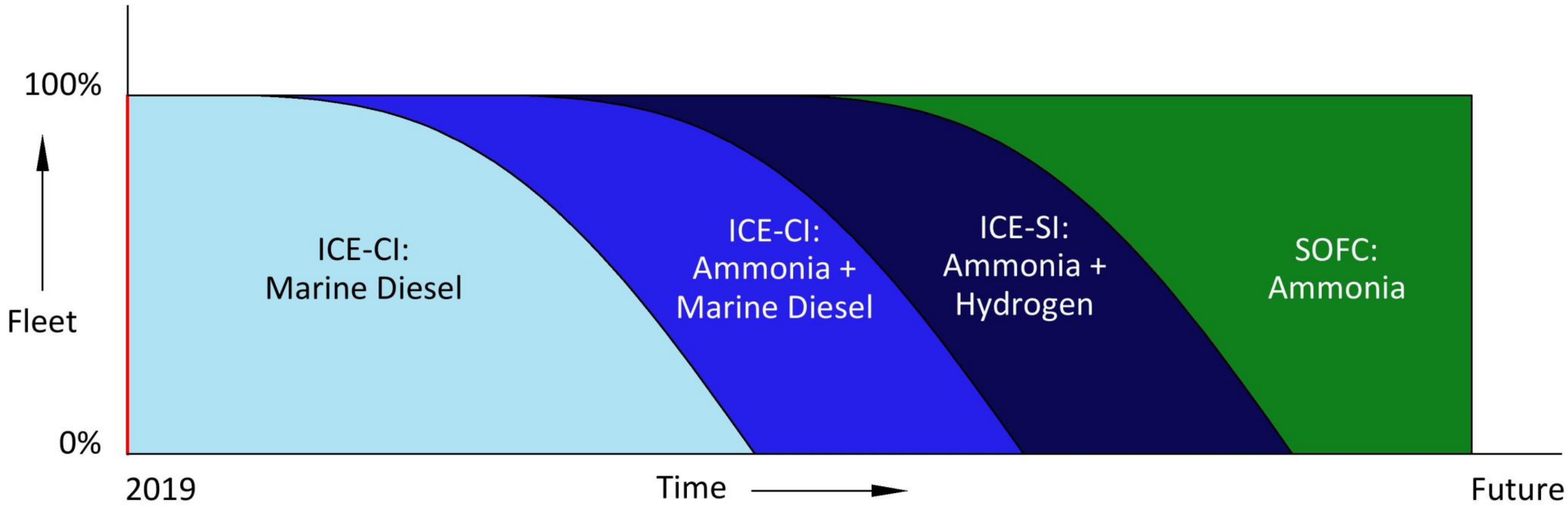
- Ammonia balanced solution
    - Volumetric energy density
    - Renewable synthetic production cost

Ammonia Properties

- Ammonia
  - Flammable and highly toxic gas
  - Auto-ignition temperature: 651 °C
  - Flammability limits: 15-28% (vol)
  - Low flame speed
  - High heat of vaporization

- Ammonia Hydrogen Mixtures
  - Improve combustion properties

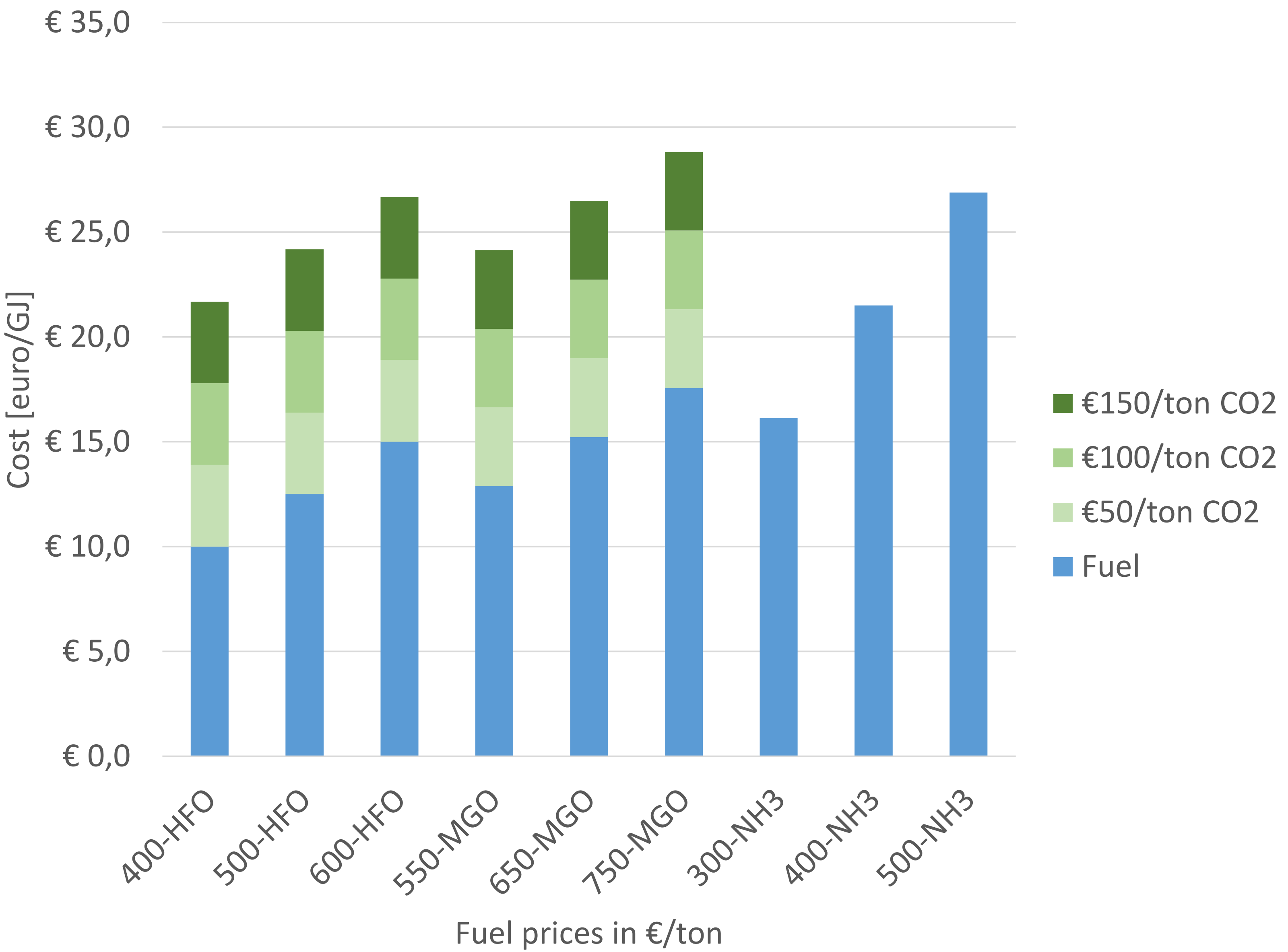


Reduction of Harmful Emissions			
CO_2	>80%	100%	100%
NO_x	0% (Apply SCR)	0% (Apply SCR)	100%
SO_x	>80%	100%	100%
PM	>80%	100%	100%

ICE: Internal Combustion Engine
CI: Compression Ignition
SI: Spark Ignition
SOFC: Soild Oxide Fuel Cell

SCR: Selective Catalytic Reduction
Exhaust gas after treatment, capable of reducing NOx more than 95%

Fuel Pricing



General Ammonia Safety

- Risk levels:
  - Flammability
    - Flammable gas
    - A narrow flammability limit: 15-28%, with a high lower limit compared to other fuels
    - A high absolute minimum ignition energy compared to other fuels
    - A high auto ignition temperature: 651 °C
  - Toxicity
    - AEGL 3: Life-threatening health effects or death

(ppm)	**10 min**	**30 min**	**60 min**	**4 hr**	**8 hr**
AEGL 1	30	30	30	30	30
AEGL 2	220	220	160	110	110
AEGL 3	2,700	1,600	1,100	550	390

Table 7-4: Acute Exposure Guideline Levels (AEGL): Ammonia

  - Environmental impact
    - Very toxic to aquatic life with long lasting effects

Risk Assessment Methodology

- Assessment based on IGF Code No. 146

Multiple fatalities	Catastrophic damage	**E**					
*Single fatality	Major damage	**D**					
Major injury	Localised damage	**C**					
Minor injury	Minor damage	**B**					
Zero injury	Zero damage	**A**					
People	Assets/ Environment		**1**	**2**	**3**	**4**	**5**
Severity ↑		Chance	Remote	Extremely Unlikely	Very Unlikely	Unlikely	Likely
		Chance per year	$<10^{-6}$/y	$\geq10^{-6}$/y $<10^{-5}$/y	$\geq10^{-5}$/y $<10^{-4}$/y	$\geq10^{-4}$/y $<10^{-3}$/y	$\geq10^{-3}$/y
Likelihood →		Chance in Vessel Lifetime	<1 in 40,000	≥1 in 40,000 <1 in 4,000	≥1 in 4,000 <1 in 400	≥1 in 400 <1 in 40	≥1 in 40

Table 9-1: Risk matrix, People, Assets and Environment combined

Ammonia as Marine Fuel Risk Assessment

Mitigations types similar as natural gas fuel system:

Highlights:

- Redundancy
- Ammonia and hydrogen detection
- Ventilation
- Pressure relieve system
- Remote operated isolation valves
- Route piping with sufficient distance from shell
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- Double-walled piping

E	2	4	9	10	
D		3	4	9	
C				1	
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A			2	8	
	1	2	3	4	5

Table 10-2: Original risk rating results risk assessment 1

E		1			
D	9	1			
C		12		2	
B				2	
A		3	10	21	
	1	2	3	4	5

Table 10-3: Final risk rating results risk assessment 1

More information

- https://cjob.nl/the-next-step-in-c-jobs-ammonia-research/
- https://repository.tudelft.nl/islandora/object/uuid:be8cbe0a-28ec-4bd9-8ad0-648de04649b8?collection=education


FOSSIL FUELS
OTHERS
METHANOL
AMMONIA
BATTERIES
HYDROGEN

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DEDICATED NAVAL ARCHITECTS

www.c-job.com

info@c-job.com

+31(0)880243700

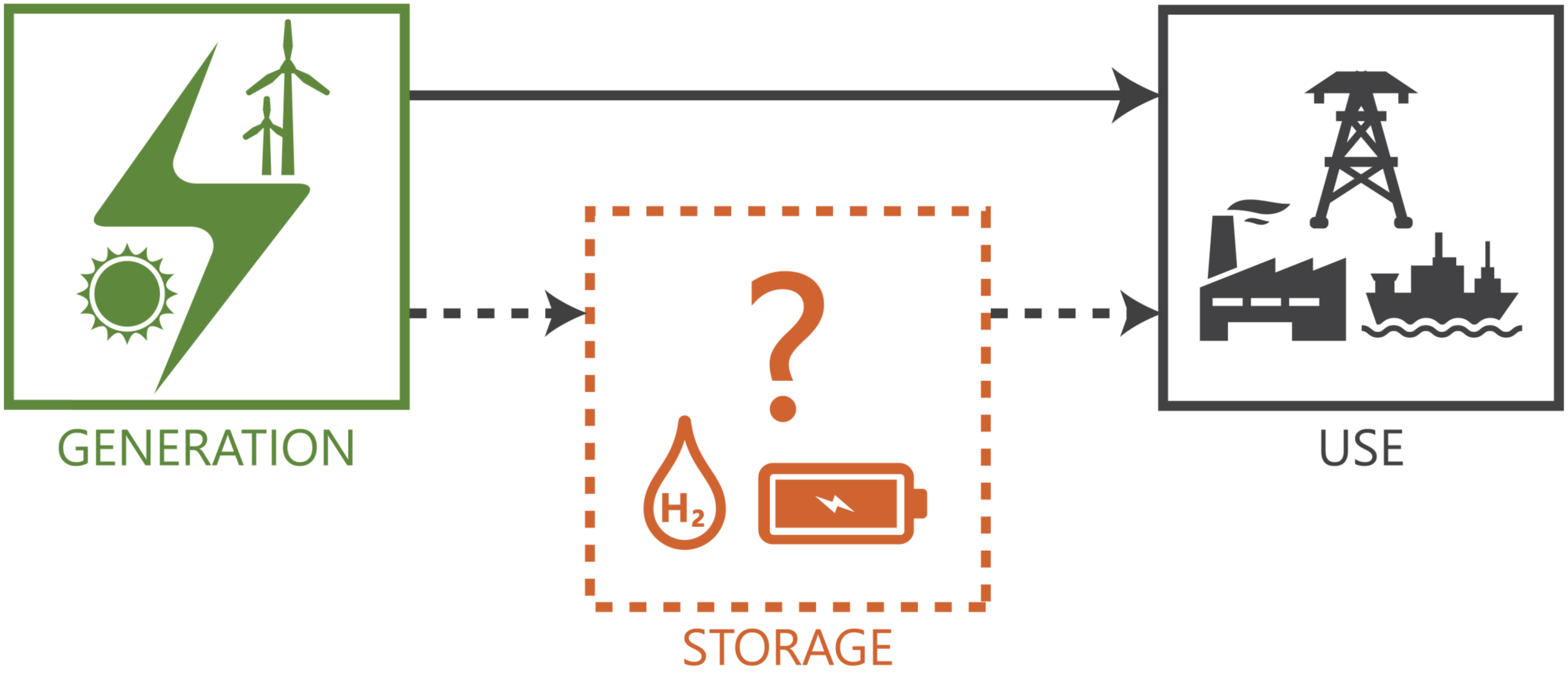
Niels de Vries

n.devries@c-job.com

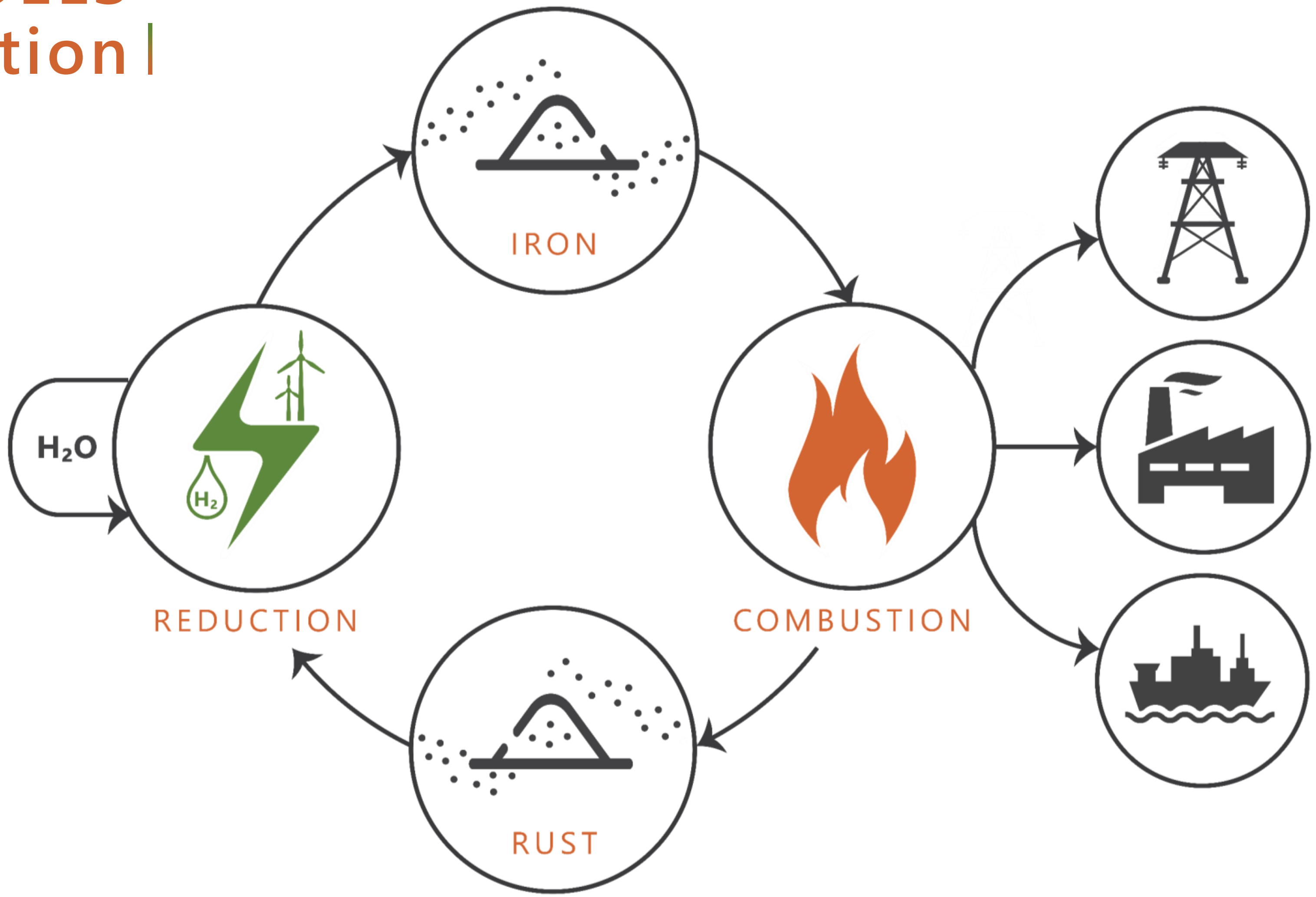

SOLID
ENABLING CIRCULAR ENERGY

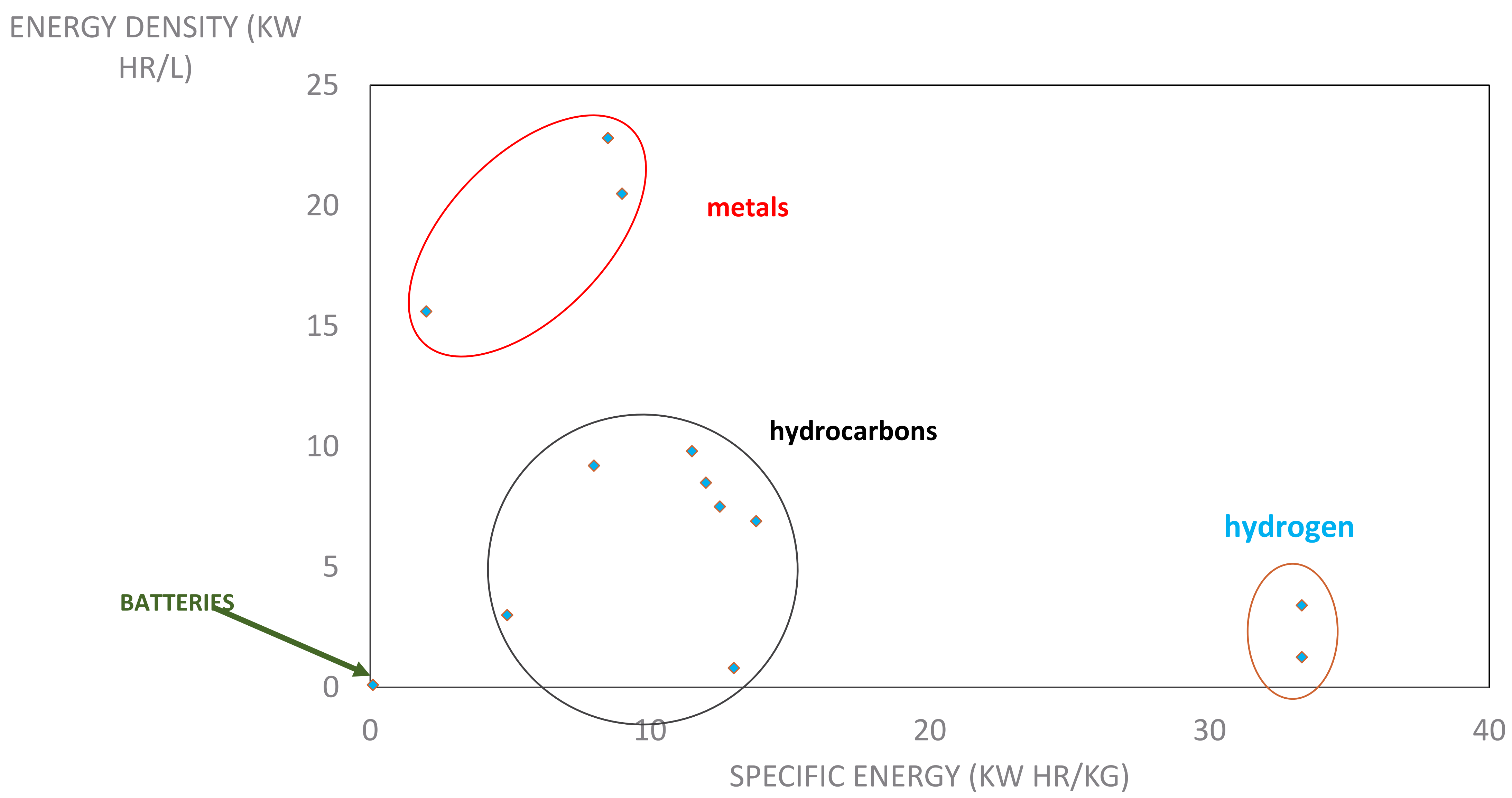
PROBLEM |

PROBLEM |

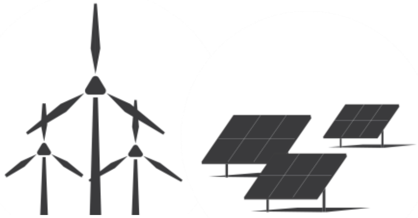


METAL FUELS
Solution




ENERGY DENSITY (KW HR/L)
25
20
15
10
5
0
metals
hydrocarbons
hydrogen
BATTERIES
0
10
20
30
40
SPECIFIC ENERGY (KW HR/KG)

USP metal fuels

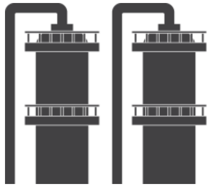


Sustainable

Circular
Free of CO_2

Maritiem fit

Scalable
High temperature
Retrofit



Storable

Long term
Low in CAPEX


SOLID
ENABLING CIRCULAR ENERGY

SOLID

HEATPOWER

ROMICO HOLD
ROMICO ENGINEERING SOLUTIONS

TU/e

Shell

SUMUS ET FORE SPERAMUS

ENGIE

uniper

TNO

SOLID
ENABLING CIRCULAR ENERGY

RWE

''Creating an ecosystem for metal fuels as circular energy carriers''

Maritiem Kennis Centrum

Pometon
METAL POWDERS AND GRANULES

enpuls

metalot

Provincie Noord-Brabant

EMGROUP
ENERGY AND ENVIRONMENTAL TECHNOLOGIES


15451
EMGROUP

MIIP project - *IJzer als alternatieve en hernieuwbare brandstof voor schepen*

Doel: technische en economische haalbaarheid van ijzerpoeder als recyclebare energievoorziening van diverse typen schepen.

- Systeemanalyse
- Economie
- Roadmap-opzet naar varend prototype

Eindrapportage in december 2019.

Klankbordgroep bestaande uit wetenschappelijke & industriële partners:


15451
EMGROUP
ENERGY AND ENVIRONMENTAL TECHNOL

MARINE NH3

NH3 (Ammonia) as Marine Fuel

Platform Schone Scheepvaart - Niels de Vries

3 December 2019

C-JOB

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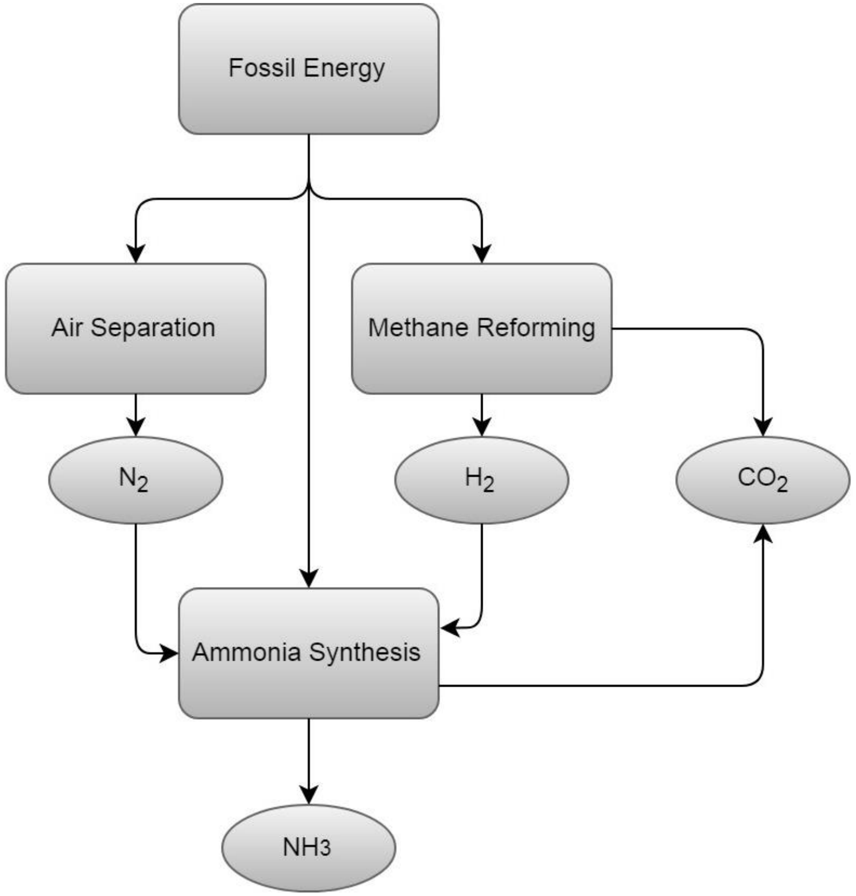

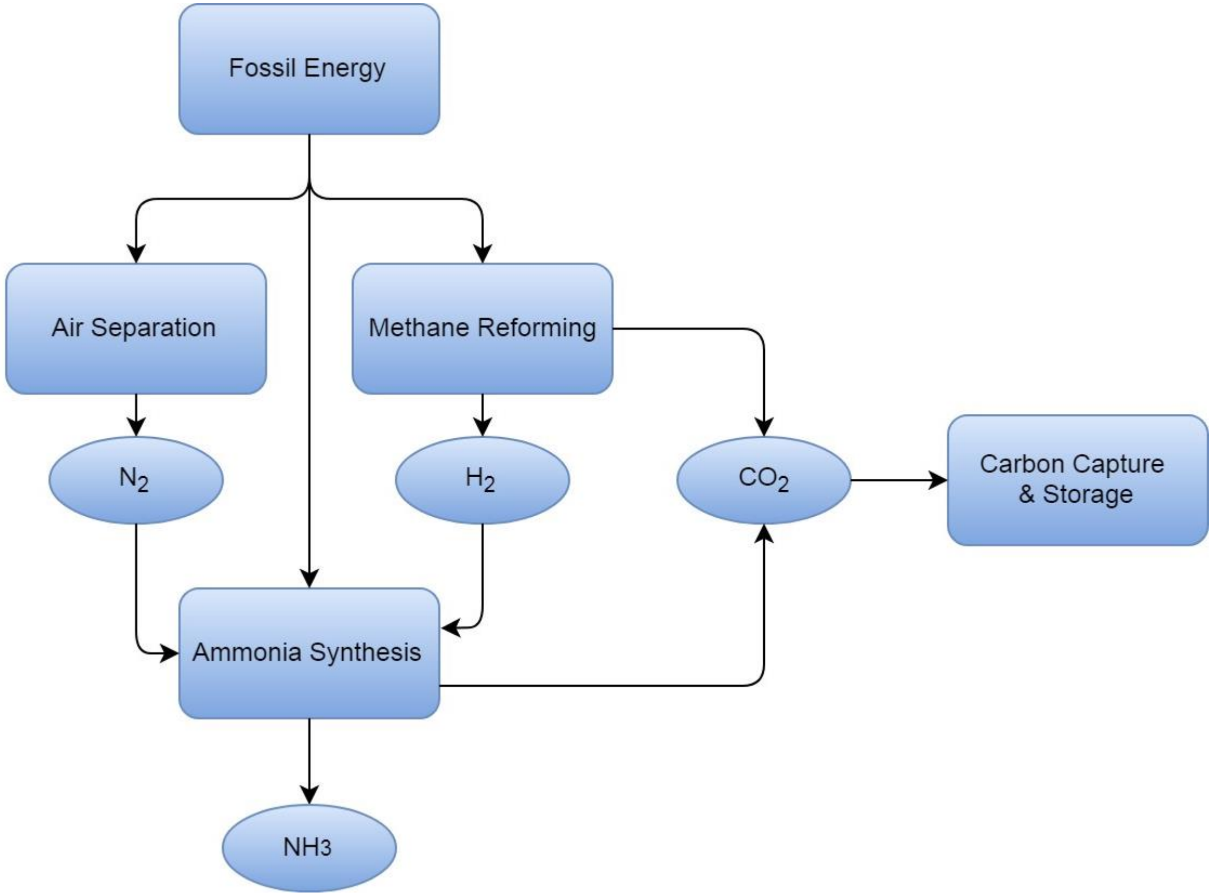

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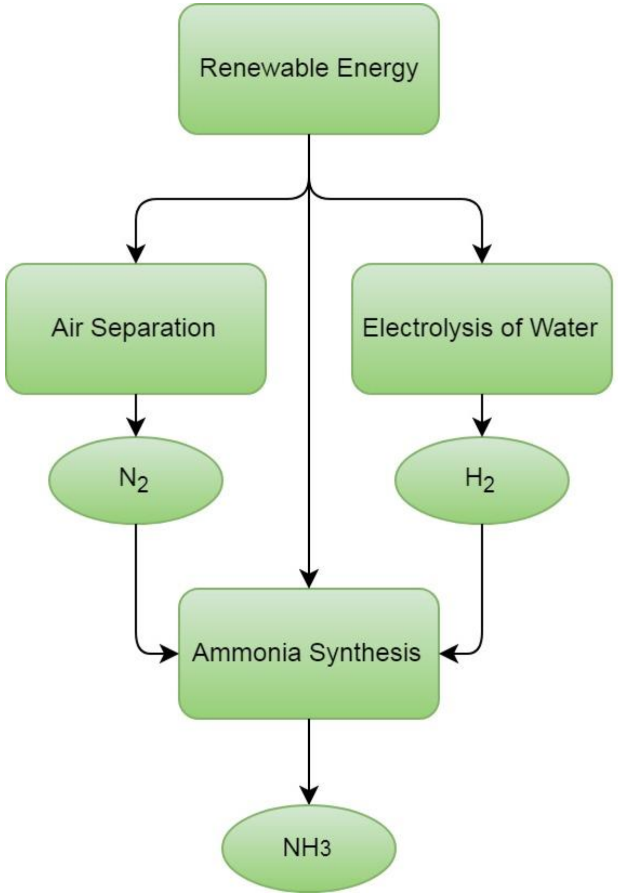

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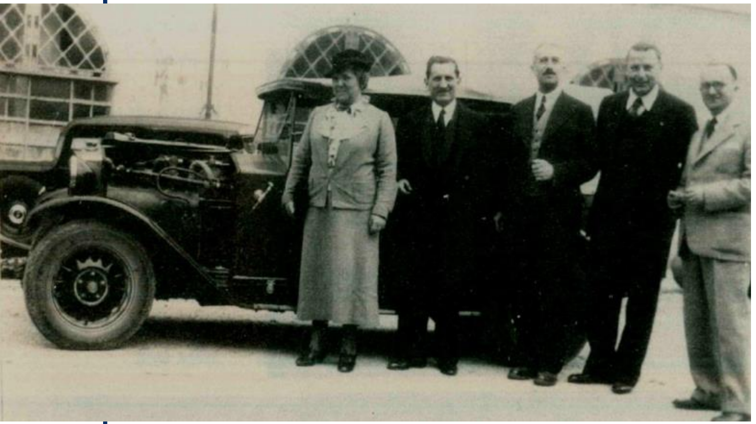

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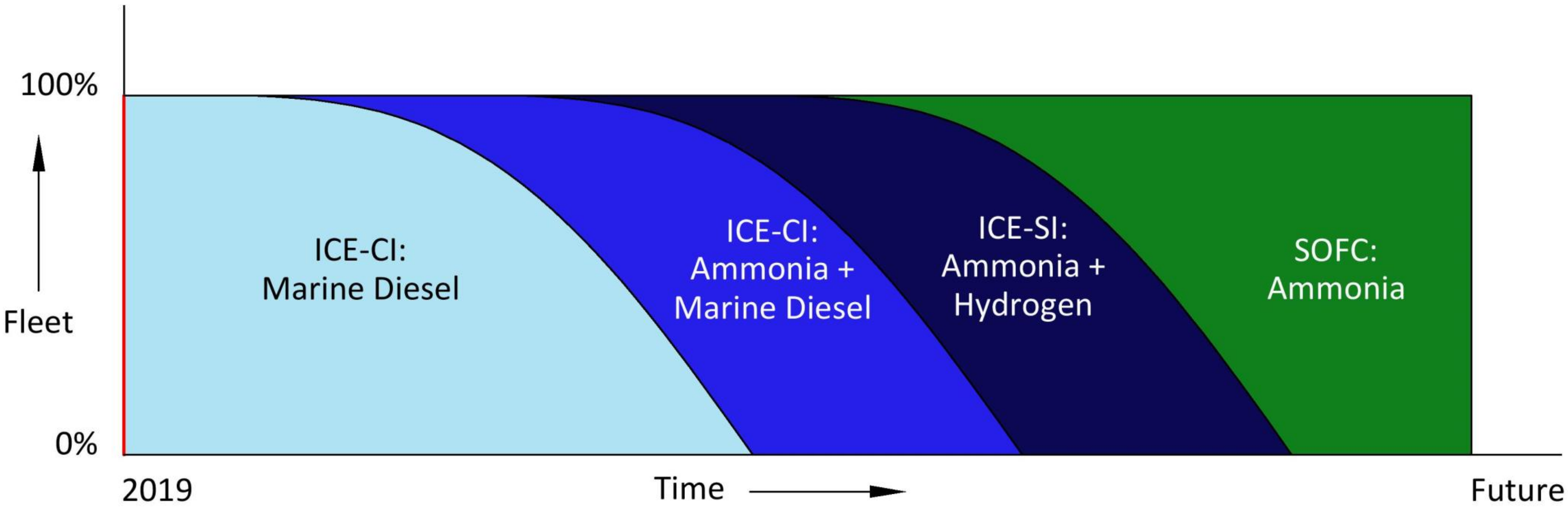

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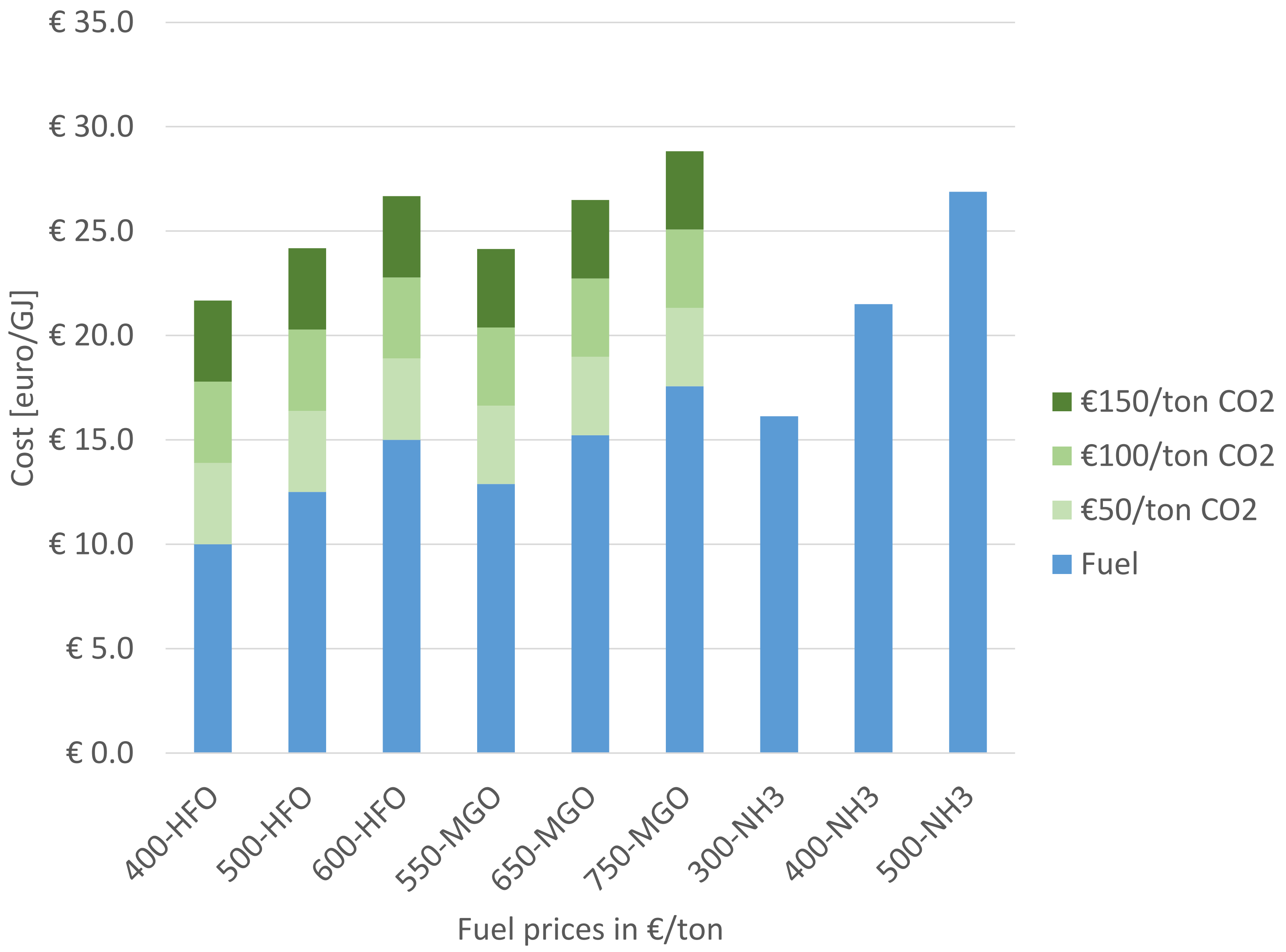

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Niels de Vries

n.devries@c-job.com

ECSA
European Community Shipowners' Associations

European outlook on finance
Schone Scheepvaart Seminar

Katalin Dobranszky-Bartus
Director, Financial- and Fiscal Affairs
Katalin.Dobranszky@ecsa.eu

3 December 2019

What is going on?

"Bank of England's boss says global finance is funding 4C temperature rise"
Source: The Guardian, 15 October 2019

"EU Bank launches ambitious new climate strategy and Energy Lending Policy"
Source: European Investment Bank, 14 November 2019

As long as the temperatures and sea levels continue to rise and with them the climate-related financial risks, central banks, supervisors and financial institutions will continue to raise the bar to address these risks and to green the financial system.
Frank Elderson, NGFS Chairman, 17 April 2019

"The financial sector needs to throw its full weight behind the fight against climate change. This is a challenge, but also an exceptional opportunity."
Valdis Dombrovskis, Commissioner

(Environmental) regulation turns into innovation -> innovation needs funding

What is happening right Now

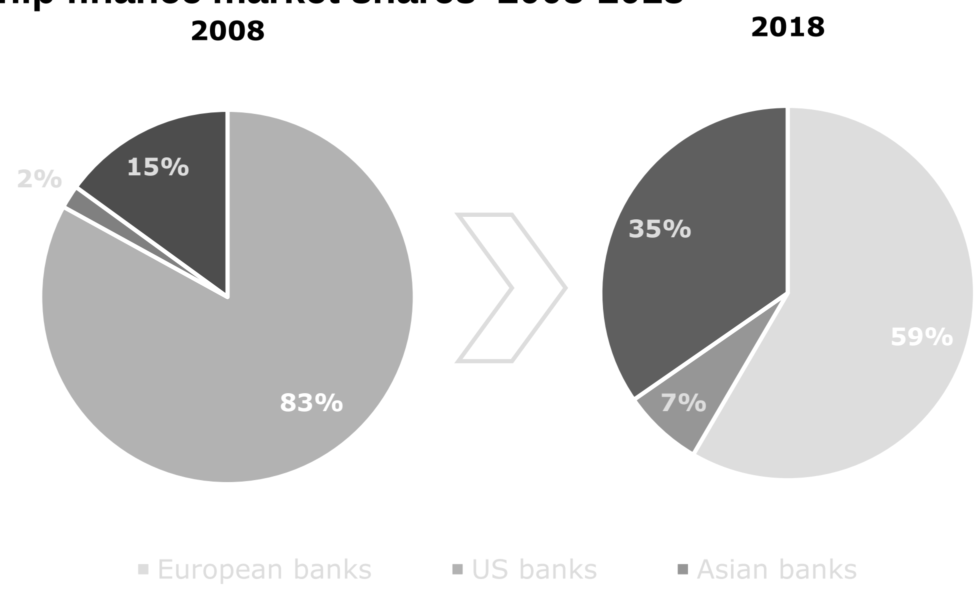
- Important shipping banks agree on Poseidon Principles
- The European Investment Bank (EIB) to become a green finance bank
- There is a possibility that European funding will turn into “green” finance
- Central banks want banks to price climate risk -> an industry that is not considered “green” is expected to become more expensive

The financing landscape is changing

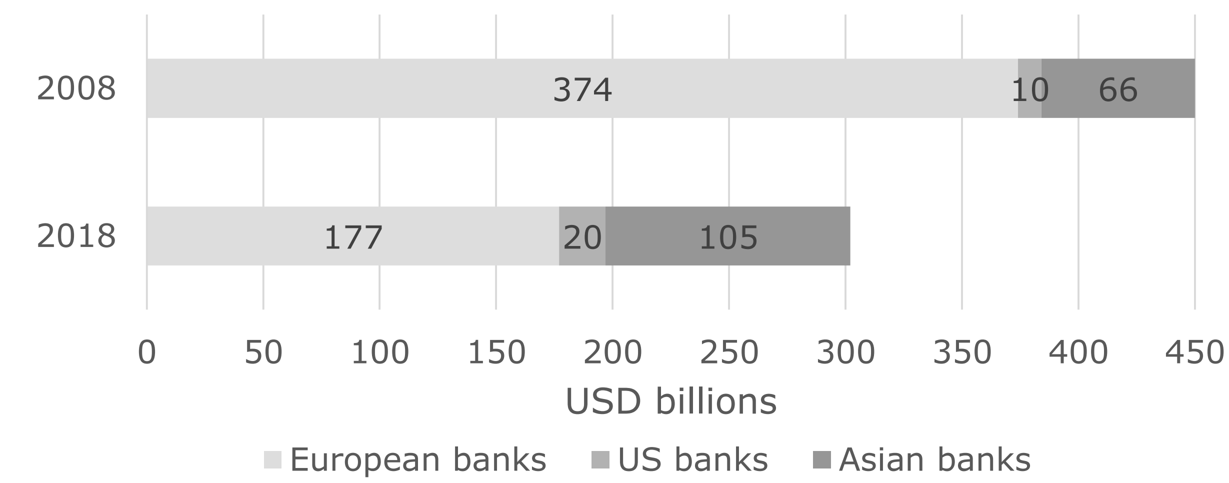
- Commercial banks
- Capital markets (the sum of all investors etc.)
- European Investment Bank (EIB)
- EU Funds
- Pension funds/Insurance companies

Development in ship finance over the past decade

Ship finance market shares 2008-2018



Ship finance loan books 2008-2018



Source: Petrofin Global Bank Research 2018

- The top 40 commercial banks have decreased shipping exposure by USD 54 billon from 2016 to 2018. Ship finance portfolio are at the lowest level in 12 years
- From 2008 to 2018 banks shipping exposure decreased by 35%, while the fleet grew 32%.
  - The main reason is lower vessel values and the entrance of leasing on the market
  - Of European banks, German and UK banks had by far the largest decline, but Scandinavian banks also trimmed their portfolio considerably
- Now some of the largest lenders globally are Asian
- In 2018, Chinese leasing amounted to USD 51.3 billion
- ECA backed financing is increasing – it ranks 3rd after bank debt and Chinese & Japanese leasing

What is already happening in regulation?

- Access to finance for shipping is becoming more difficult because of 'Basel'
  - Basel III.5 implementation (impact?) by 2021 and
  - Basel IV scheduled for 2022

- Sustainable finance: how to define green

- Challenge: less funding opportunities for shipping because of risk modelling
- Opportunity: a green vessel brings in investors

Impact on shipping

- Capital intense sector and technology driven
- One size fit all technology does NOT work
- Transition to recognise
- EU importance with a significant international role

Funding green transition: the first steps …

- Tell the story
- Data
- Co-operation

… and the next steps

- Give examples of sustainable cases to the financial stakeholders
- Raise your maritime voice as one
- Join your efforts on green
- Encourage new thinkers

Green Shipping Fund

Maarten van der Klip,
Maarten.vanderklip@greenshippingfund.com
GSF Consultancy

Contents

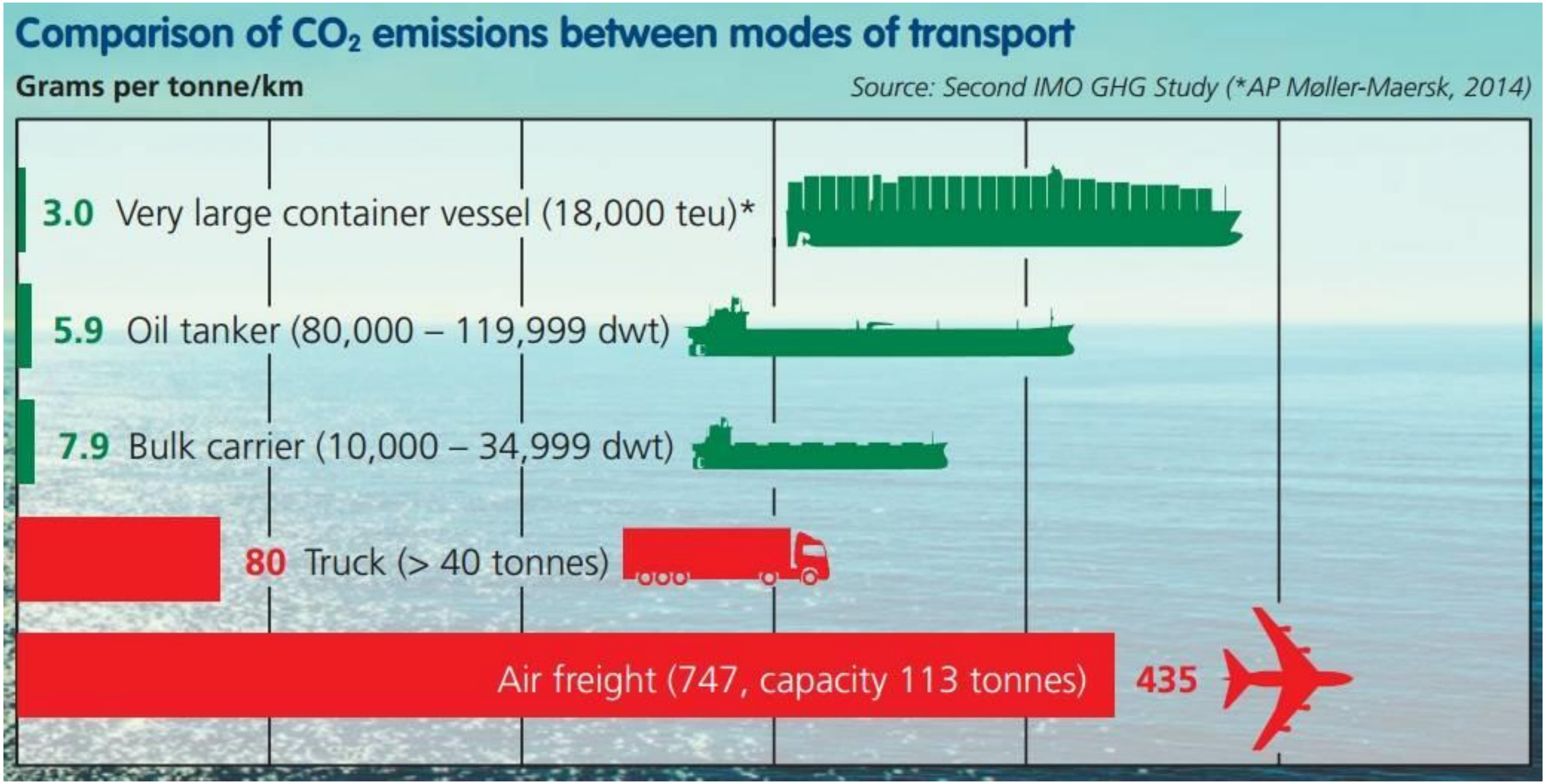
Mission and Objectives

Mission of the Green Shipping Debt Fund

Provide **debt funding** to enable the shipping industry’s transition to a **climate neutral** state

GSF expected launch: first quarter 2020

Efficient way of Transport



Source IMO ghg Study

Environmental challenges for shipping

CO2 Carbon
Total 981 Mio t (2,2%)
Global Warming
EEDI Phase 3 2025 / MRV

NOx, Nitrogen
Total 18 Mio t (13%)
Smog, acid rain
Global warming
Tier 1-3

SOx, Sulphur
Total 10 Mio t (12%)
Cancer causing
0,5% Global 2020

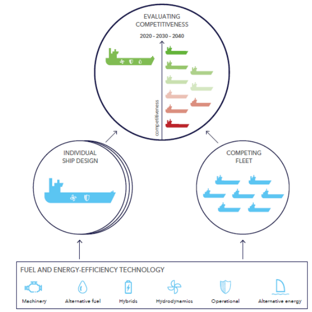
PM, Particle matters
Total 1,6 Mio t
Black smoke, Health
Inland Water Ways

__IMO__ Strategy on __reduction__ of GHG __emissions__ from ships to __reduce__ the total annual GHG __emissions__ by at least 50% by __2050__ compared to 2008

Source IPCC & IMO GHG emissions shipping

How to come to a future proof ship?

Solutions to reduce emissions



NOW	Drop in Bio fuel	2050 Greenhouse Gas reduction
Fuel Oil	BIo Fuel	- 50% BIo Fuel oil
LNG/ LPG	Bio LNG	-80 to -99% Bio LNG
Electricity/ Hybrid	Renewable	-20 to -50% based on Feedstock
Alternative	Hydrogen/ PTG Methanol/ Amonia	-50% With Bio Feedstock

Source DNV GL Future Fuels

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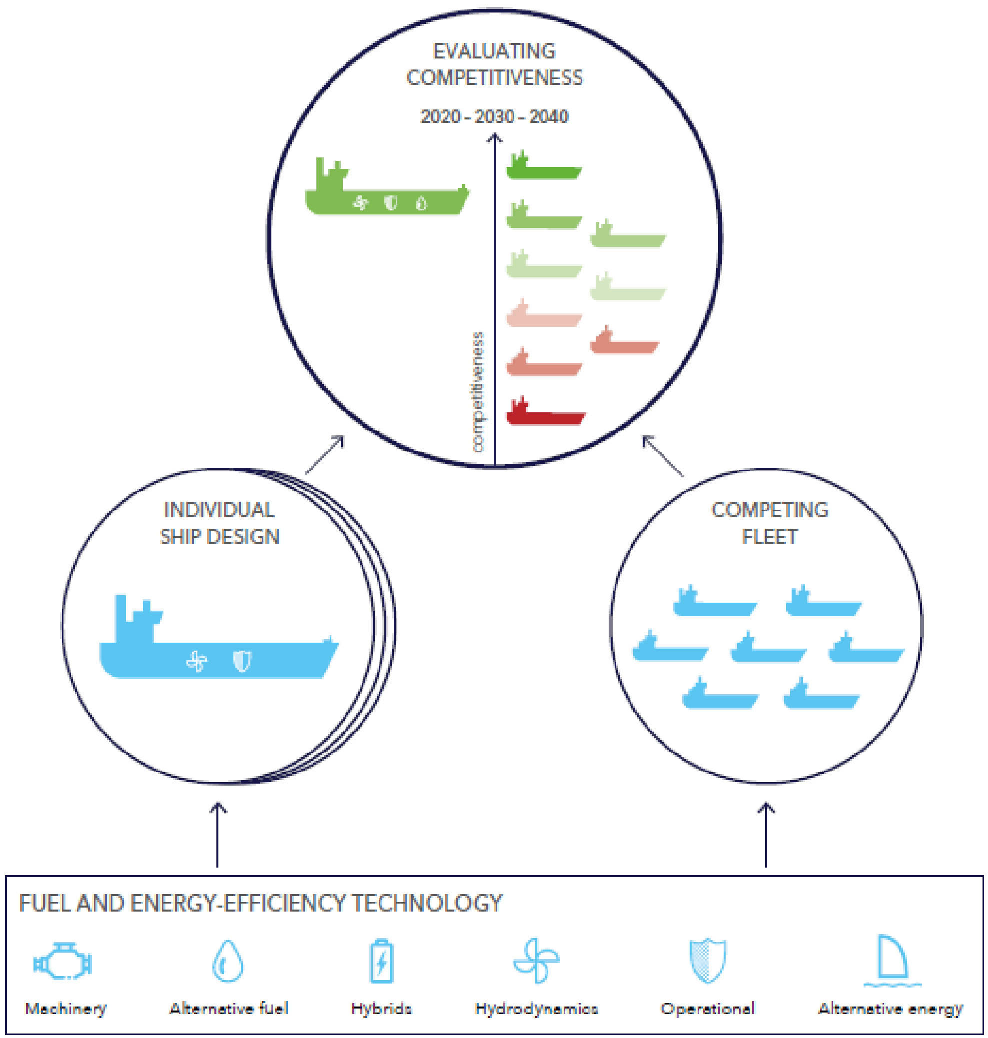
Solutions to reduce emissions

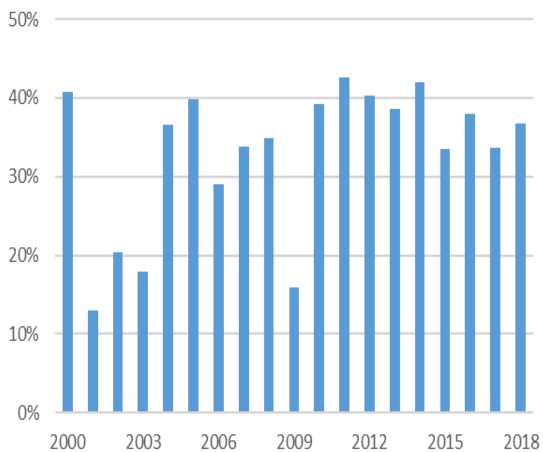


Source DNV GL Future Fuels

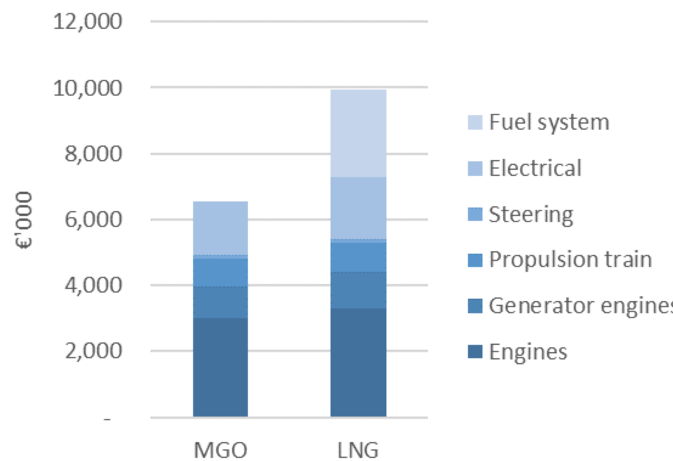
Business rationale for transition by shipping lines

LNG Shipowner example

LNG discount vs MGO



Machinery investment cost 40K bulker



Emissions reduction LNG vs MGO

CO_2 Carbon

-20% compared to MGO

N0x, Nitrogen

-80% compared to MGO

SOx, Sulphur

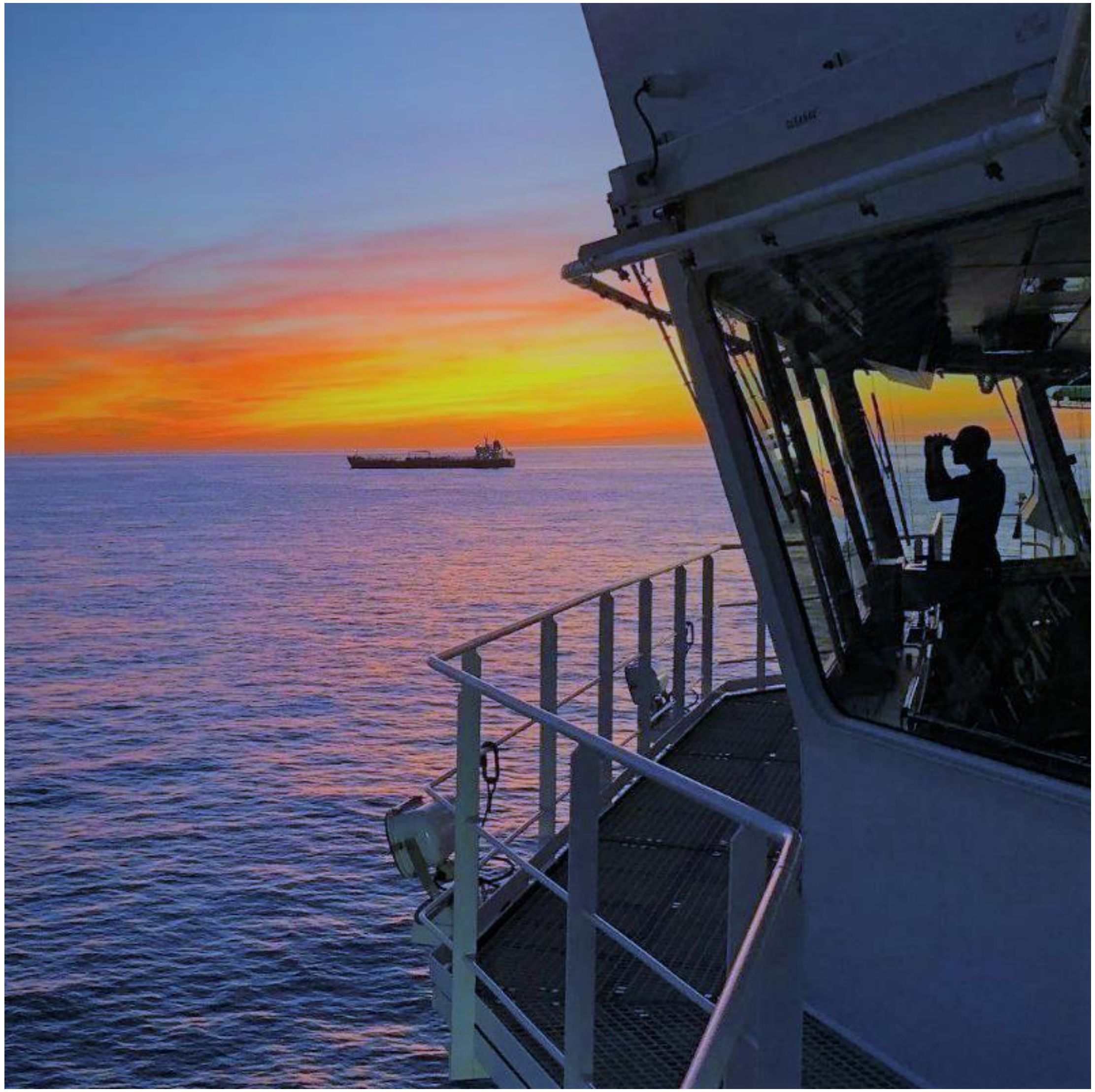
-98% compared to MGO

PM, Particle matters

96 % compared to MGO

Sources: Wärtsilä, DNVGL

Thank you



Ministerie van Infrastructuur en Waterstaat

Connecting Europe Facility (CEF) and Motorways of the Sea (MoS)

Call for green business cases

Kasper van der Gugten, Ministry of Infrastructure and Water Management

Short introduction to CEF and MoS

- EU infrastructure policy consists of two main pillars:

1) **Trans-European Transport Network** (TEN-T) regulation, which includes requirements and maps (policy side); and

2) **Connecting Europe Facility** (CEF) regulation, which provides the budget for supporting the realisation of the TEN-T network, mainly through grants/co-funding (€ 26.3 bln for 2014-2020, of which € 11.3 bln is reserved for Cohesion countries);

- Motorways of the Sea (EU language for short sea shipping connections) is part of TEN-T and CEF as the maritime dimension of the TEN-T network

MoS further explained

- MoS is defined in EU legislation as “the maritime links between maritime ports of the TEN-T network or between a TEN-T port and a third-country port”;
- In practice, when grants/co-funding available, the possibility of obtaining funding is narrowed down to a maritime link with the involvement of at least one TEN-T core sea port (in NL, Amsterdam, Rotterdam, Zeeland Seaports and Moerdijk). Co-funding rate for MoS is max. 30%;
- Eligible for funding (examples): activities related to port facilities, freight terminals, information and communication technologies (ICT) such as electronic logistics management systems, safety and security and administrative and customs procedures, infrastructure for direct land and sea access. Maritime vessels were eligible in the past as well.

Current funding opportunities

- Two calls under the CEF envelope are open now for proposals:

1) **2019 Transport multi-annual work programme (MAP) call**, with budget of € 1.4 bln (deadline: 26 February 2020)
2) **Transport Blending Facility**, with budget of € 198 mln for grants (first deadline: 14 February 2020)

- Under the CEF MAP call, there will € 30 mln of grants allocated for MoS-projects, with the following activities being eligible:

1) Implementation of new facilities and technologies regarding provision and use of alternative fuels or energy, e.g. LNG bunkering and shoreside electricity;
2) The alleviation of congestion and/or the reduction of the environmental impact of land transport through the creation of alternative short sea shipping routes.

- Maritime vessels are not eligible under the current MoS-call, but can instead make use of the Blending Facility-call (under the deployment of alternative fuels-priority), which requires the involvement of e.g. private-sector finance institutions or private-sector investors.
- Only activities that are completed at the latest on 31 December 2023 are eligible.

Thank you for your attention !
Need more information ?
Any questions ?

https://www.rvo.nl/subsidie-en-financieringswijzer/cef-transport

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Banking on Green Shipping

Platform Schone Scheepvaart

Robin Willing
Head of Sustainability, NIBC

3 December 2019

NIBC

COP25 Madrid

Dutch Banks are represented at this week's climate conference in Madrid

Climate change

Climate emergency: world 'may have crossed tipping points'

Warning of 'existential threat to civilisation' as impacts lead to cascade of unstoppable events

Damian Carrington
Environment editor
@dpcarrington
Wed 27 Nov 2019 18.00 GMT

10,999

▲ 'Part of the west Antarctic ice sheet may be in irreversible retreat,' said one of the researchers. Photograph: Handout/AFP/Getty Images

The world may already have crossed a series of climate tipping points, according to a stark warning from scientists. This risk is "an existential threat to civilisation", they say, meaning "we are in a state of planetary emergency".

https://www.theguardian.com/environment/2019/nov/27/climate-emergency-world-may-have-crossed-tipping-points

EU Parliament: Our House is on Fire

Clear signals that EU ambition is increasing

European Union

'Our house is on fire': EU parliament declares climate emergency

Bloc warned against making symbolic gestures not backed up by concrete action

Jennifer Rankin *in Brussels*
Thu 28 Nov 2019
14.38 GMT

2806

▲ European parliament declares climate emergency: 'do we want to leave our children a world?' – video

The European parliament has declared a global "climate and environmental emergency" as it urged all EU countries to commit to net zero greenhouse gas emissions by 2050.

The vote came as scientists warned that the world may have already crossed a series of climate tipping points, resulting in "a state of planetary emergency".

https://www.theguardian.com/world/2019/nov/28/eu-parliament-declares-climate-emergency

- All companies are increasingly monitored in terms of their Sustainability
- Sustainability has become a must have, no longer viewed as purely non-financial and "nice to have"
- Financiers and companies are increasingly expected to work together to increase company sustainability

Earth Overshoot Date

#MoveTheDate

- The date when humanity’s demand for ecological resources (fish and forests, for instance) and services in a given year exceeds what Earth can regenerate in that year.
- For 2019, the date was July 29
- Every year the date has been moving earlier
- #MoveTheDate - All actors in all value chains incl Shipping need to take decisive action, move the date, work together to reduce this global ecological deficit.

EARTH OVERSHOOT DAY

https://www.overshootday.org/

Regulatory Environment

Financial and non-financial regulations continue to progress

- Upcoming: Basel IV
  - Potentially a ~ 30% increase in capital costs for banks for asset-based financings

- 2013 EU Ship Recycling Regulation
  - Requires IHMs and EU-certified yard from 31 Dec 2018

- 2017 EU Non-financial reporting directive
  - Required sustainability specific disclosures in annual reports of large companies as of 2018
    - Material environmental risks
    - Material or salient human rights risks

- Draft EU Green Taxonomy
  - Originally was expected to be completed Q4 2019, required in 2020 for new green financial products
  - Concerns raised by certain countries

- UK Modern Slavery Act
  - Increased oversight and disclosures regarding risks in supply chains expected year by year
  - New disclosure requirement in 2019 for smaller companies

NIBC, Sustainability and the Shipping Sector

Aligning our financings and investments with the Sustainable Development Goals

- Emissions: NIBC is actively reviewing the emissions of our (financed) fleet and discussing with our clients
- NL Green Deal: NIBC helped to coordinate the banks involved in the recent Scheepvaart, Binnenvaart en Havens Green Deal
- Responsible Ship Recycling Standards (RSRS): 9 leading financiers have joined RSRS, an initiative started by NIBC, ABN, and ING
- SDGs: NIBC's Shipping Team has selected SDG8: Decent Work and Economic Growth as their team Sustainable Development Goal

Sustainable Solutions

Banks are developing solutions to support companies transition

- Green Financings
  - Guided by the Green Bond Principles, Green Loan Principles
- Social Financings
  - Guided by the Social Bond Principles, Social Loan Principles
- Sustainability-linked Loans
  - Margin linked to KPIs
- Transition Bonds/Loans
  - Linked to KPIs
- ESG-Compliant Financings
  - NIBC launched the 1st ESG-compliant Collateralised Loan Obligation (CLO) last week

Disclaimer

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THINK YES NIBC

the bank for entrepreneurial people

MARIN

BETTER SHIPS, BLUE OCEANS

Future Ships Power & Energy Concepts

Moritz Krijgsman

Dec 2019

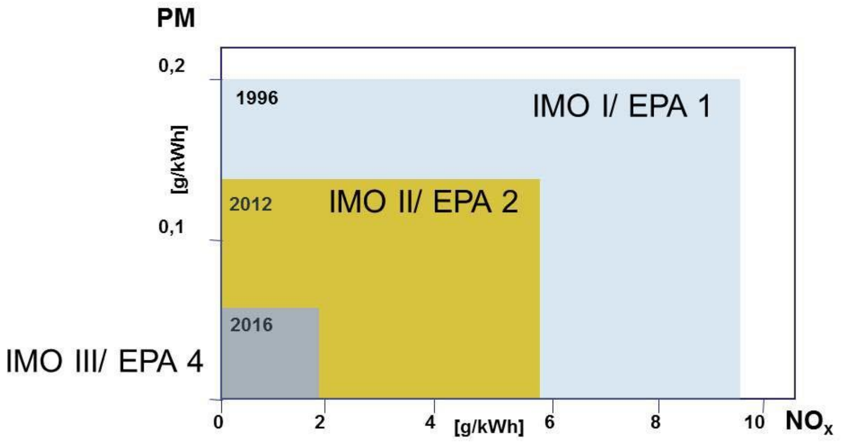
CONTENT

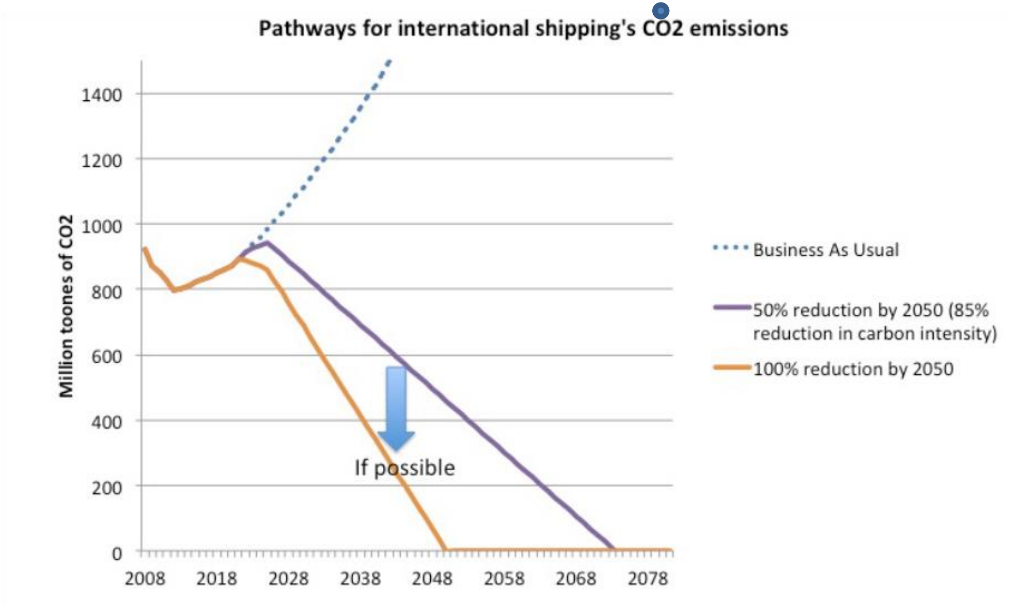
‘Schepen schoner, slimmer en veiliger maken en bijdragen aan een duurzaam gebruik van de zee’

Objective: Reduction of exhaust emissions

2015 → 2020

Shifting target





SPEC: Ships Power and Energy Concept

MARIN's method for conceptual design of climate neutral ships.

SPEC's objectives:

- Get an overview of alternative energy carriers and power systems.
- Compare solutions for climate neutral power for your ship.
- Compare scenario's and see consequences of your requirements and priorities.
- Get a 3D impression of the layout and arrangement of the systems in your ship.

SPEC: Objectives and pre-selection

Start with objectives and requirements

Environment/Regulations		
CO_2 price (tax)	25	€ / tonne CO_2
Primary Particulars		
(Original) pay load	6000	m^3
Reference/typical displacement of ship	3000	tonnes
Approximate total installed power	940	kW -optional-
Client Requirements		
Minimum endurance required	192	hours
Average power requirement for endurance	658	kW
Zero emission solutions only	No	
Min. TRL		*optional*
Min. SRL		*optional*

Example 110 m Inland container vessel 200 TEU

SPEC: Ranking for Technology & Investments (110 m Inland container)

MARIN

Using weighing factors the relevance of different aspects can be provided

Conservative profile

Energy carrier Weighing factors (1..100)	
Contained Energy Density Volume	12
Contained Energy Density Weight	8
CapEx Energy carrier	29
TRL energy carrier	19
SRL energy carrier	0

On board power systems Weighing factors (1..100)	
Specific volume on board power systems	0
Specific weight on board power systems	0
CapEx on board power systems	22
Average power system efficiency	0
TRL on board power systems	10

Overall solution Weighing factors (1..100)	
Harmfull exhaust emission	0
Green House Gas emission	0

SPEC: Ranking for Operations (110 m Inland container)

Use weighing factors to determine the best solutions for Operations

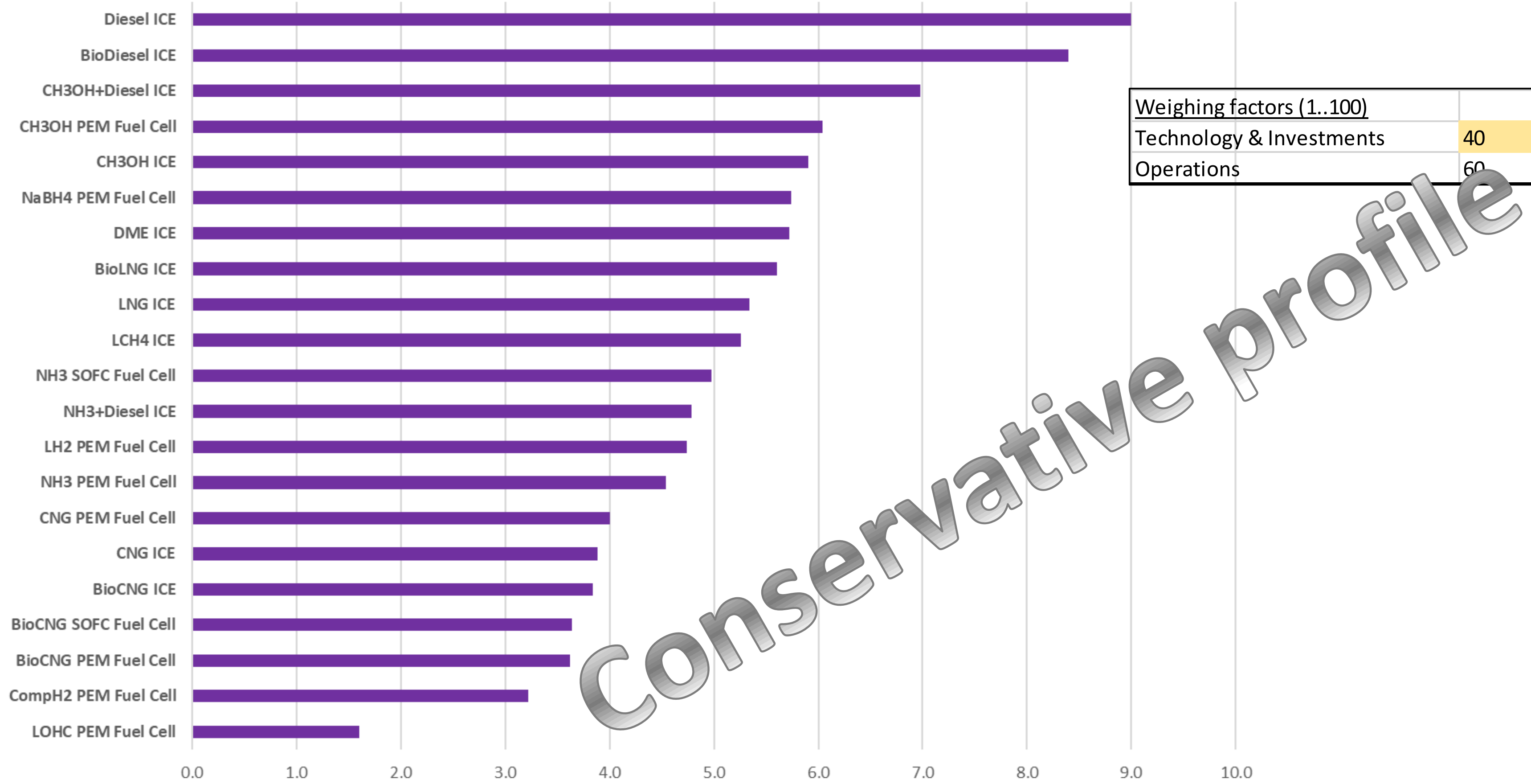
Conservative profile

Energy carrier	
Weighing factors (1..100)	
Gross Energy Density Volume	40
Gross Energy Density Weight	10
OpEx Energy carrier	30

On board power systems	
Weighing factors (1..100)	
Average power system efficiency	20

Overall solution	
Weighing factors (1..100)	
Harmfull exhaust emission	0
Green House Gas emission	0

SPEC: Overall solution ranking (110 m Inland container)



Weighing factors (1..100)	
Technology & Investments	40
Operations	60

Future proof profile

Energy carrier	
Weighing factors (1..100)	
Contained Energy Density Volume	7
Contained Energy Density Weight	5
CapEx Energy carrier	8
TRL energy carrier	7
SRL energy carrier	5

On board power systems	
Weighing factors (1..100)	
Specific volume on board power systems	5
Specific weight on board power systems	2
CapEx on board power systems	8
Chain efficiency systems	8
TRL on board power systems	5

Overall solution	
Weighing factors (1..100)	
Harmfull exhaust emissior	20
Green House Gas emissior	20

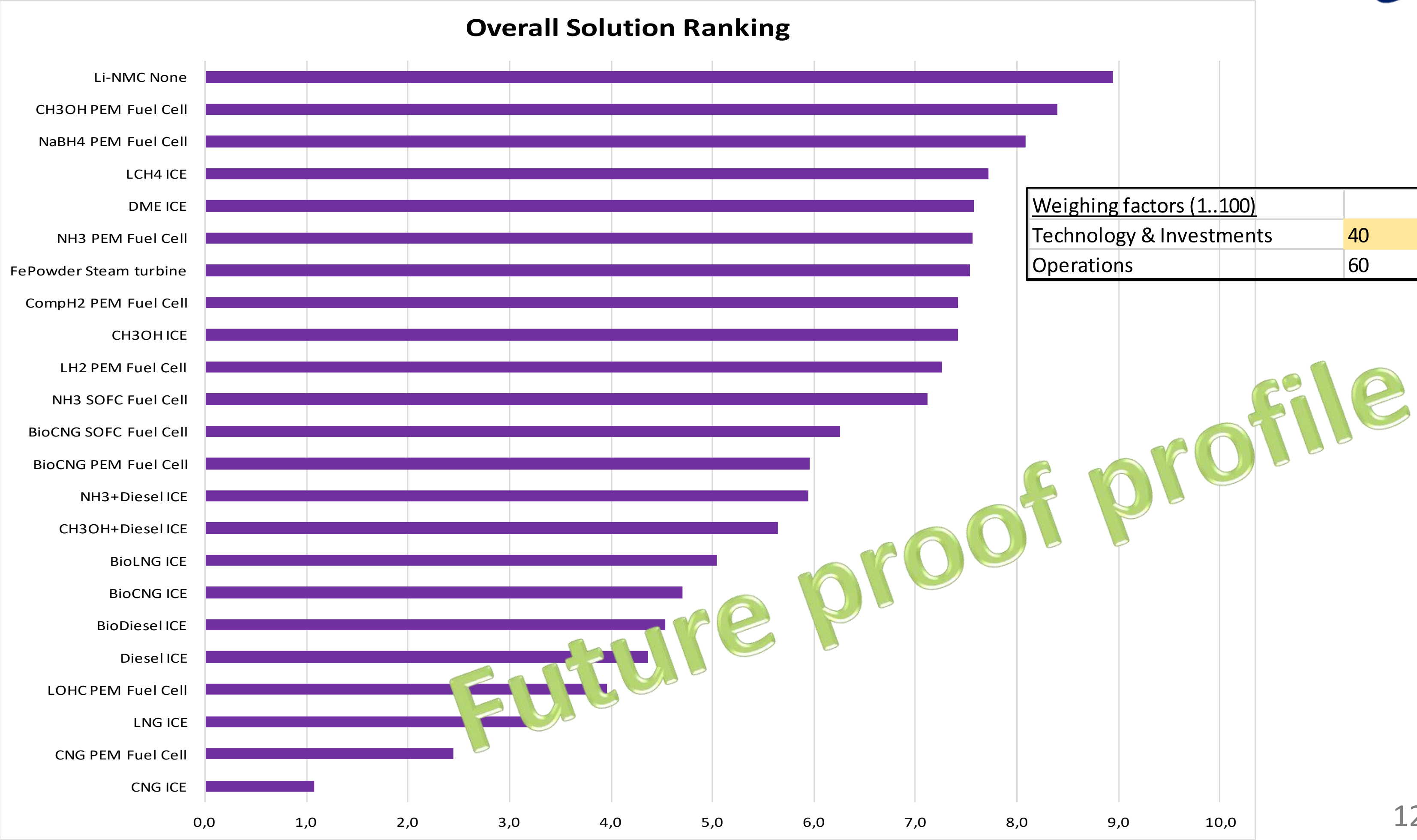
Future proof profile

Energy carrier	
Weighing factors (1..100)	
Gross Energy Density Volume	18
Gross Energy Density Weight	9
OpEx Energy carrier	21

On board power systems	
Weighing factors (1..100)	
Chain efficiency systems	12

Overall solution	
Weighing factors (1..100)	
Harmfull exhaust emissior	20
Green House Gas emissior	20

SPEC: Overall solution ranking (110 m Inland container)

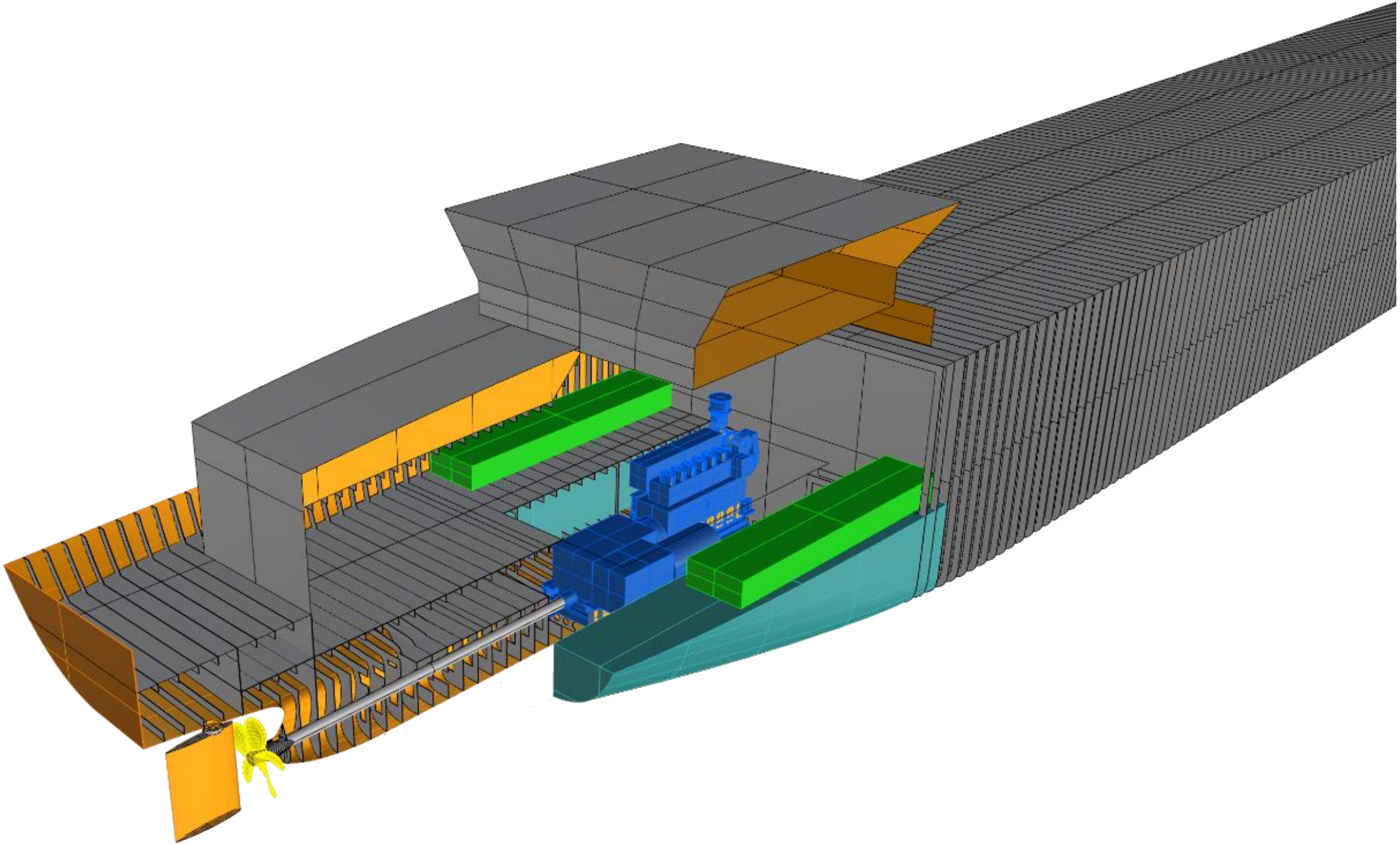


Weighing factors (1..100)	
Technology & Investments	40
Operations	60

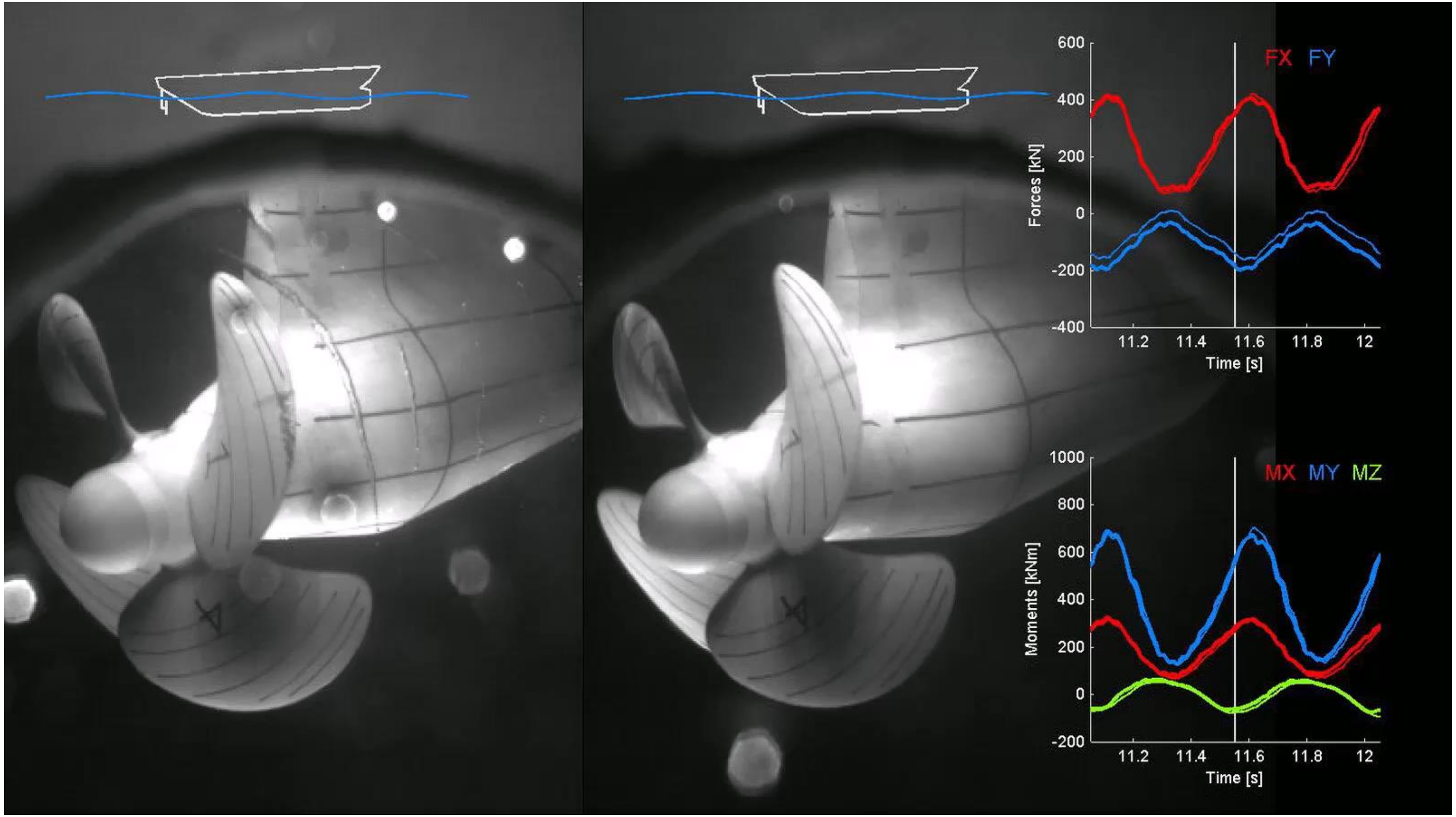
SPEC: 110 m Inland container vessel

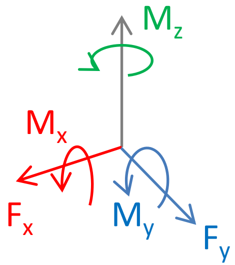
Tanks and systems	Endurance [days]	Volume of tanks [m^3]	Mass of tanks [ton]	Volume of engine room components [m^3]	Mass of engine room components[ton]	CapEx engine room and tanks [k€]	Annual OpEx [k€]
Methanol-hybrid ICE electric	8.0	85.9	70.7	10.2	4.7	1552	1571
LH_2 fuel cell electric	8.0	231.9	124.7	115.1	29.5	2998	2518
Diesel-direct	8.0	38.3	38.3	11.5	6.3	703	513

110 m Inland Container Vessel – Methanol Hybrid



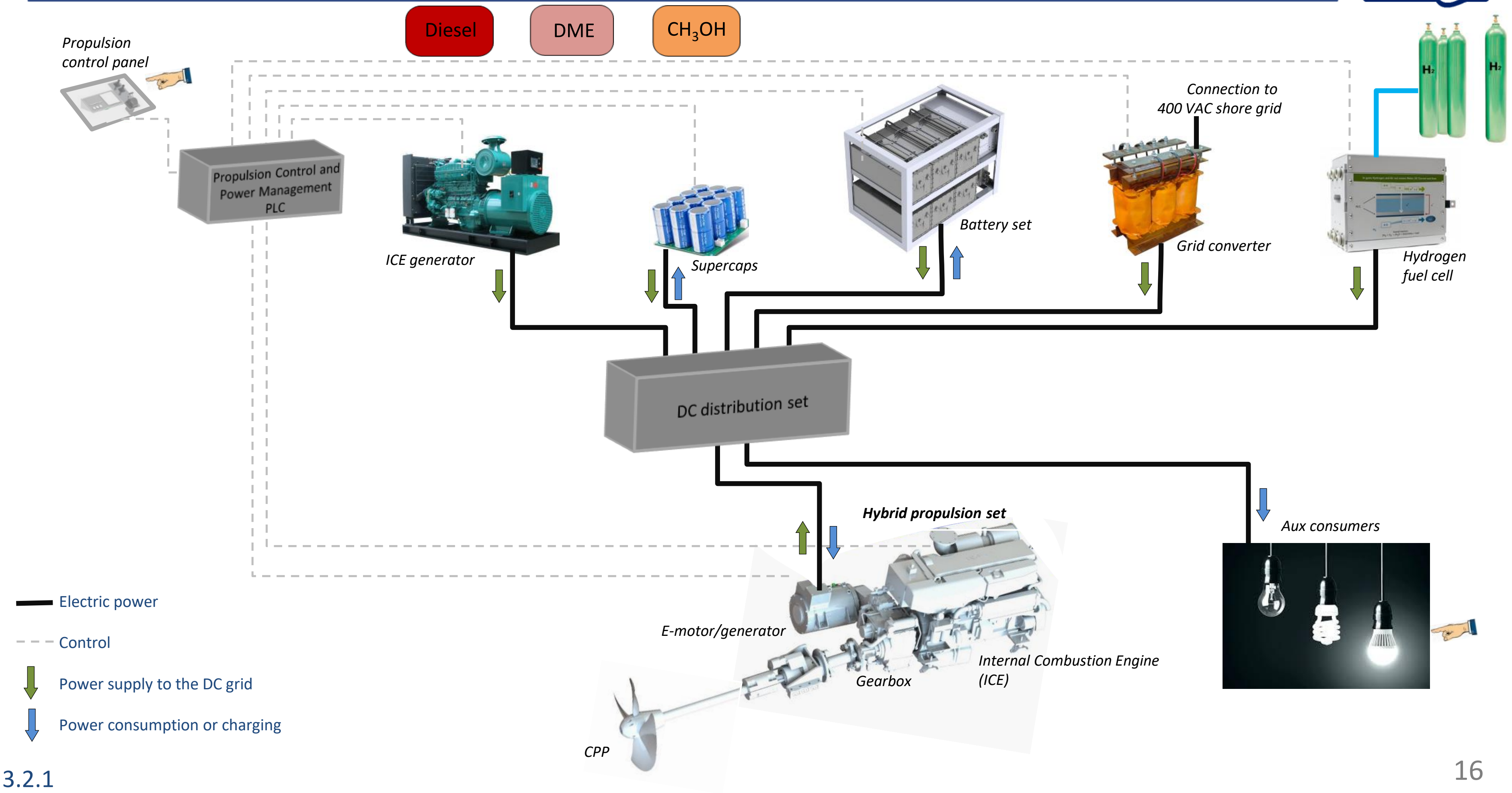
What to test in the new Lab?



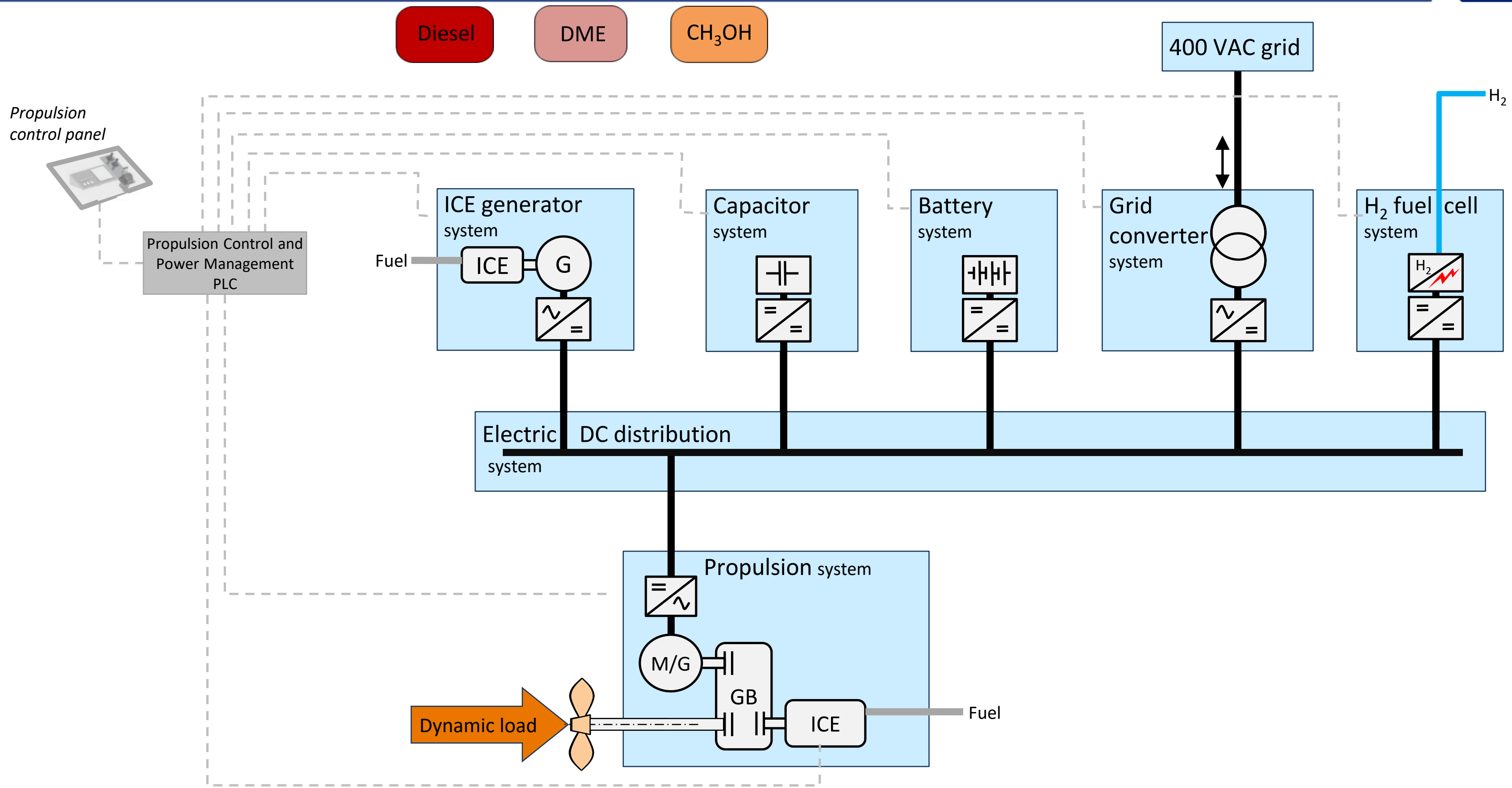


How to make alternative power and propulsion systems meet the load disturbances

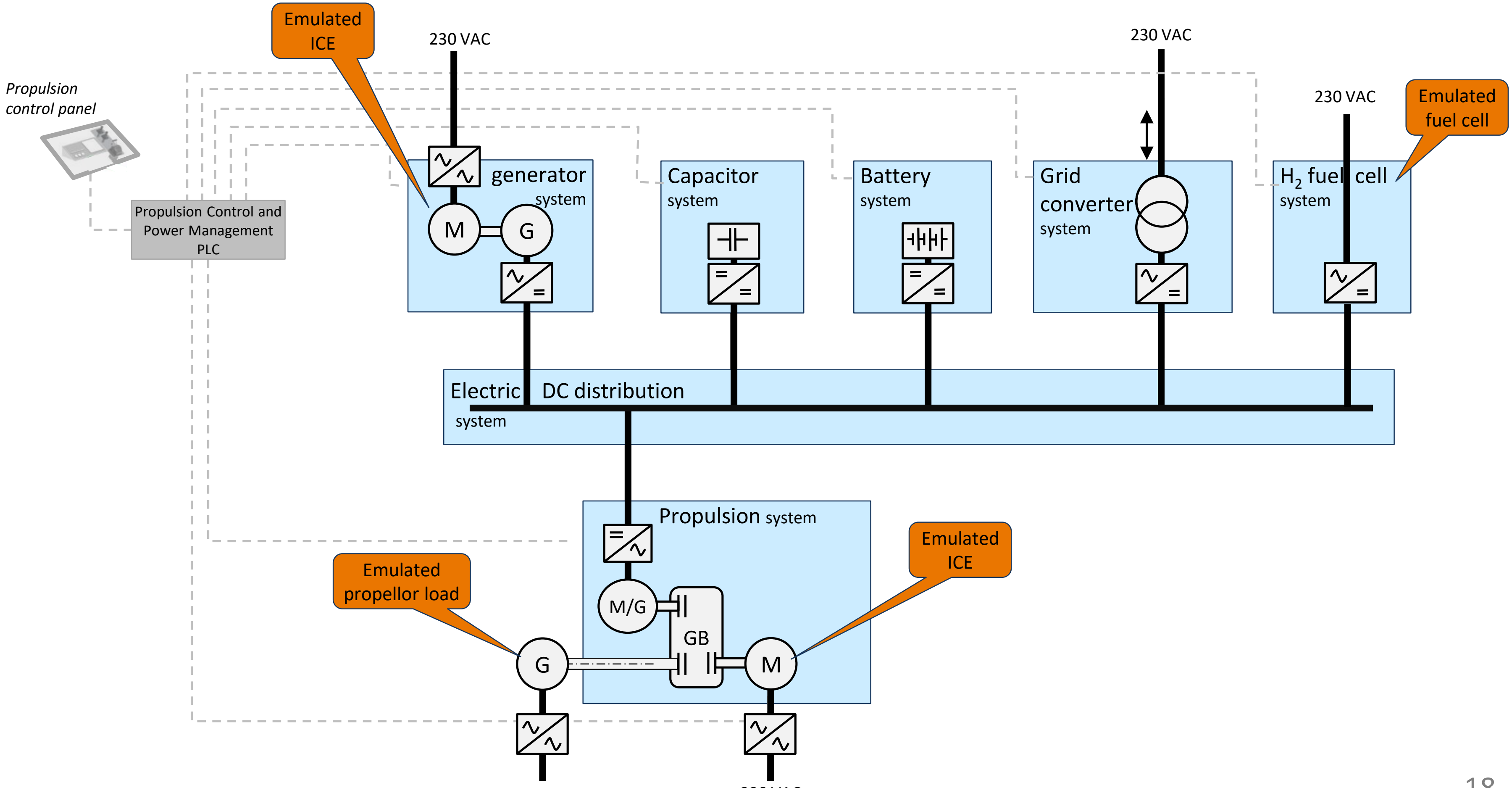
Zero Emissions Lab: Which systems are simulated?



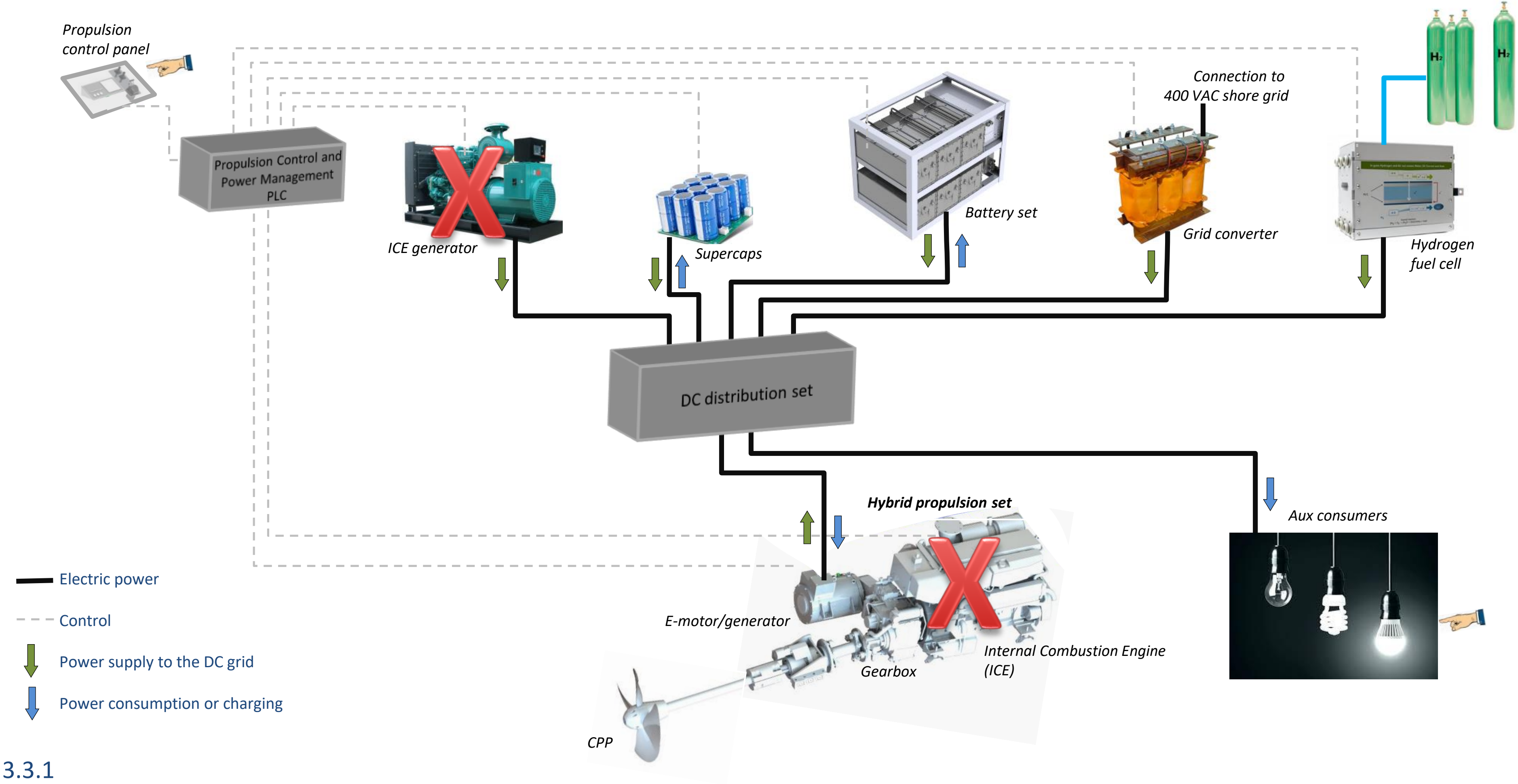
Electric diagram of the simulated systems



How ICE's and fuel cell are emulated in ZEL 0.5

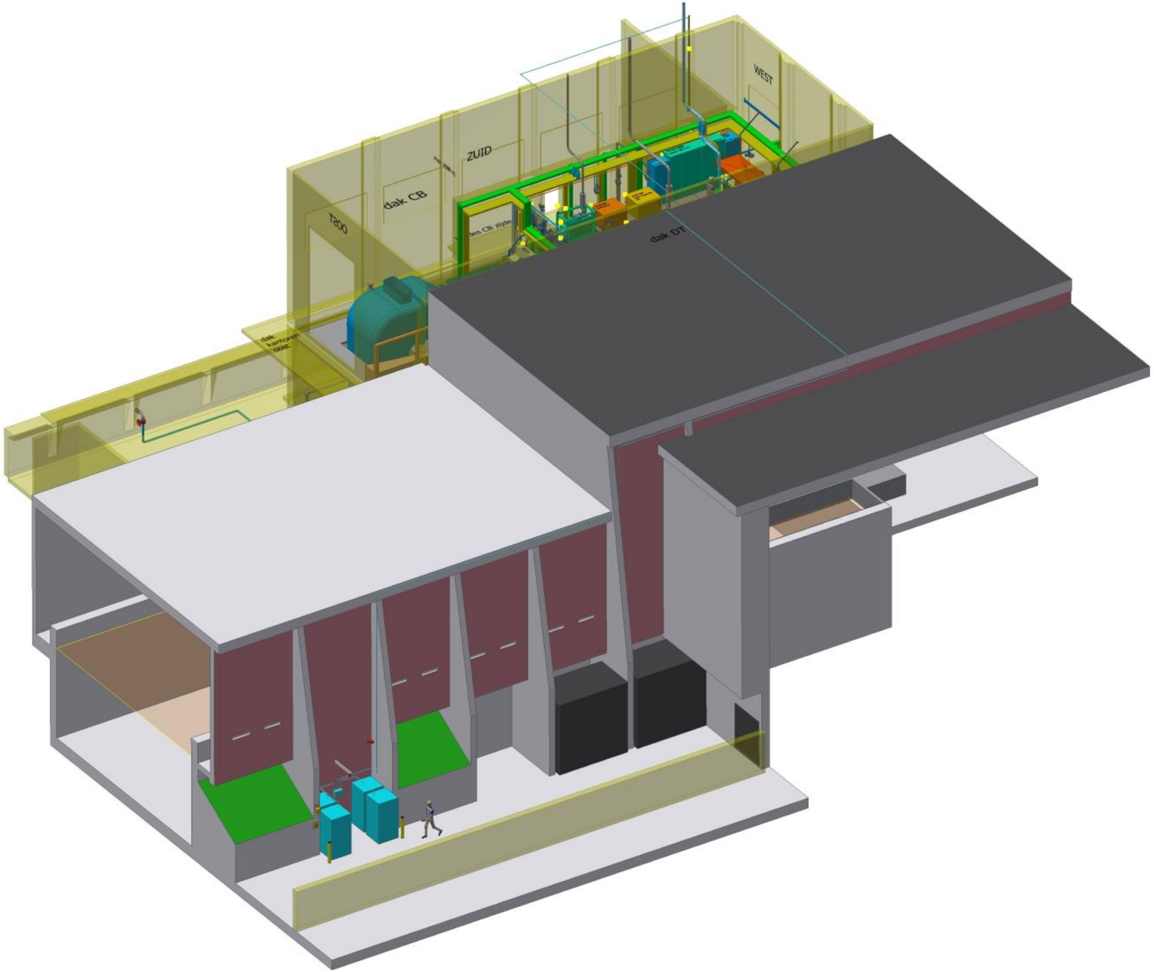


Follow up tests FELMAR 2020

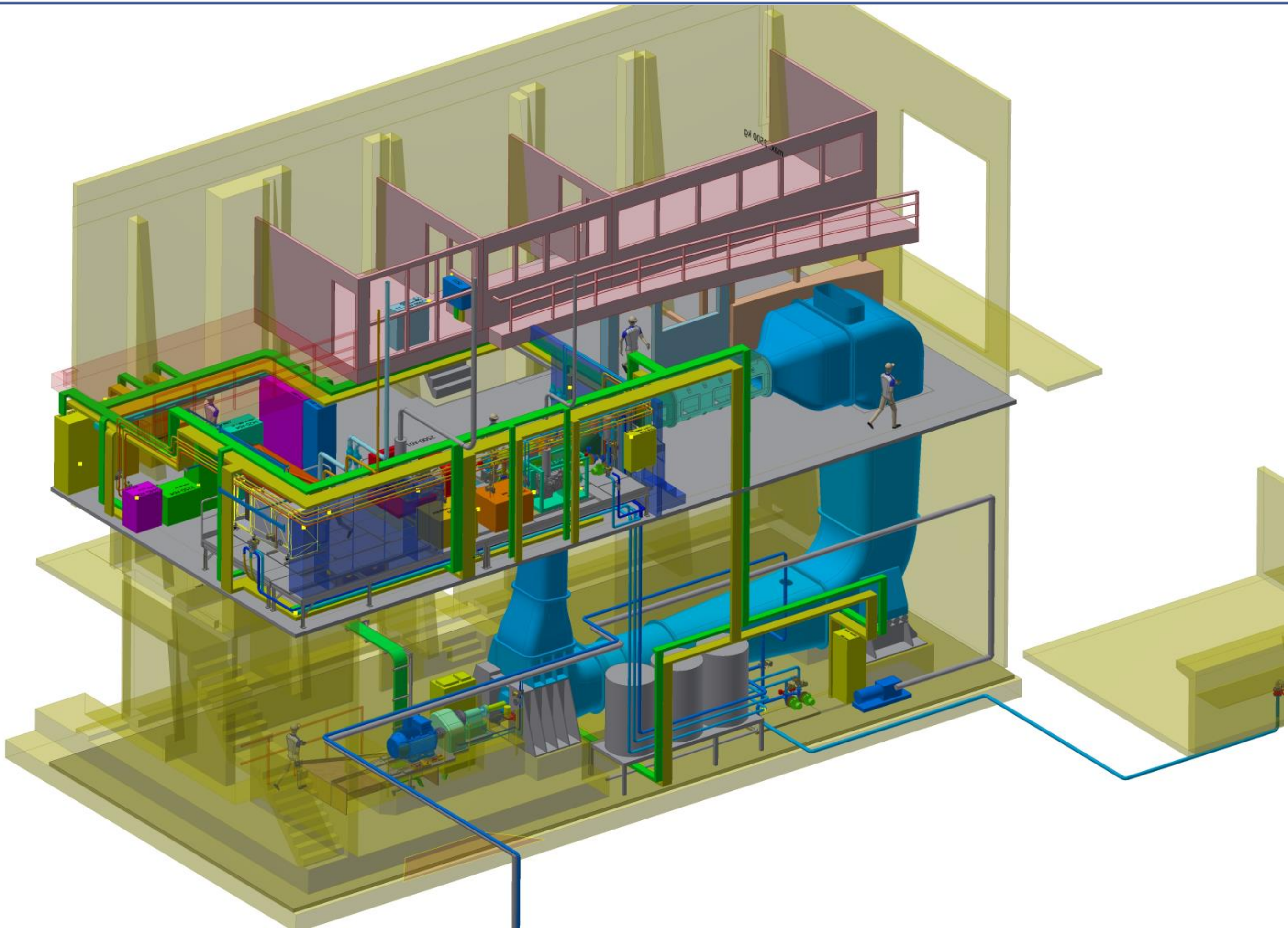


Fuel Cell System

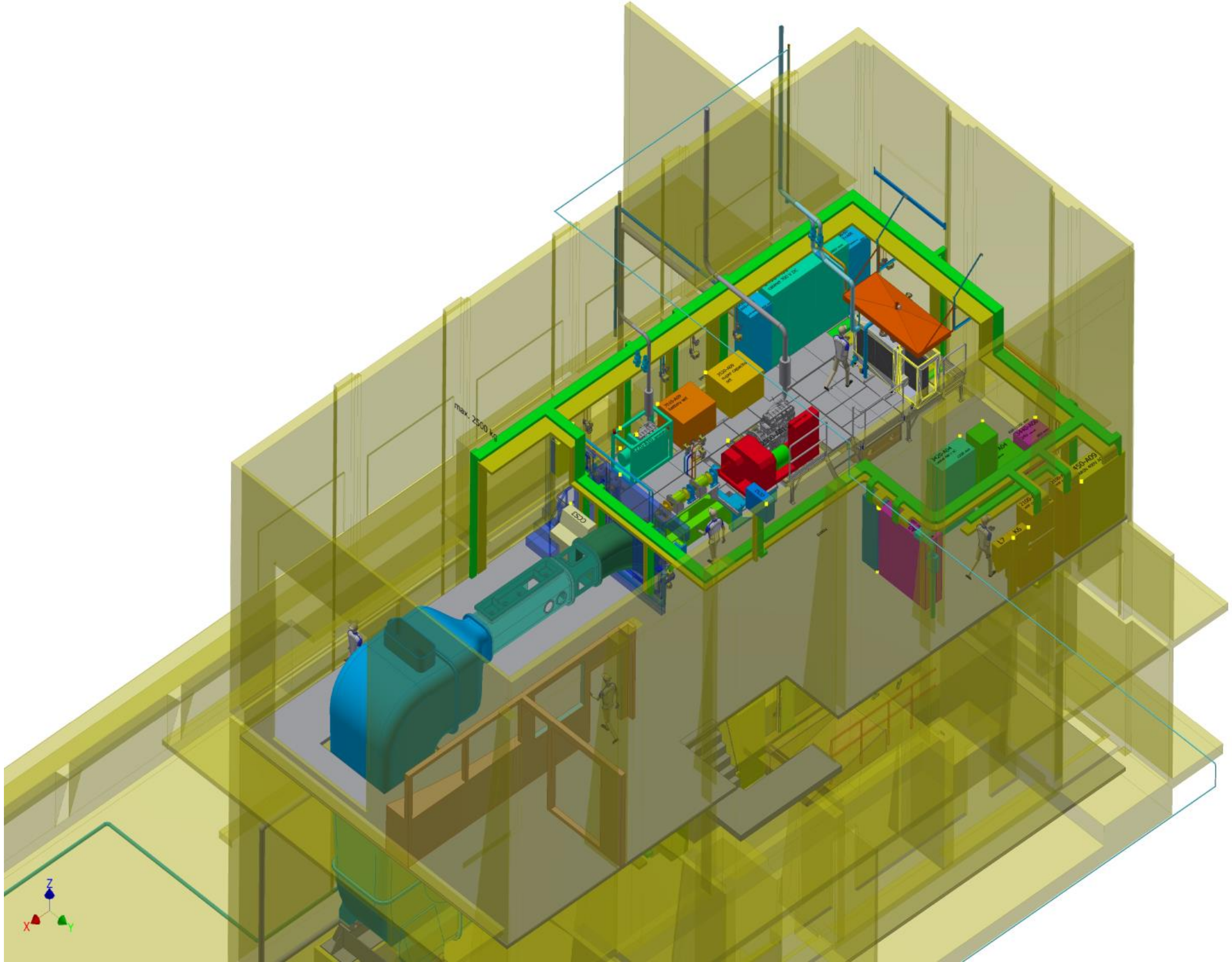
Cavitation Tunnel Building Construction – 2 dec 2019



Cavitation Tunnel Building Construction – 2 dec 2019



Cavitation Tunnel Building Construction – 2 dec 2019



Cavitation Tunnel Building Construction – 2 dec 2019

Thank you

THRUST

Giving the energy transition on water a push forward

Merriam-Webster Dictionary

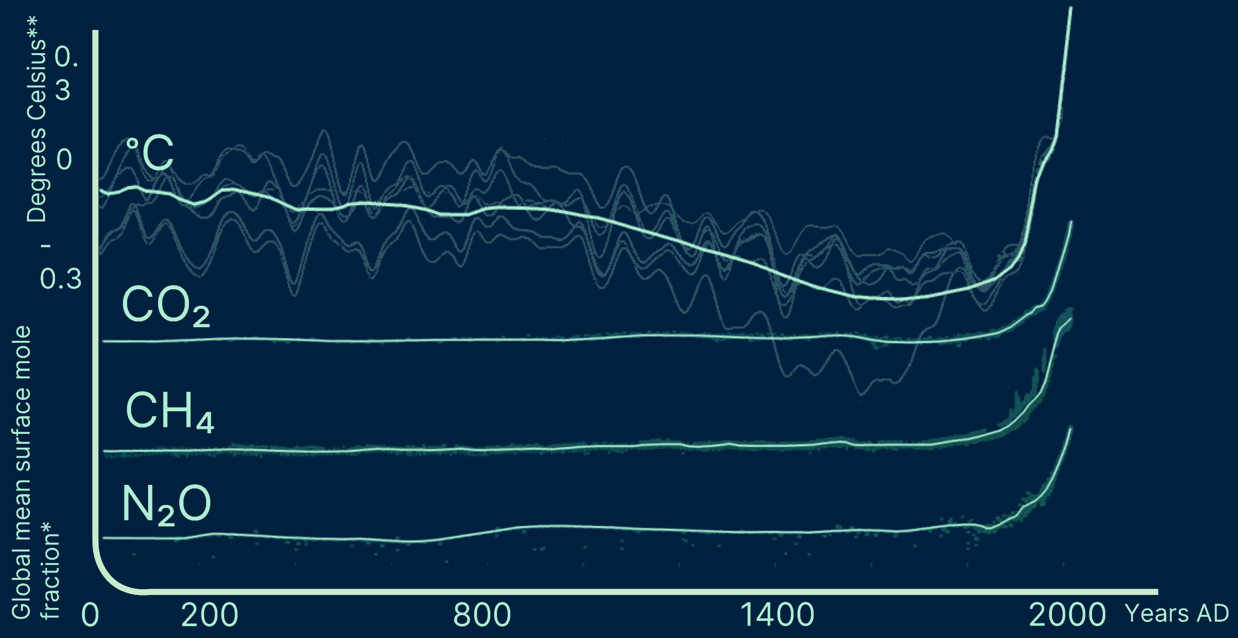
1. A forward or upward push;
2. A movement (as by a group of people) in a specified direction

Acronym: Towards Hydrogen-based Renewables Used for Ship Transportation

THRUST is an initiative by: enviu

Climate Change is happening and the world may be fatally wounded if we don’t act immediately

Past 2000 years of greenhouse gas concentrations and global warming

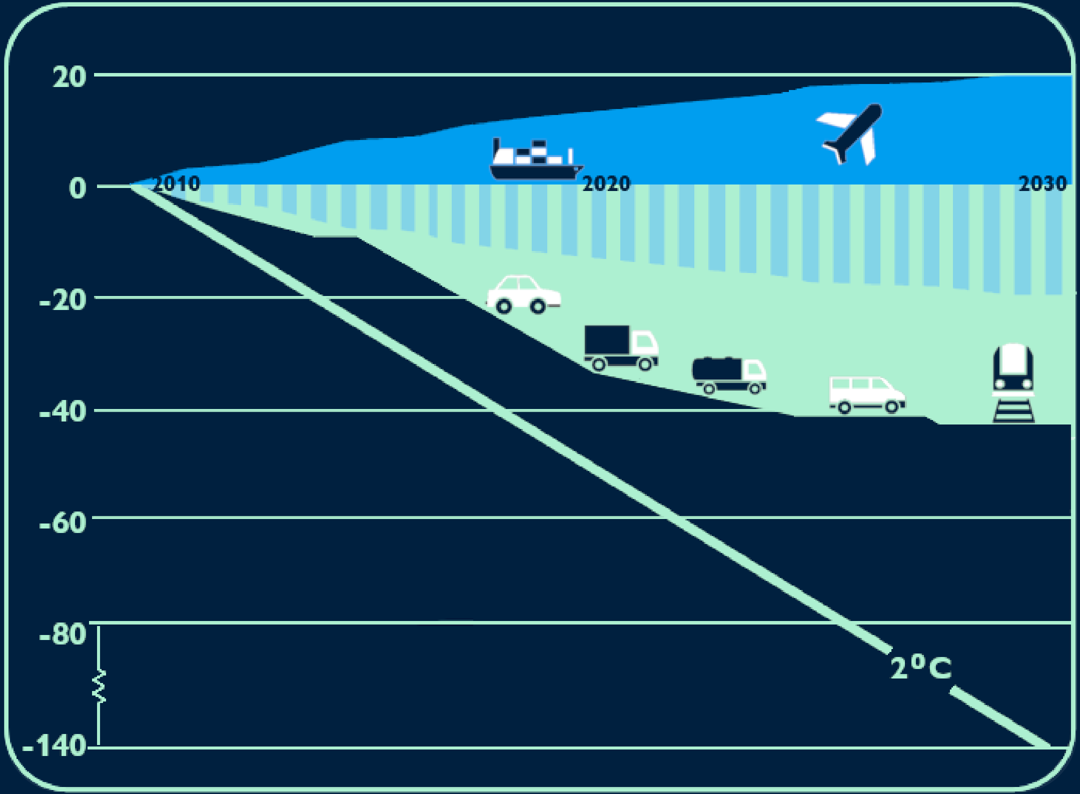


- Climate is warming faster than in the past 2000 years - across the globe
- Paris Agreement (2015) commits to stay within 2°C global - we are heading towards 3°C by 2100
- We need to take action NOW

* Open access journal of the European Geosciences Union

** Nature and Naturegeoscience

The impact of fossil fuel consumption of the maritime transport industry has a significant and rising impact on global warming ...



Fossil fuel consumption
(MTOE*)

- If the maritime industry were a country, it would be among the top six producers of GHGs globally - emitting 1 billion tonnes of CO2 /year

- IMO ambition:

*"Reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008, while, at the same time, pursuing efforts towards phasing them out entirely."***

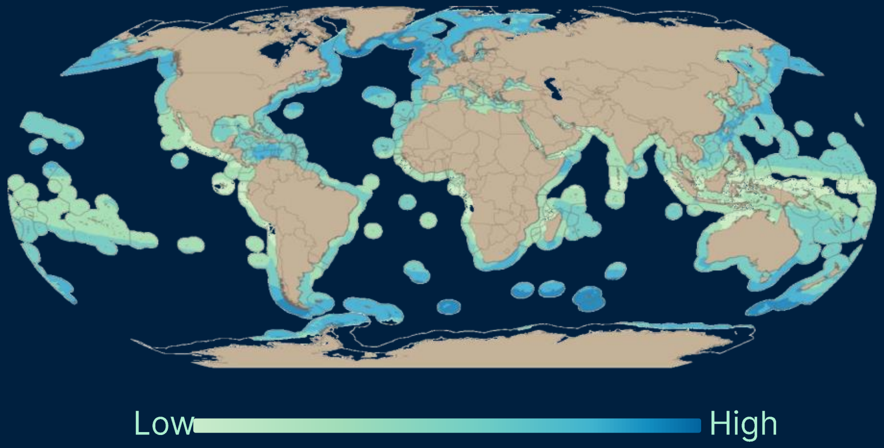
- Phasing out entirely can only be achieved by using 100% renewables

*MTOE = Million Tonnes Oil Equivalent
**IMO = International Maritime Organization

Renewables can generate the required energy without emissions

- Off-shore wind can generate abundant amounts of energy
- Imbalance generation vs. utilisation in timing and location leads to huge transport and storage losses
- Hydrogen offers storage solution and utilising it close to production will avoid most transport costs
- The maritime sector uses enormous amounts of energy in potential off-shore wind locations

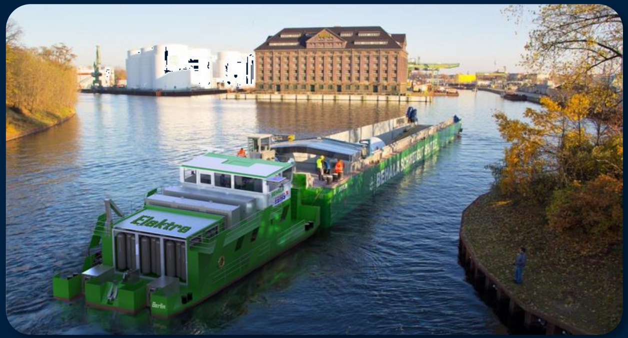
Wind energy potential in shallow waters



Maritime traffic on world oceans

Hydrogen technologies for storage and transport are becoming increasingly mature …

Hydrogen-fuelled transport on land



Hydrogen-fuelled transport on water

Hydrogen offers the missing link towards a sustainable future, but larger scale deployment is required ...

Hydrogen as key technology

Search | Bloomberg | Sign In

Technology

Hydrogen Is the Fuel of the Future. For Real This Time, IEA Says

Fuel Cells Bulletin

Volume 2018, Issue 1, January 2018, Page 1

ELSEVIER

News

Hydrogen key to unlock North Sea wind energy

OIL & GAS / NORTH SEA

Neptune Energy selected for pioneering hydrogen plant in Dutch North Sea

CNN Sports Football Tennis Equestrian Golf Skiing Horse Racing Motorsport Sailing Rugby Formula E Edition

SPORT England benefited from 'clear mistake,' says former umpire Simon Taufel

'Crossing the Atlantic with no fuel:' Can superyachts really go green?

Public perception & political will

The Guardian

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Sport | Culture | Lifestyle | More

Wildlife Energy Pollution

National Trust to divest £1bn portfolio from fossil fuels

16 APRIL 2018 NEWS

IMO agrees 50% reduction in GHG emissions by 2050

The Economist | Topics | Current edition | More

A polder vision

Costly climate measures are hard to sell, but the Netherlands has a plan

How about the urgency....!?

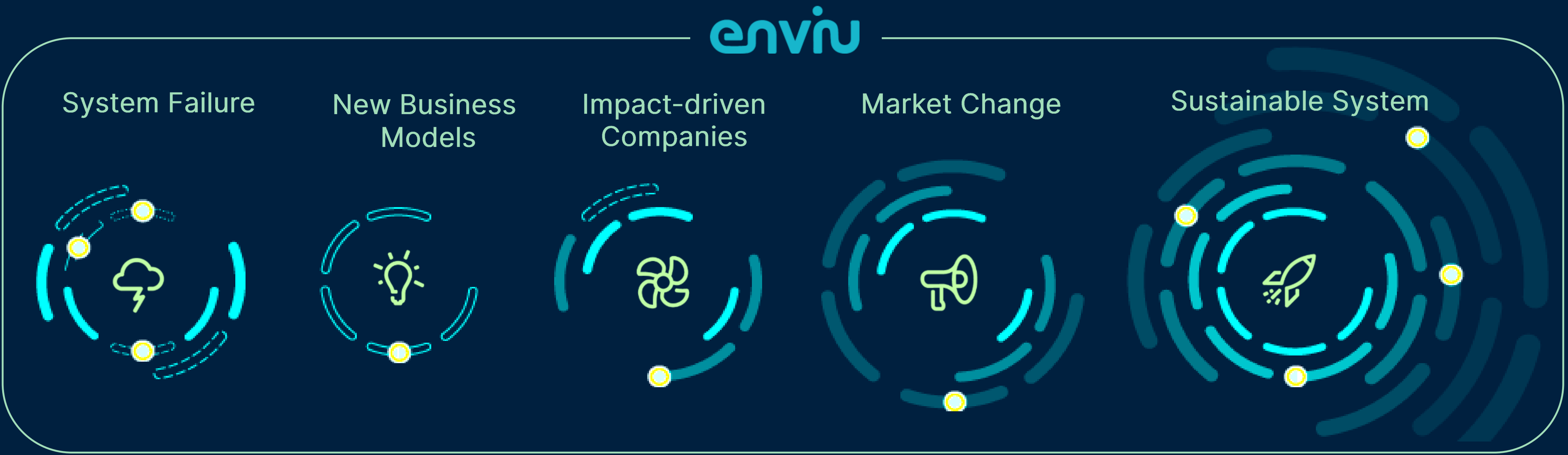
BBC NEWS

Home | UK | World | Business | Politics | Tech | Science | More

Climate change: 12 years to save the planet? Make that 18 months

Creating business opportunities is crucial to accelerate the required transition

Enviu runs programs to build world changing companies in a variety of sectors that need change*

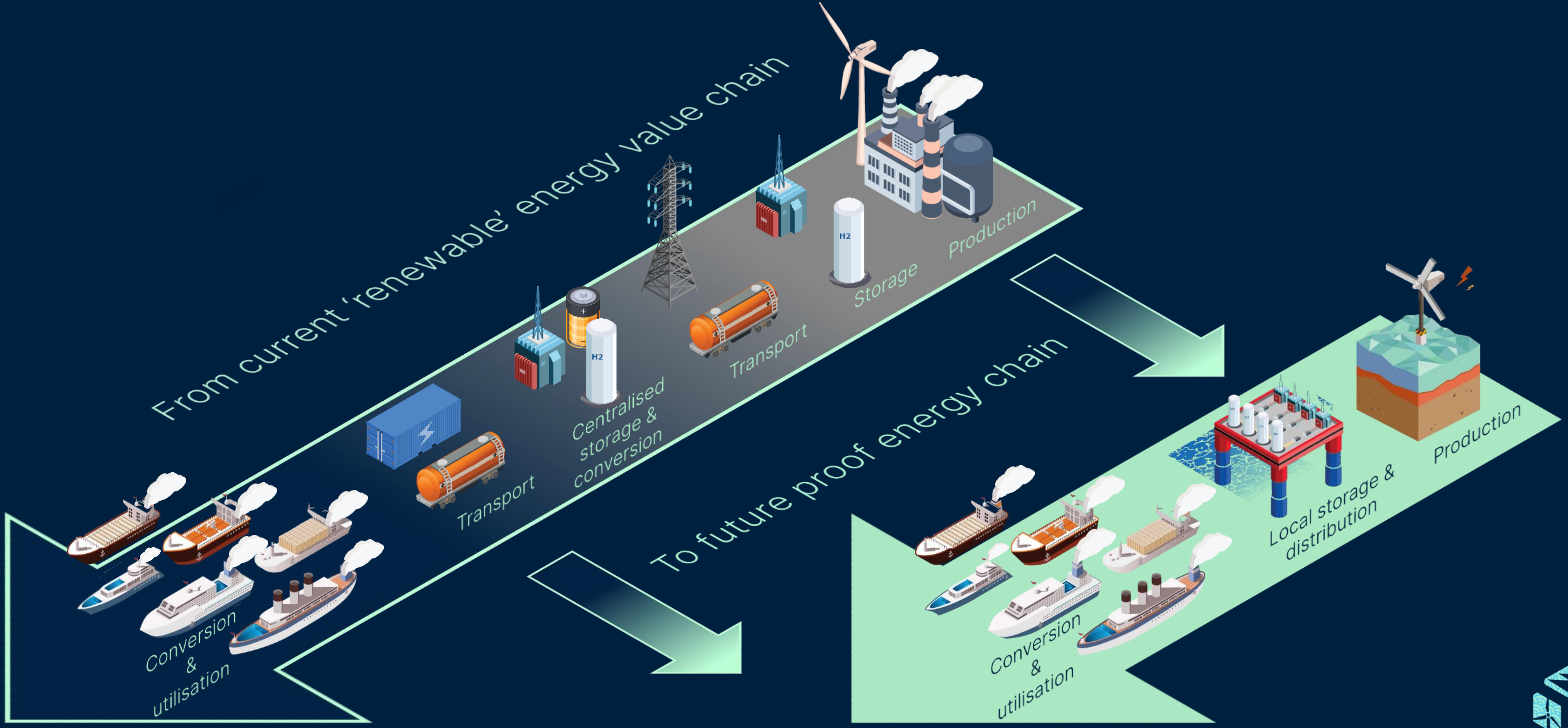


THRUST is a program initiated to accelerate the transition to zero harmful emission shipping

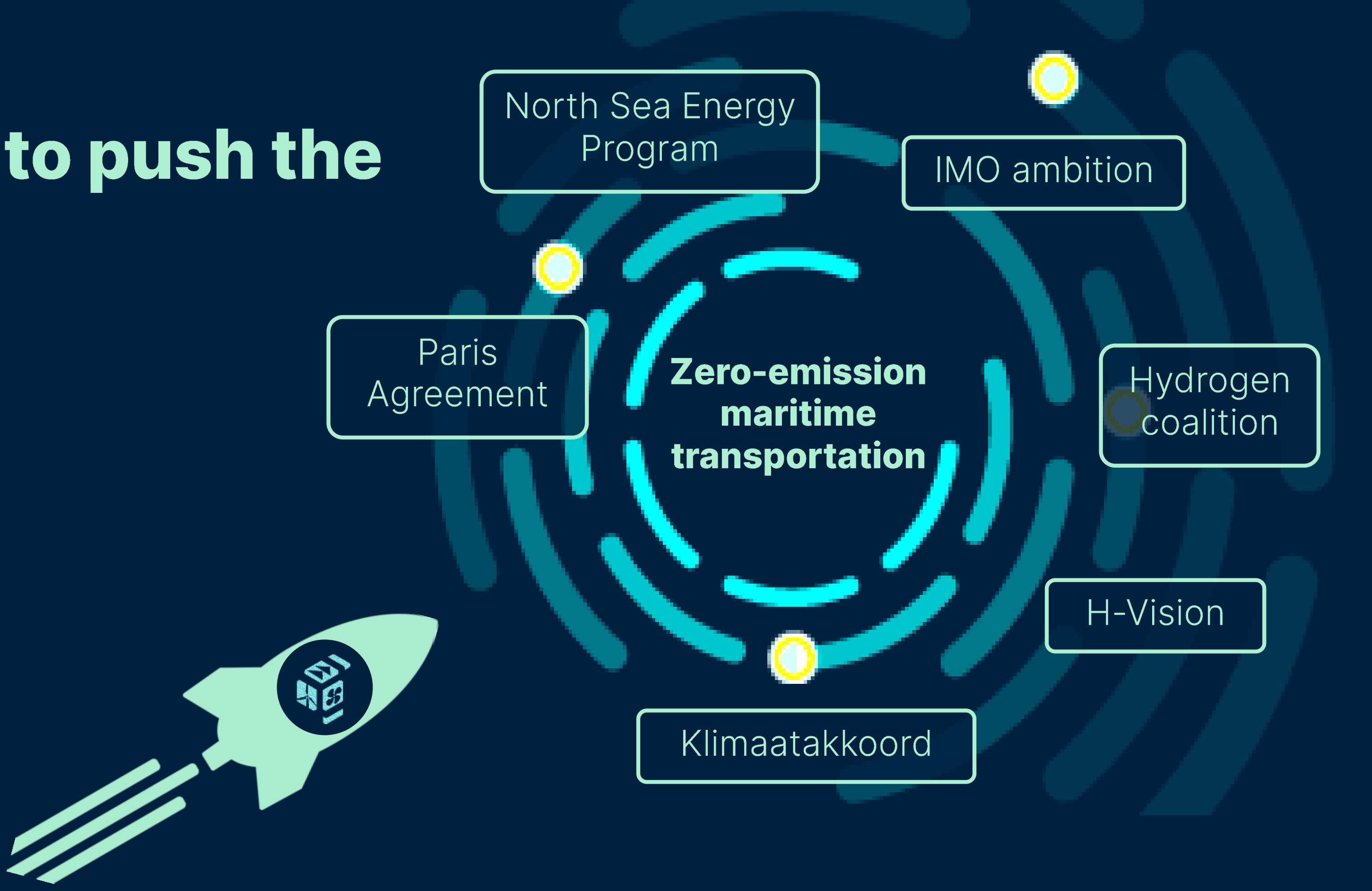
A selection of our program partners:

* See ANNEX for Enviu's track record

To make fossil-fuel free alternatives competitive we need to re-think & shorten the entire value chain



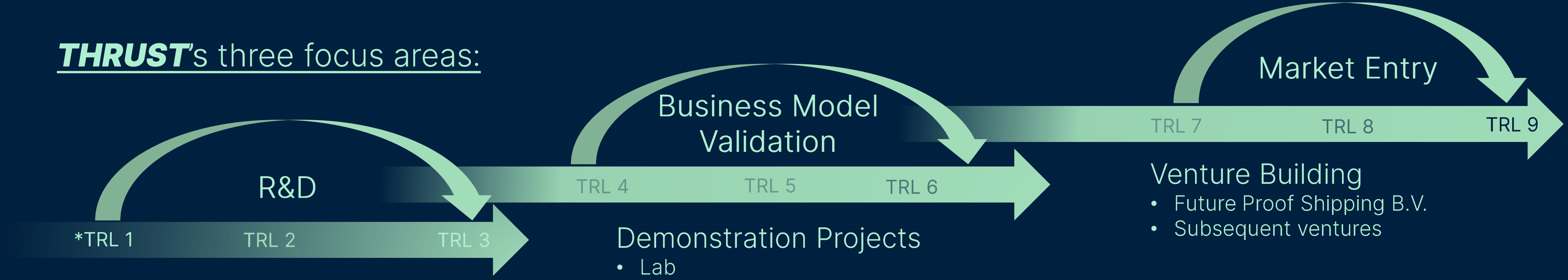
THRUST connects the dots to push the Energy Transition on Water



Re-shaping value chains with new business models is in our DNA

- Role: integrator, business case & venture builder
- Skillset: system-thinking, venture building, cross sectoral market understanding & network, technical & commercial expertise
- Scope: scouting, development & dissemination of disruptive technologies, acceleration of technologies and business concepts towards market entry & uptake

THRUST's three focus areas:



Knowledge development
- Fundamental Research
- Scouting Innovations
- Dissemination of results

Demonstration Projects
- Lab
- Inland
- Off-Shore
- Dissemination of results

Venture Building
- Future Proof Shipping B.V.
- Subsequent ventures

* TRL = Technology Readiness Levels

Towards zero-emission operations on water: ongoing activities

Research & Development

A Transition pathways for electro-fuels in the Maritime Industry

B Hydrogen concepts, safety & regulations Maritime sector

C Zero harmful Ammonia in Fuel Cells

D Generating Green Energy for Maritime Applications

Business Model Validation

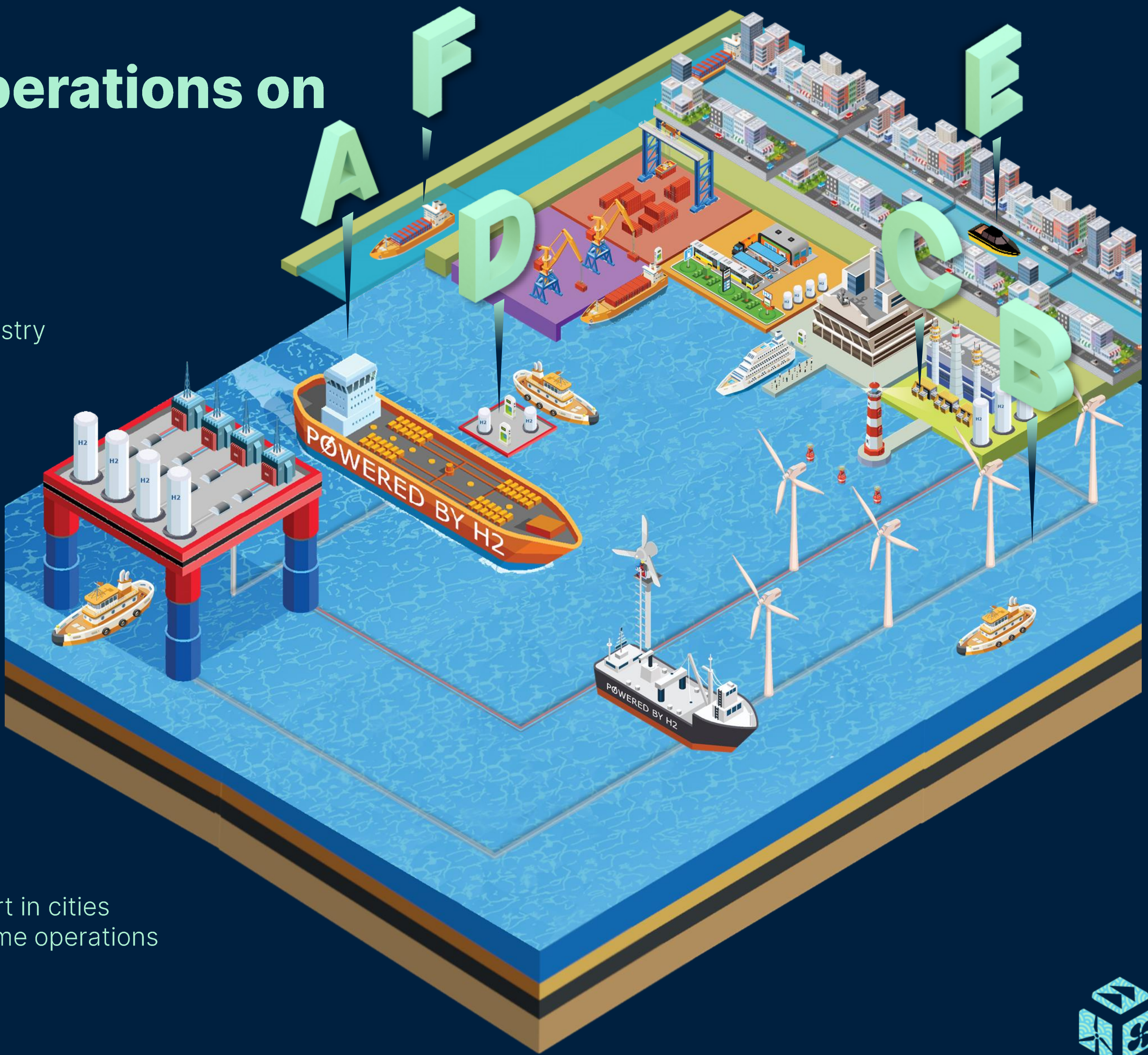
E Watertaxi Rotterdam on Hydrogen & Ammonia

Market Entry

F Future Proof Shipping B.V. – Piloting inland barge on 100% H2

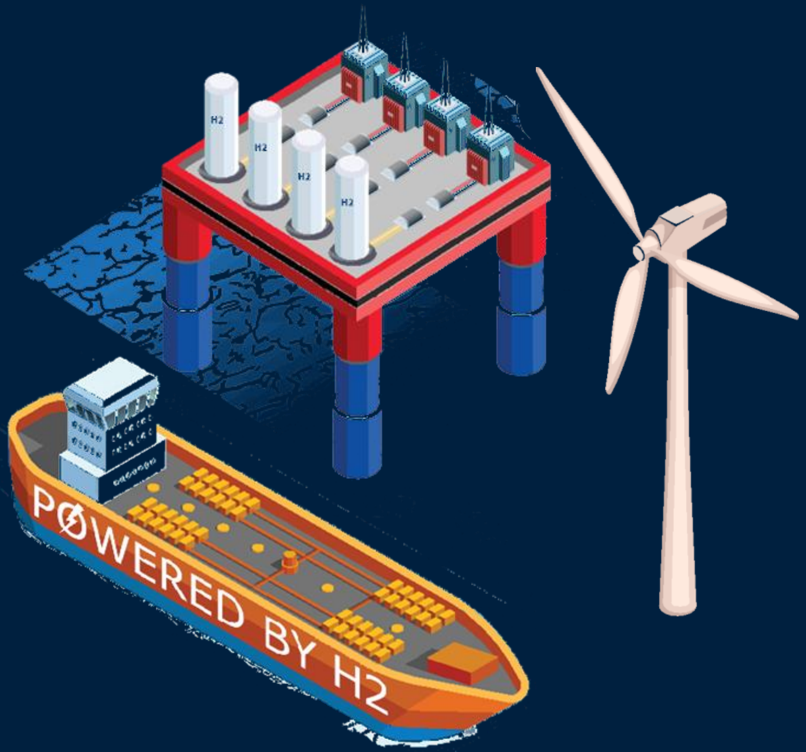
New initiatives

- Floating fossil-free fuel station for waterborne transport in cities
- Decentral production of green fuel for short sea maritime operations
- Hydrogen power barge



Build business case & confirm NL and consortium partners at the forefront of the energy transition at sea

Off-shore green fuel bunkering



Capitalising its positive effects…

- Efficient, decentral & direct use of green energy
- Less fuel consumption, voyage costs, OPEX
- No more compliance issues, subsidies

…will help tackling the short term hurdles

- Higher fuel prices, higher initial CAPEX
- Limited sailing range
- Increased on board storage requirements
- Reduced flexibility in choice of bunkering locations
- Limited regulations for hydrogen as a fuel

Join us if you have the ambition to:

1. Create **real impact** by proving that zero-emission business models can work already today

2. Create a new sustainable industry on the North Sea, setting the pace for **maritime decarbonisation globally**

3. Invest in a future we can be proud of - **re-shaping the Dutch oil & gas, maritime & offshore industries** - maximising the benefits of our geographic location and technological expertise

*Let's create **THRUST** together*

Tim van Vrijaldenhoven

tim@enviu.org

Maarten Fonteijn

maarten@enviu.org

https://thrust.enviu.org/

ANNEX

Enviu runs issue-driven programs to build world changing companies

Selection of Ventures & Programmes

Financial Inclusion

LAKSHY · TWU · People's Pension Trust

Providing access to financial stability through financial education, financial advice and (micro)products for the BoP in India & Africa

Food

Janta Meals · Soko Fresh

Drastically reducing post-harvest food loss in Kenya, leading to increased farmer income and food security

Working on zero-plastic-waste in Indonesia by creating disruptive alternative delivery solutions to radically reduce plastics

Circular Value Chains

UPSET · Zero Waste Living Lab · Leather Matters

Reweaving the set-up of the textiles industry in India towards a circular and socially fair value chain

Creating a circular leather value chain by accelerating innovations that tackle the biggest issues and by re-designing the value chain

Cleantech

Future Proof Shipping · TWU · THRUST · ENERGY FLOORS

Building a sustainable, future proof shipping market towards zero emission in 2040