Seminar 'Samenwerking om doelstellingen klimaatakkoord zeevaart te realiseren'

23 mei 2018

PLATFORM SCHONE SCHEEPVAART

KVNR   NETHERLANDS MARITIME TECHNOLOGY   Port of Amsterdam   Port of Rotterdam   MARIN   TNO innovation for life   Stichting De Noordzee

Over het platform

- Opgericht in 2007. Vorig jaar 10 jarig bestaan gevierd!
- Doelstelling: *Het reduceren van emissies van schepen op een wijze die de concurrentiepositie en bedrijfsvoering van de Nederlandse maritieme sector ten goede komt of niet schaadt.*

- Drie tot vier seminars per jaar
- Op de hoogte blijven? Sluit u aan bij onze LinkedIn groep
- Meer informatie via www.schonescheepvaart.nl

Programma

13.00	**Ontvangst**	
13.30	Openingswoord en introductie door dagvoorzitter	Nick Lurkin *Beleidsadviseur Milieu,* **KVNR**
13.40	Visie vanuit het energieagentschap, als energieadviseur, op IMO's Klimaatakkoord	Renske Schuitmaker *Directorate of Sustainability, Technology and Outlooks*, **Internationaal Energieagentschap** (IAE)
14.10	'It's all about the money'… visie vanuit een bank	Michael de Visser *Managing Director Shipping & Intermodal*, **NIBC**
14.40	Vaargereed voor de transitie: Binnenvaart en Short Sea, de proeftuin voor de zeevaart	Johan de Jong & Moritz Krijgsman **MARIN**
15.10	Pauze	
15.40	Een lopend initiatief bij de Zuiderburen: Maritime Industry Decarbonization Council	Nathan de Bruyn *Maritiem ingenieur*, **Koninklijke Belgische Redersvereniging**
16.00	Visie vanuit een motorenontwikkelaar	Sebastiaan Bleuanus *General manager research coordination & Funding* **Wärtsilä Marine Power Solutions**
16.20	Brandstoffen van de (CO2-arme) toekomst	Jorrit Harmsen **TNO**
16.50	Lange termijn visie voor raffinage van vloeibare brandstoffen in Europa	Eddy van Bouwel *Senior Advisor*, ExxonMobil spreekt namens **FuelsEurope**
17.05	Vragen	Onder leiding van dagvoorzitter
17.15	Netwerkborrel	
18.00	Einde bijeenkomst	

IMO-Klimaatakkoord in een notendop

1. Verdere aanscherping van de bestaande Energy Efficiency Design Index (EEDI-) normen;
2. De vervoersprestatie per schip reduceert met gemiddeld 40% in 2030 ten opzichte van 2008 en er wordt gestreefd naar een reductie van 70% in 2050;
3. Een absolute broeikasgasreductie van minstens 50% in 2050 ten opzichte van 2008;
4. Uitfasering van broeikasgassen (waaronder CO2) zal zo snel mogelijk in de tweede helft van deze eeuw plaatsvinden.

How to get there?

IEA Beyond 2°C Scenario: International shipping sector

Renske Schuitmaker

Harderwijk, 23 May 2018

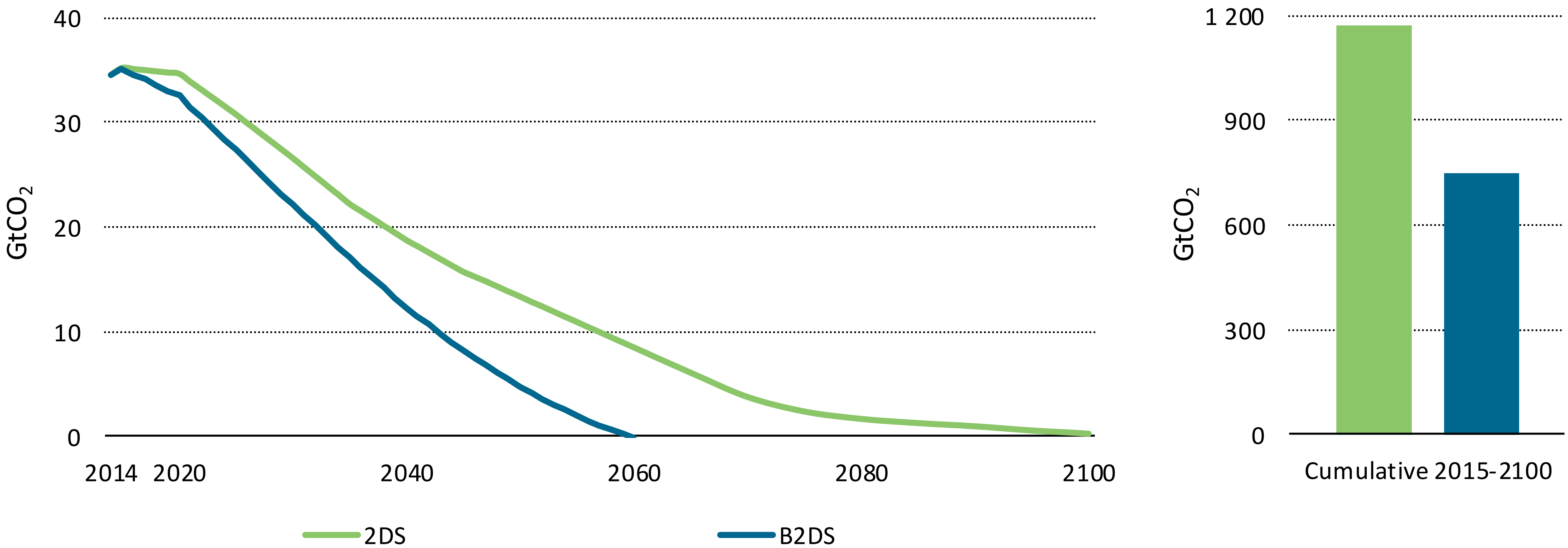
International Energy Agency (IEA) and the Mobility Model

- “The IEA is an autonomous organisation that works to ensure reliable, affordable and clean energy for its 30 member countries and beyond”
  - **Increasing cooperation with non-members, mainly BRICS**

- In transport, development of the Mobility Model (MoMo)
  - Analytical tool used to elaborate the projections of transport activity, energy demand and CO_2 emissions in Energy Technology Perspectives since 2006
  - The foundation of transport-related analysis in the Sustainable Policy and Technology Directorate
  - An essential tool for transport-related activities on…
    - energy efficiency: Global Fuel Economy Initiative (GFEI)
    - energy technology: Electric Vehicles Initiative (EVI)
    - cooperative efforts: Railway Handbook on Energy Consumption and CO_2 emissions with UIC

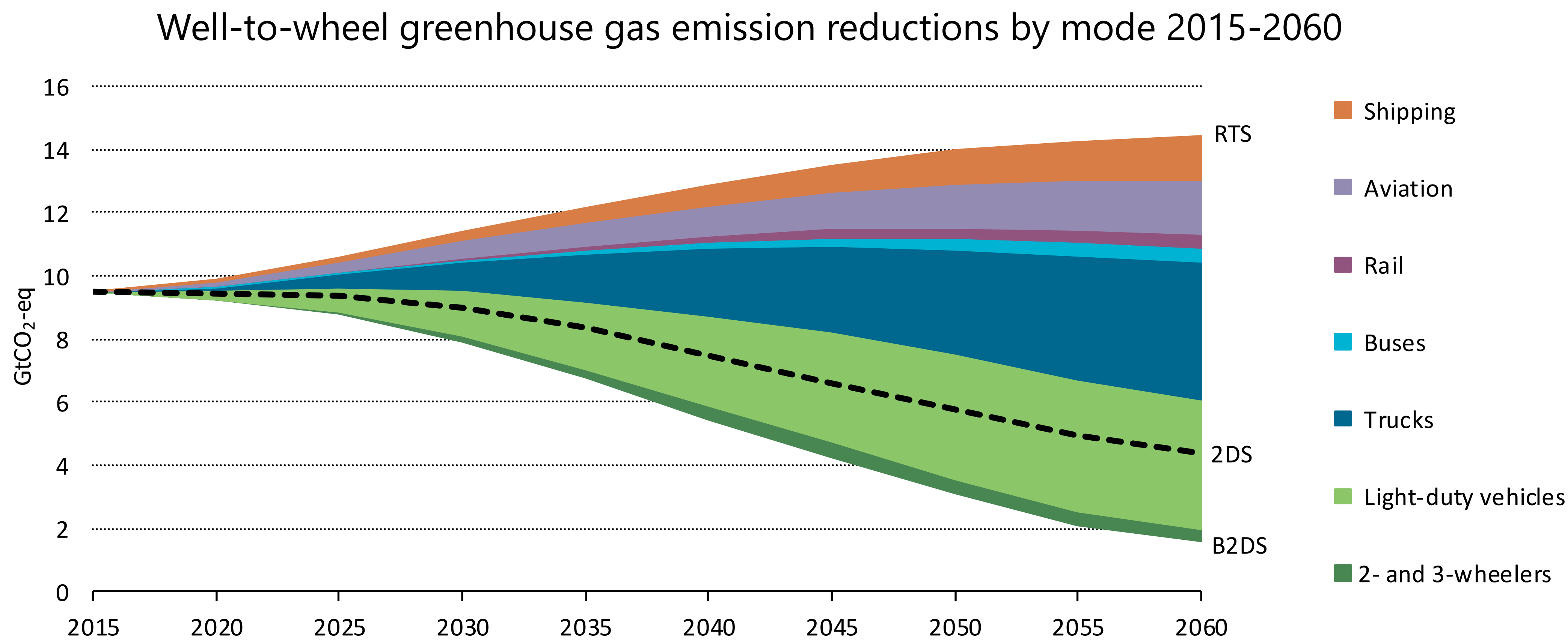
GHG emission budgets and trajectories for the global energy sector

The 2°C Scenario (2DS) and the Beyond 2°C Scenario (B2DS)



To meet the ambition of the Paris Agreement, energy sector CO_2 emissions need reach net zero in the second half of the century

B2DS: analysis of energy system decarbonisation, transport



WTW GHG emissions from transport are 89% lower in 2060 than in 2015 in the B2DS, while in the 2DS they decline by 54% over the same period. All modes contribute to decarbonisation.

Decarbonizing transport is challenging

Transport accounts for 28% of global final energy demand and 23% of global carbon dioxide (CO_2) emissions from fuel combustion. I**nternational shipping accounts for about 2% of global CO_2 emissions from fuel combustion.**

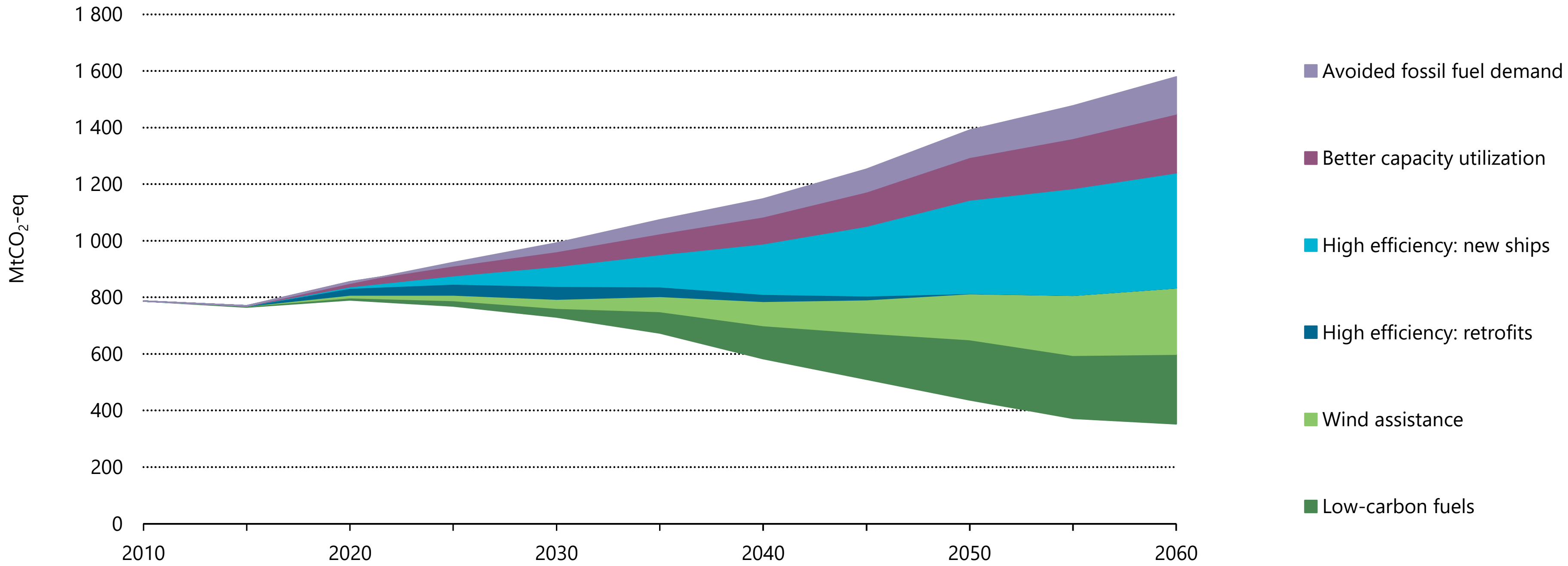
Decarbonising long-distance transport modes – in particular aviation, heavy-duty road transport and shipping – **is most challenging**.

Decarbonising the international shipping sector requires:

- major improvements in efficiency
- rapid transitions in the energy mix to low-carbon fuels

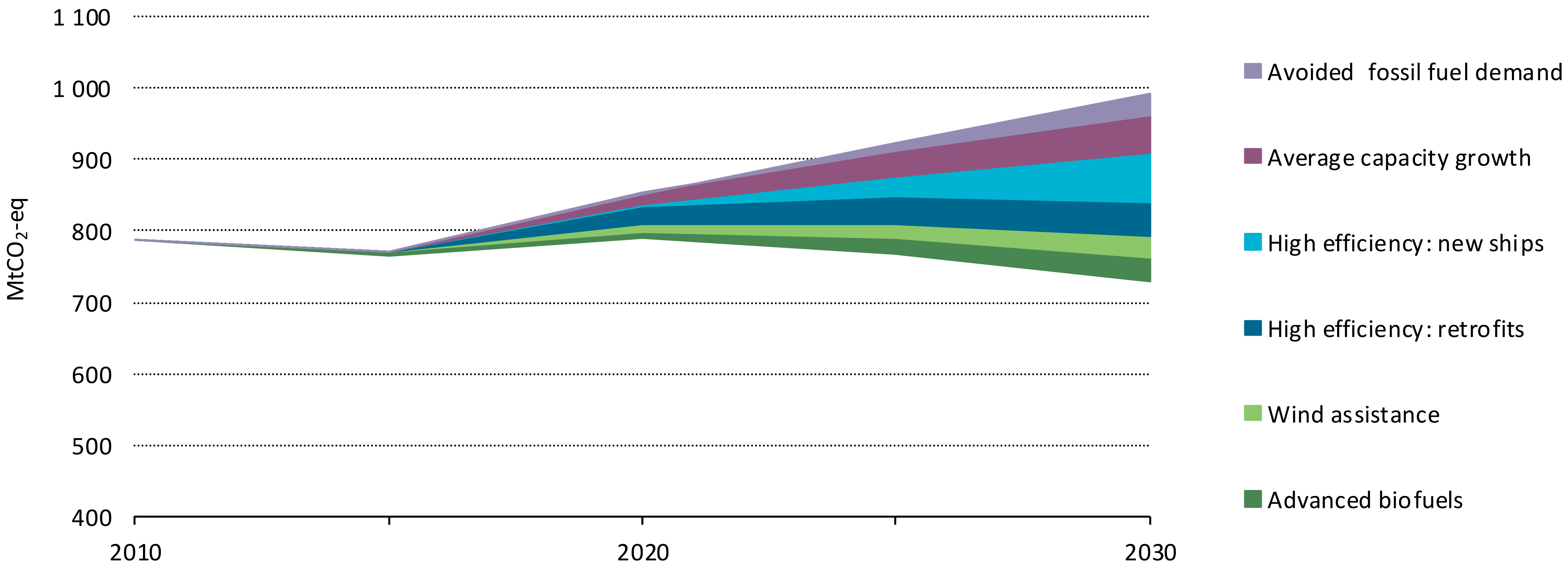
A broad portfolio of measures is needed

WTW GHG emissions in international shipping (freight) in the B2DS relative to RTS



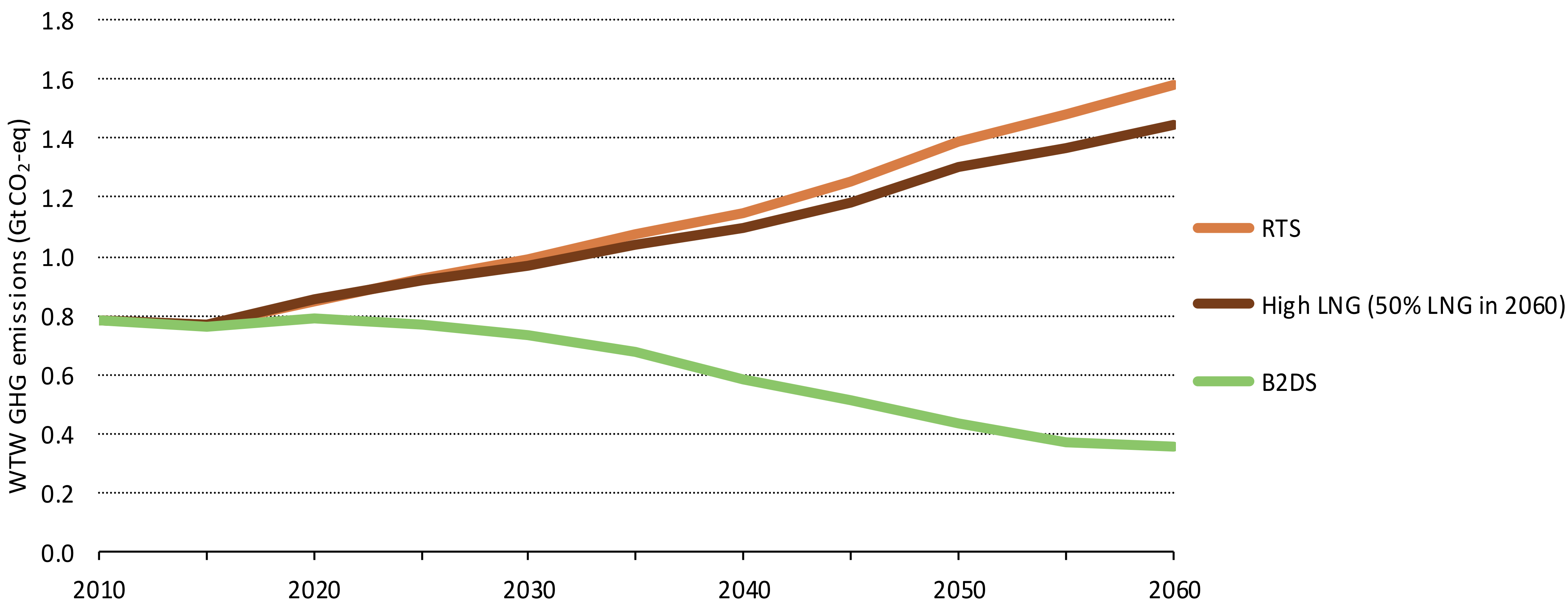
The B2DS reaches a 50% reduction of GHG emissions between 2050 and 2060 compared with 2008.

WTW GHG emissions in international shipping (freight) in the B2DS relative to RTS: 2010-2030



In earlier years the contribution of retrofits to reducing GHG emissions is significant

Why is LNG not included?



Switching 50% of the international Marine bunker fuel mix to LNG reduces GHG emissions by only 10%

How is hydrogen addressed in the 2DS and B2DS?

H_2 could play a role in the future of international shipping. Technologically feasible.

Barriers:

- High costs: limited technology learning and economy of scales
- Limited prospects of growth H_2 demand in other sectors
- Need for low-carbon hydrogen production
- Global refueling infrastructure network needed

H_2 is not included in the MoMo shipping model, but considered as a future option

Achieving B2DS targets requires immediate policy action

- **Raising the ambition of the EEDI**
  - New ships are 50-60% more efficient by 2030 in the B2DS (relative to EEDI baseline)
  - expand scope to **include operational energy efficiency requirements** to existing ships (existing ships are nearly 20% more efficient by 2030 in the B2DS)
- **Low-carbon fuel regulation** to mandate the adoption of low-carbon shipping fuels
  - By 2030, WTW carbon intensity of marine fuel needs to be 5-10% lower relative to 2015
  - By 2050, WTW carbon intensity of marine fuel needs to be close to 50% lower
- **Introducing CO_2 taxes on fuels**, to support the implementation of above measures
  - ETP model has 100 USD/tonne by 2030, but no specific carbon price for shipping was calculated

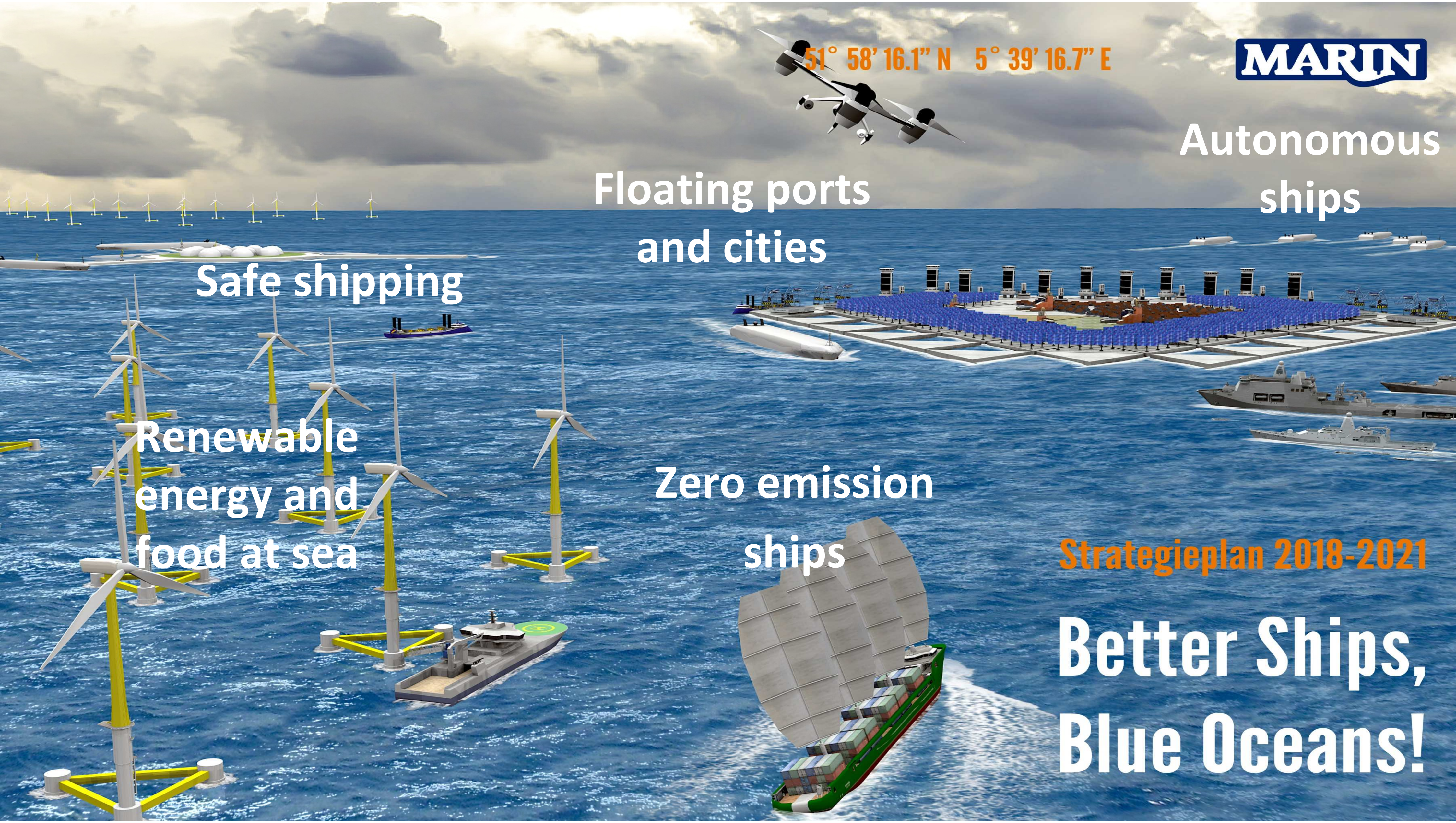
Thank you for your attention

Contact: renske.schuitmaker@iea.org

BETTER SHIPS, BLUE OCEANS

Hydro-Systems Integration Lab

Platform Schone Scheepvaart 23 May 2018


51° 58' 16.1" N 5° 39' 16.7" E
MARIN
Autonomous ships
Floating ports and cities
Safe shipping
Renewable energy and food at sea
Zero emission ships
Strategieplan 2018-2021
Better Ships, Blue Oceans!

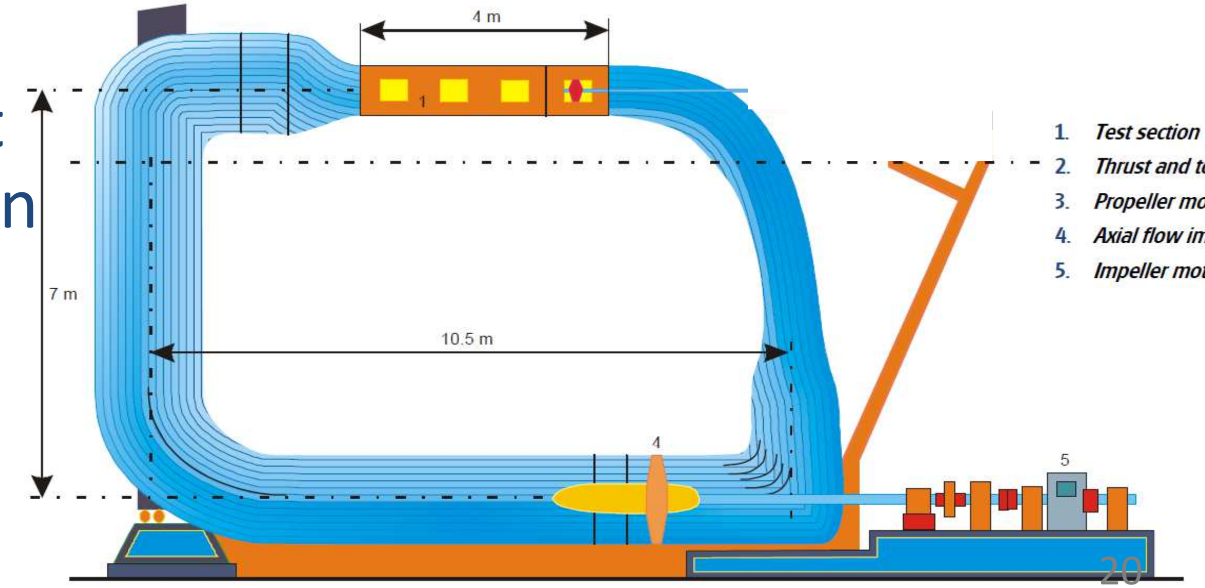
Zero Emission Shipping

Windlab

windsimulation set-up in the manoeuvreer basin for wind assistedpropulsin testing.

Hydro-Systems Integration Lab

Cavitation tunnel propulsion set up as testlab for zero emission sailing systems.



Why a Systems Integration Lab? Why Hydro? 1/3

- Energy transition -> complex, multiple-solutions envisaged, quick
- Need for standardisation -> cost reduction, enabling the transition, training & education.
- Need for design for operations -> minimizing CAPEX, saving energy, optimizing required energy next to required (max.) power.
- Need for real system integration -> cooperation, simulation, familiarisation

COÖPERATION within the industry!

Why a Systems Integration Lab? Why Hydro? 2/3

- Hydroloads significant part of the energy consumption and determine dynamic character of loads.
- Matching of system configuration and development.
- Dimension of installation for various specific operation modes
  - ‘bergfahrt vs talfahrt’ (85%/30%)
  - Dynamic behaviour during extreme weather (load variations, ventilation, racing, rudder action, ….)
  - Manoeuvring behaviour incl. crash stops & accelerations
  - Harbour operation

Need for operational data! ***& SIMULATION***

Why a Systems Integration Lab? Why Hydro? 3/3

- Optimize for total operational profile
  - Voyage simulations incl. 'fuelling' options, weather routing, various logistic contracts, sail assisted propulsion, …
- Investigate and test safety and operational availability and reliability (HAZID and FMEA)
- Investigate and test(certification) new systems introduced by others in the HSIL environment
- Train use and maintenance of 'new' systems.
- Create confidence in new systems.

MULTIPLE FUEL INFRASTRUCTURE! ***NEW RULES & REGULATIONS***

MARITIME INDUSTRY DECARBONISATION COUNCIL (MIDC)

A partnership for our future

Maritime
Industry
Decarbonisation
Council

Royal Belgian
Shipowners'
Association

INTRODUCTION RBSA

Royal Belgian Shipowners' Association

Deep sea: CMB, Euronav, Exmar, EBE , Delphis, Transpetrol, Kleimar
Dredging: Deme
Short sea: Fast lines, Bugge Shipping, Conti-Lines
Tugs: Kotug Smit, Boskalis Offshore
Cruise: Croisimer

Belgium is ranked 17th in the ranking of ownership of worldfleet based on dead-weight tonnage in 2017

MARITIME INDUSTRY DECARBONISATION COUNCIL

- Apolitical
- Evidence led
- Commercial free

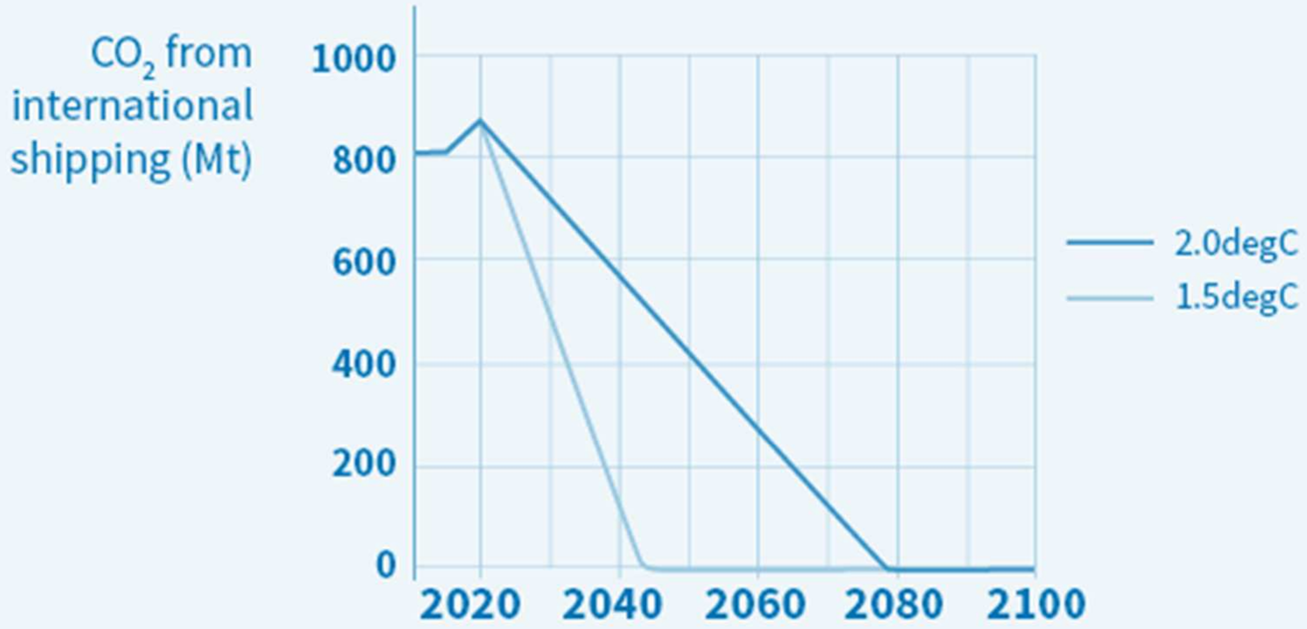
- Founded in 2016 by the RBSA
- Shipping industry too **FRAGMENTED**
- VISION: bridge the gap between shipowners, charterers, shippers, equipment suppliers, shipbuilders, the research community, banks, classification societies and oil companies to ensure the development of an evidence-based policy on GHG.
- It will enable the sector to reduce its CO_2 emissions in the most cost-effective way.
- More **STRUCTURE** in the debate on short-medium-long term **TECHNICAL** measures is needed
  - CO_2 reduction potential, Cost, Technical maturity, Scalability
  - What are the possibilities for existing ships and new builds?
  - What can we actually do for the current fleet?
- Bringing **INSIGHT** to all interested parties in a **COMPREHENSIBLE** way

- Royal Belgian Shipowners' Association
- CMB
- EXMAR
- IACS International Association of Classification Societies
- DEME Dredging, Environmental & Marine Engineering
- FuelsEurope REFINING PRODUCTS FOR OUR EVERYDAY LIFE
- SEA Europe Shipyards' & Maritime Equipment Association
- MEYER WERFT PAPENBURG 1795
- Lloyd's Register Marine
- sustainable shipping initiative
- UCL ENERGY INSTITUTE
- MAERSK
- Port of Antwerp
- NETHERLANDS MARITIME TECHNOLOGY

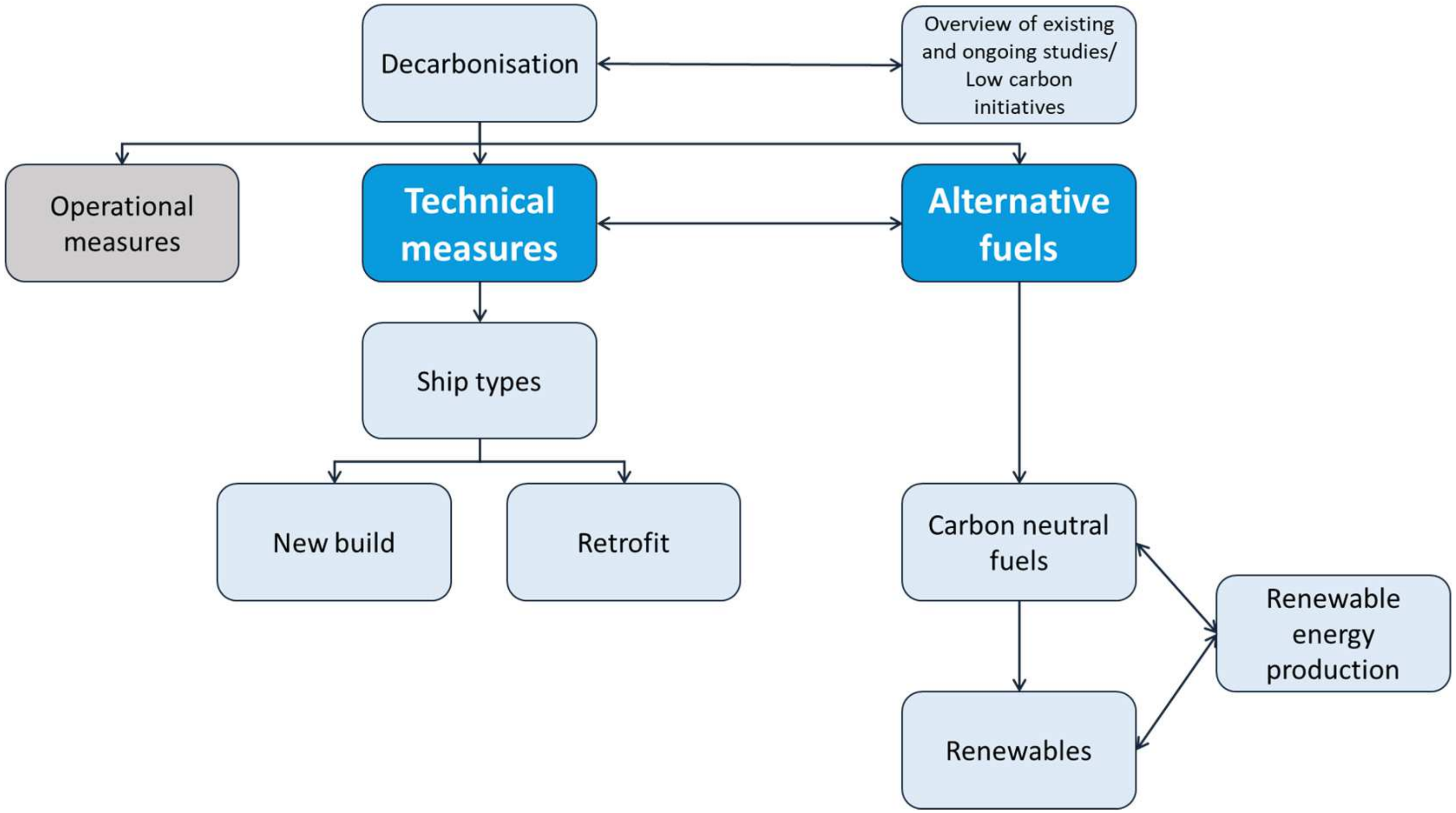
PARTICIPANTS

SHIPPING CAN DO MORE

International shipping emissions



Source: University College London, University of Manchester
Transport & Environment



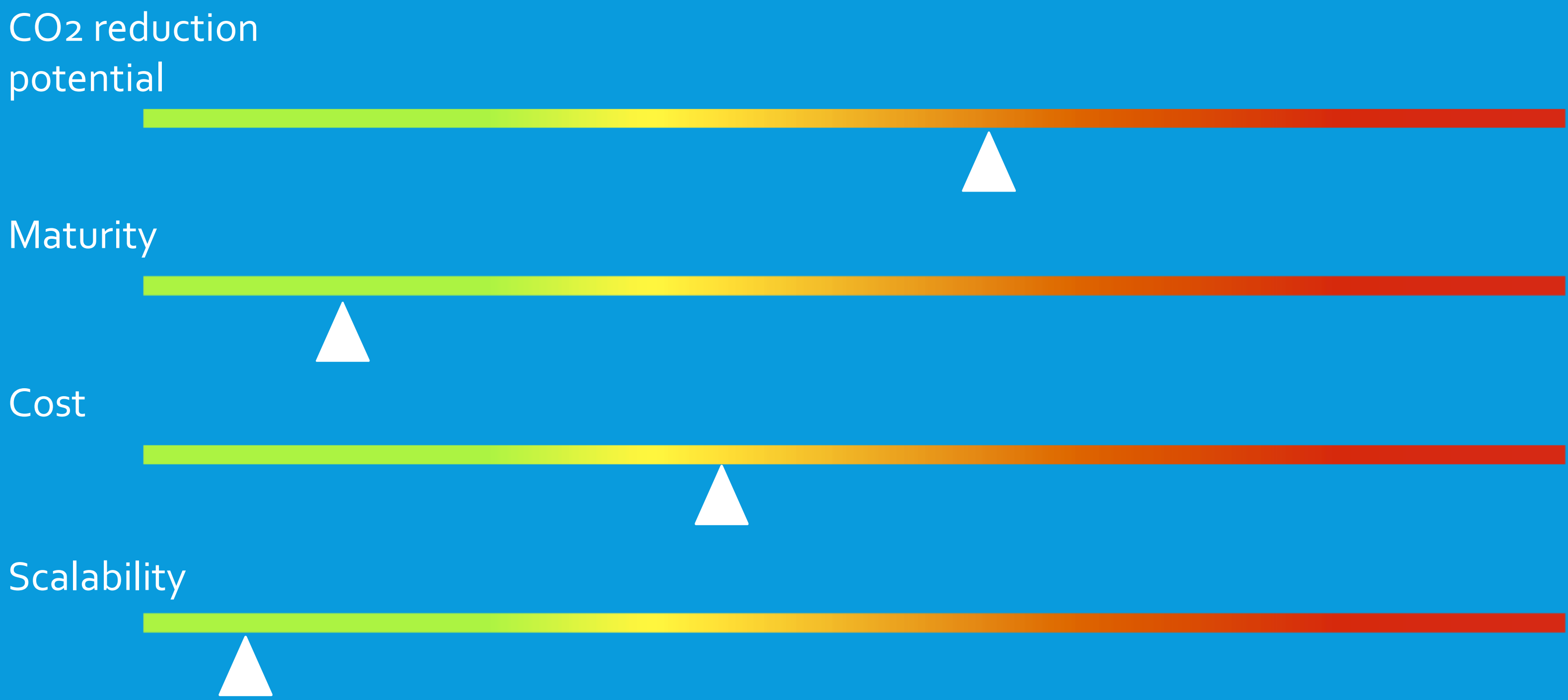
PUTTING STRUCTURE IN THE DEBATE

5 CATEGORIES OF MEASURES

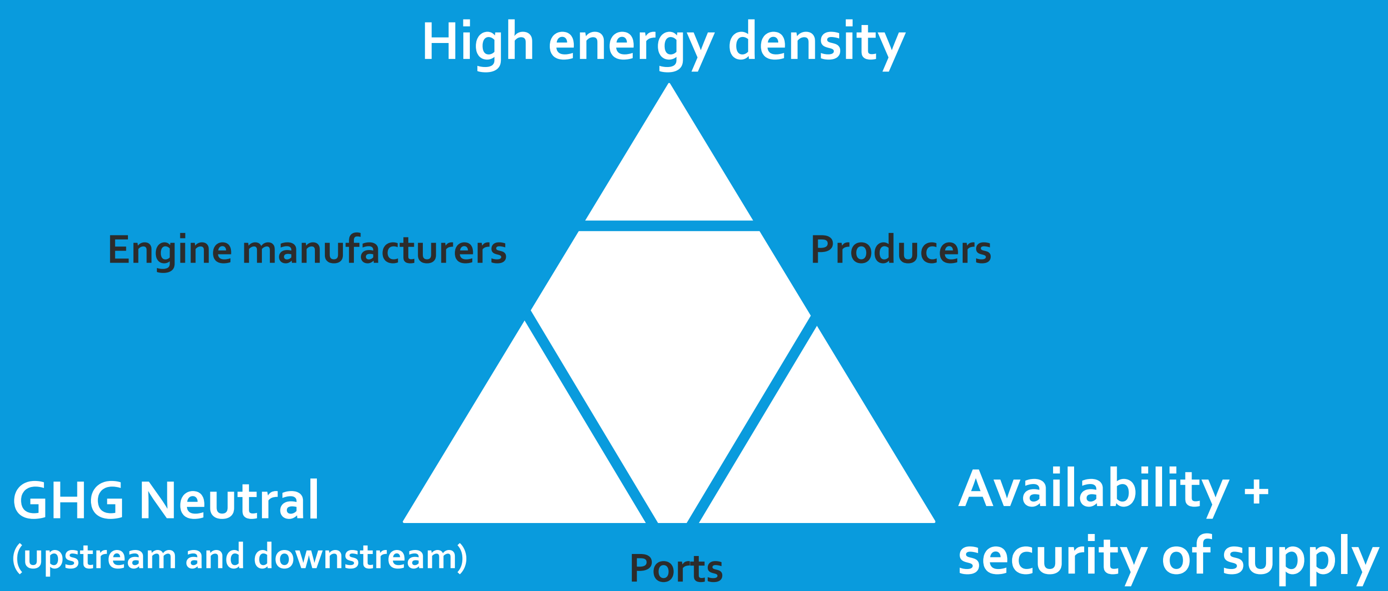
1. Hydrodynamics
2. Alternative fuels
   - Hydrogen
   - Methanol
   - Amonia
   - ...
3. Renewables
4. Design
5. Machinery

KEY CRITERIA

FOR LNG AS AN EXAMPLE

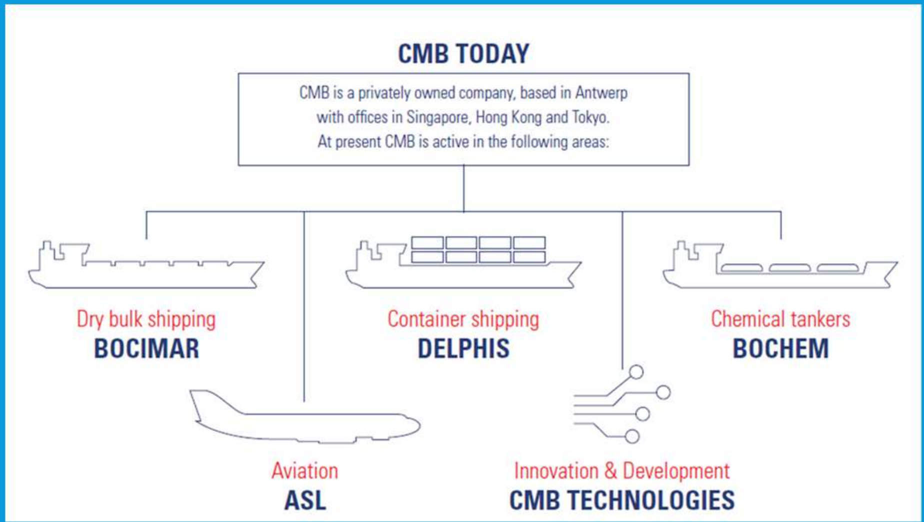


ALTERNATIVE FUELS



HYDROVILLE: A PLATFORM TO TEST HYDROGEN-TECHNOLOGY FOR COMMERCIAL SEA GOING VESSELS

CMB OWNS AND OPERATES 85 SHIPS AND 140 AIRCRAFT

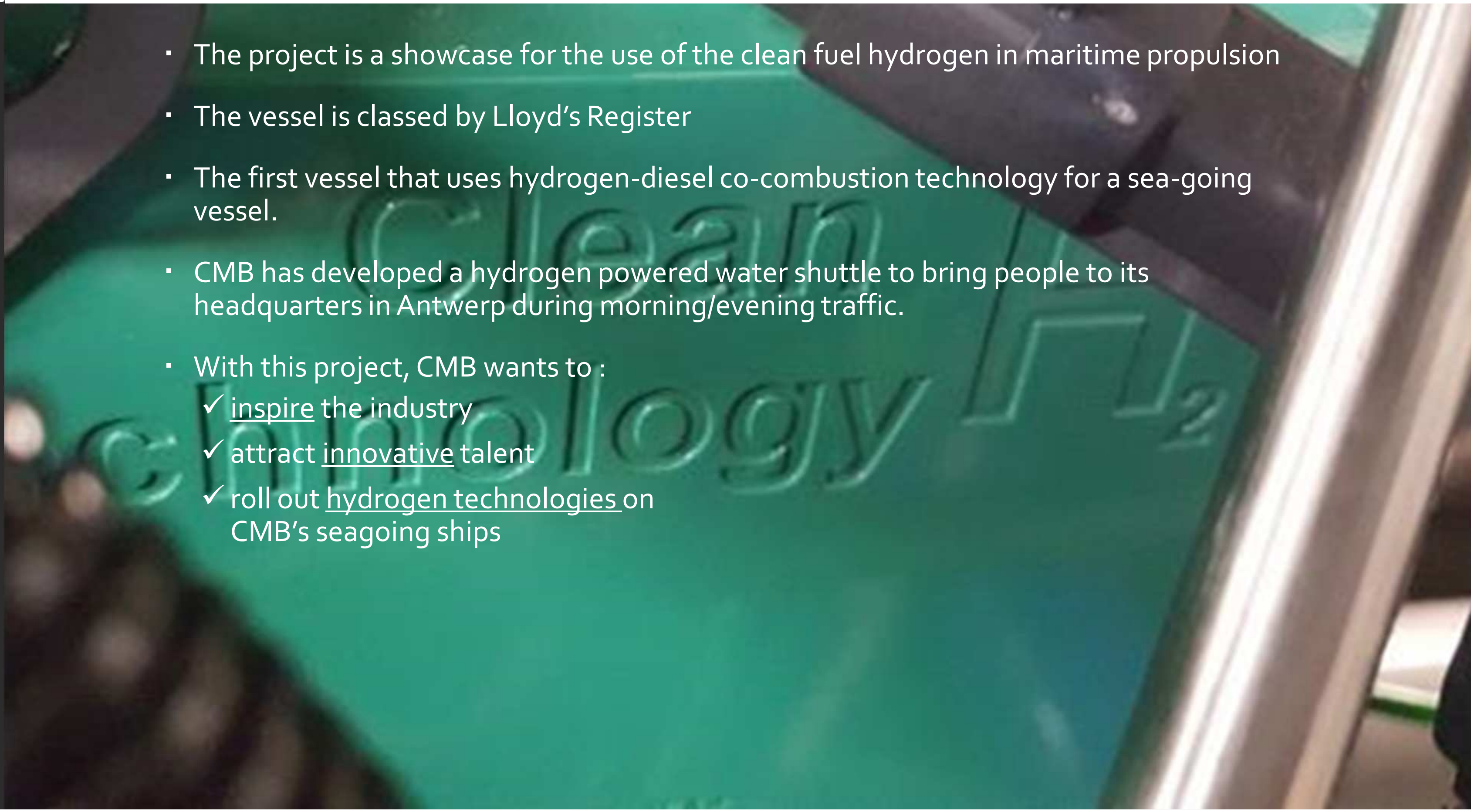




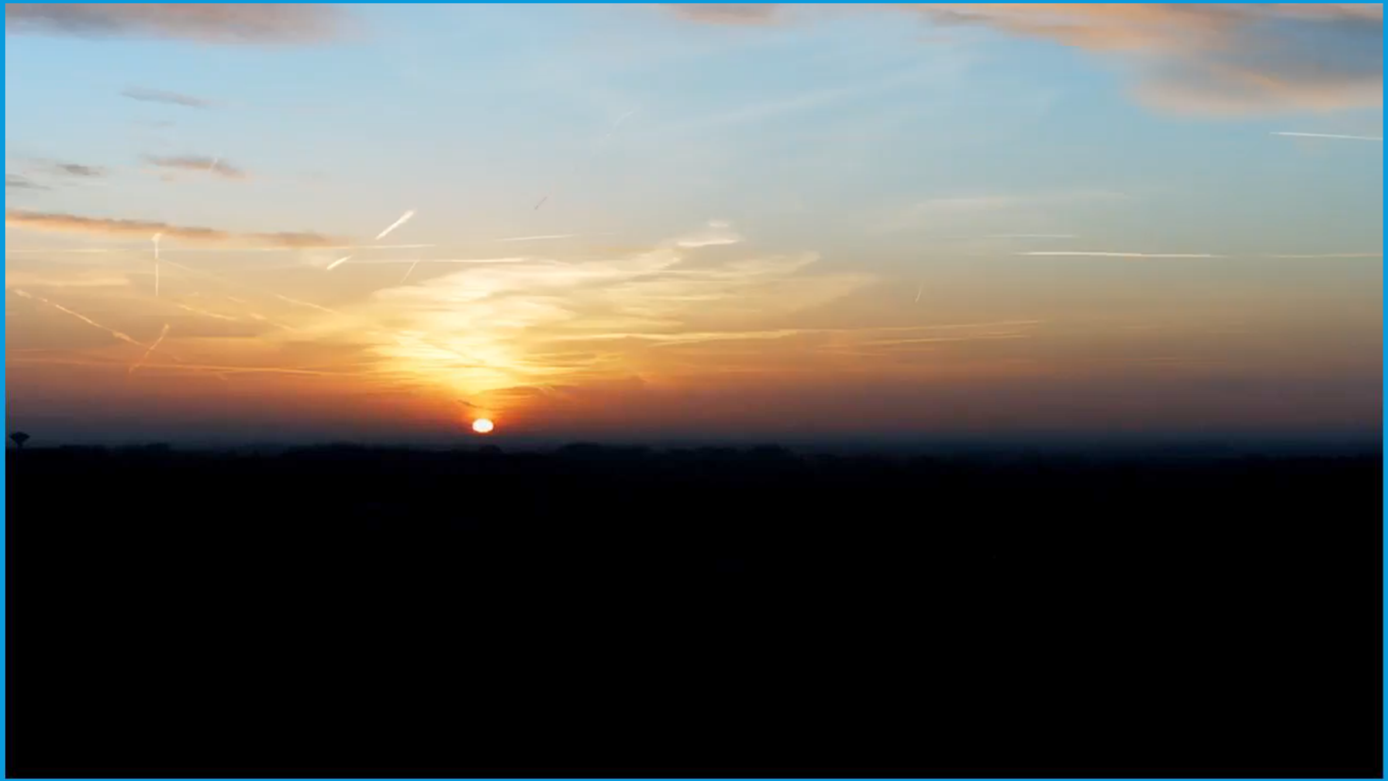



CMB TECHNOLOGIES DEVELOPED THE FIRST CLASS APPROVED VESSEL WHICH USES HYDROGEN FOR PROPULSION

- The project is a showcase for the use of the clean fuel hydrogen in maritime propulsion
- The vessel is classed by Lloyd's Register
- The first vessel that uses hydrogen-diesel co-combustion technology for a sea-going vessel.
- CMB has developed a hydrogen powered water shuttle to bring people to its headquarters in Antwerp during morning/evening traffic.
- With this project, CMB wants to :
  - ✓ inspire the industry
  - ✓ attract innovative talent
  - ✓ roll out hydrogen technologies on CMB's seagoing ships



HYDROVILLE: CLEAN, FAST AND INNOVATIVE

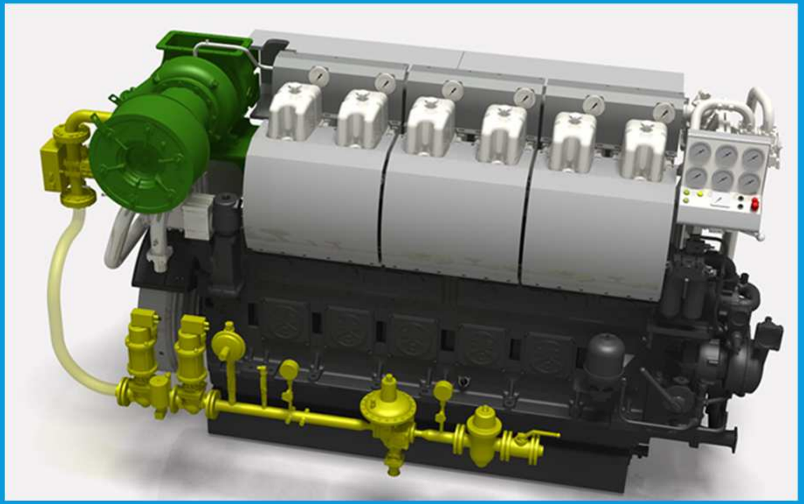


2 MARINE ENGINE WERE RETROFITTED TO CO-COMBUSTION HYDROGEN AND DIESEL

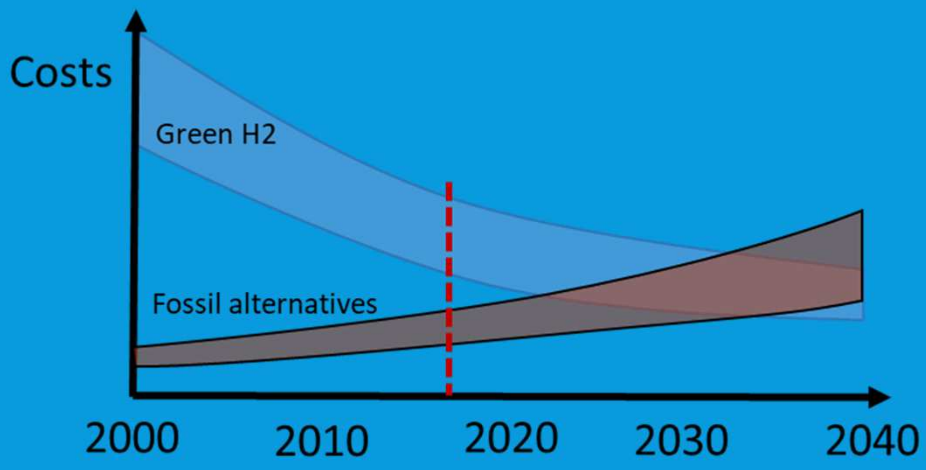
- 2 Volvo Penta D4s were retrofitted with a hydrogen injection system
- The hydrogen is aspirated in the intercooler
- The engines were tested on a dyno for 3 months
- For the amount of energy injected with hydrogen, the equivalent amount of diesel was reduced, thereby saving emissions
- Diesel is still needed to burn the hydrogen. The displacement factor depends on the load and RPM of the engine
- The engine ECU nor hardware have not changed

CMB TECHNOLOGIES IS ALREADY WORKING ON THE NEXT STEPS TO IMPLEMENT HYDROGEN ON A LARGER SCALE

- A new Hydroville engine is being developed which has optimized software tuning to combust hydrogen. New tests have shown hydrogen displacements up to 85% are possible
- Preparations for testing a 1MW H2DF marine engine (900RPM, 6cyl) are ongoing
- Further feasibility studies are being conducted
  together with research institutes, universities and consultancy firms
- Other vessel designs with hydrogen technology
  are being considered: crew transfer vessel, inland water, larger Hydroville, etc



IF WE WANT HYDROGEN TO BE USED IN SHIPPING WITHIN 10Y, WE NEED TO START WITH PILOTS PROJECTS NOW



- Hydrogen will become cheaper in the future, while fossil alternatives will show an opposite trend
- The development and construction of new vessel takes about 4y
- The cost of the first vessel with H_2 will be very costly. In order to reduce the risks, multiple pilot projects with milestones must be succeeded successfully

HYDROGEN-DIESEL CO-COMBUSTION IS VERY SUITABLE TO BE APPLIED ON SHIPS

- No fundamental changes required to the main engine:
  - When no hydrogen can be supplied, the engines runs on usual MGO.
  - If something fails on the hydrogen system, the system is switched back to the original situation (pure MGO combustion).
  - Co-combustion has almost no effect on maintenance schedule.
- The alternative of fuel cells is not favored:
  - Salty environment of shipping and the large movements (up to 40° of banking) is probably too challenging for fuel cells.
  - At high constant power output, the fuel cells have less efficiency compared to the co-combustion concept.
  - Fuel cells produce electrical energy, but we need mechanical energy for the propulsion. The need for power electronics will make it very expensive.
  - ICEs will remain cheaper than FCs
- Hydrogen quality can be lower than the fuel cell grade ➔ cheaper production

Maritime
Industry
Decarbonisation
Council

Royal Belgian
Shipowners'
Association

Q&A

Samenwerking om doelstellingen klimaatakkoord zeevaart te realiseren

Visie vanuit een motorenontwikkelaar

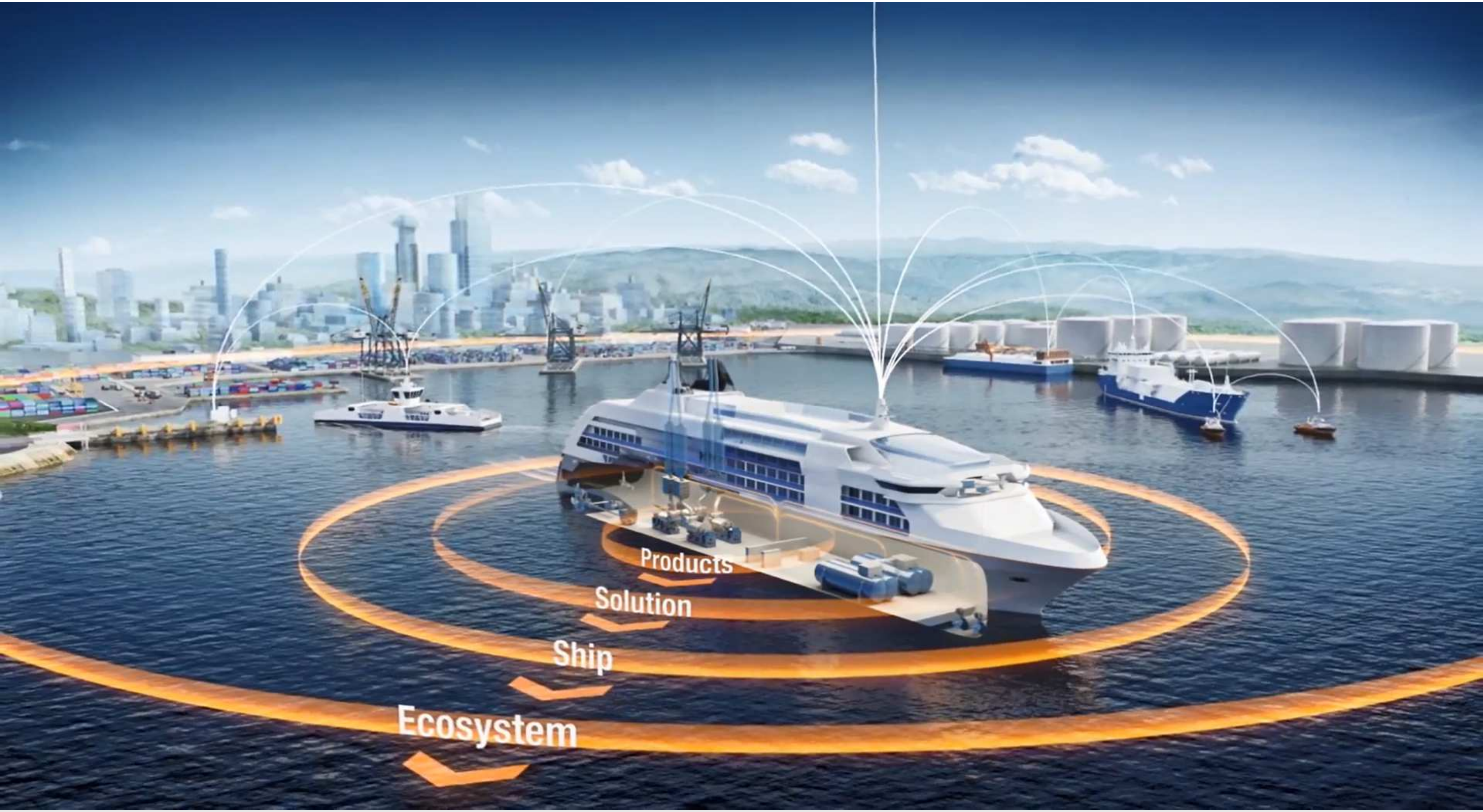
Woensdag 23 mei 2018

Sebastiaan Bleuanus
Wärtsilä Marine Power Solutions R&D&Engineering
Research coordination & funding

THIS IS WÄRTSILÄ

A global leader in advanced technologies and complete lifecycle solutions for the marine and energy markets


Enabling sustainable societies
with smart technology
WÄRTSILÄ


Products
Solution
Ship
Ecosystem

IMO remains committed to reducing GHG emissions from international shipping and, as a matter of urgency, aims to phase them out as soon as possible in this century.

Level of ambition

- ***GHG emissions from international shipping to peak and decline*** as soon as possible and to reduce the total annual GHG emissions by **at least 50% by 2050** compared to 2008 whilst pursuing efforts towards phasing them out as called for in the Vision as a point on a pathway of CO_2 emissions reduction consistent with the Paris Agreement temperature goals.

- ***carbon intensity of international shipping to decline*** to reduce CO_2 emissions per transport work, as an **average** across international shipping, by **at least 40% by 2030**, pursuing efforts **towards 70% by 2050**, compared to 2008

- ***carbon intensity of the ship to decline through implementation of further phases of the energy efficiency design index (EEDI) for new ships***

- Key differences between segments mean that there is no one-size-fits-all solution
- This is nothing new though!

However:

- Total system efficiency is and remains key
- Lower energy consumption means lower emissions
- We are pushing the system boundaries
  - From Product to solution, ship and ecosystem

WHAT OTHERS ARE SAYING, BASED ON SCENARIOS FOR THE FUTURE

Even though aviation and shipping continue to rely on crude oil for the first decades of **Sky**, fuel synthesised from biomass begins to take more and more of the market share. **Sky** assumes that this is in the form of liquid biofuels, given its greatest flexibility, but if the conversion to methane proves the more successful, then this equally could be in the form of compressed or liquefied bio-gas for ship, rail, and road uses. In the latter stages of the transition, hydrogen emerges as a new energy carrier, particularly for aviation.

WHAT OTHERS ARE SAYING, BASED ON SCENARIOS FOR THE FUTURE

WHAT OTHERS ARE SAYING, BASED ON SCENARIOS FOR THE FUTURE

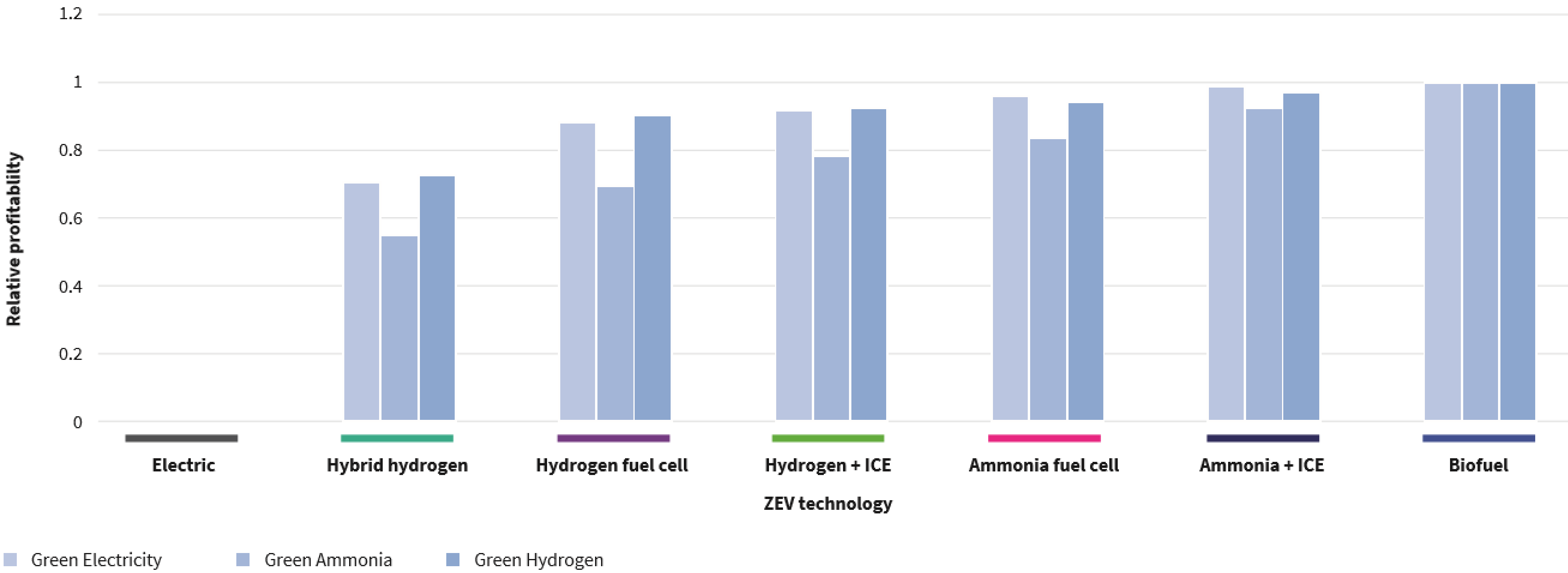
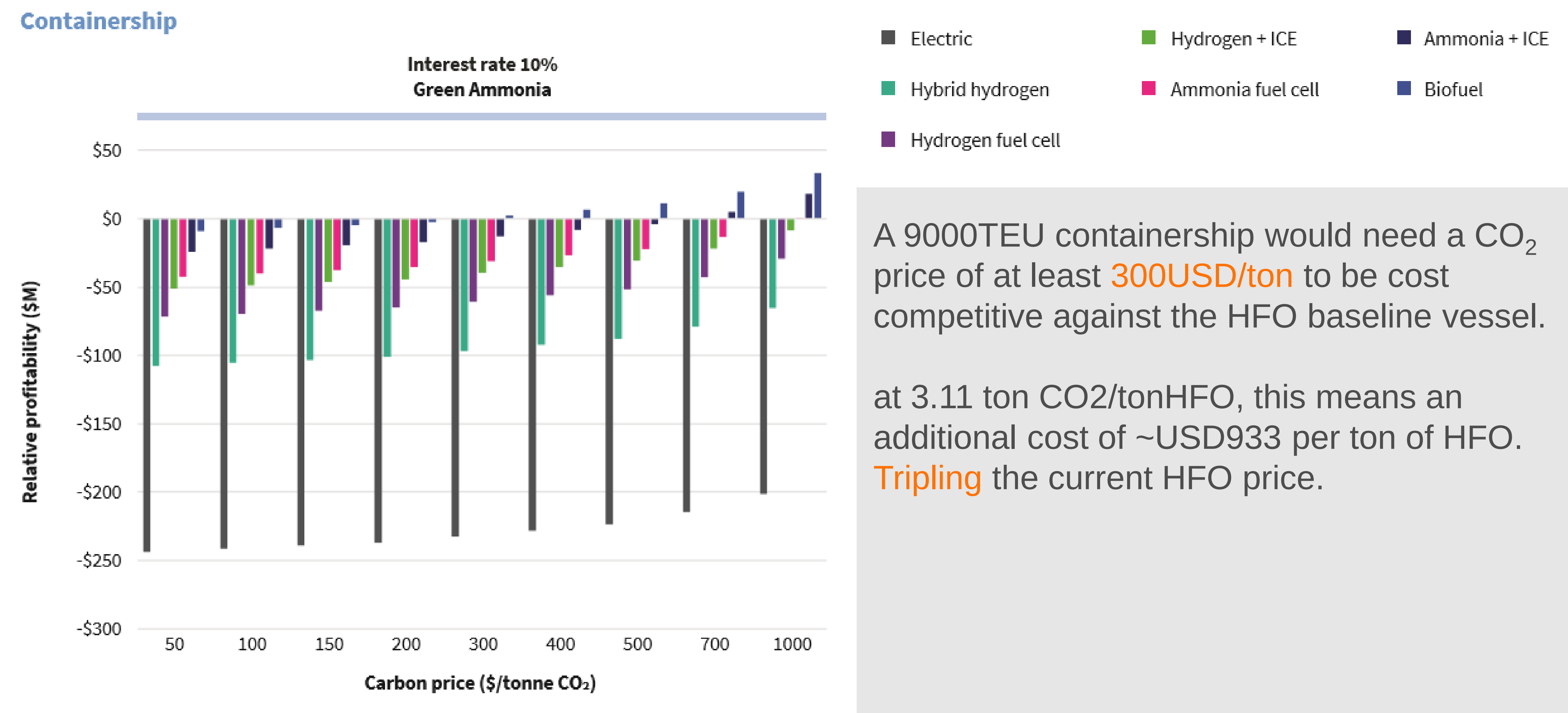


Figure 5 The relative profitability of ZEV technologies aggregated for all ship types and scenarios

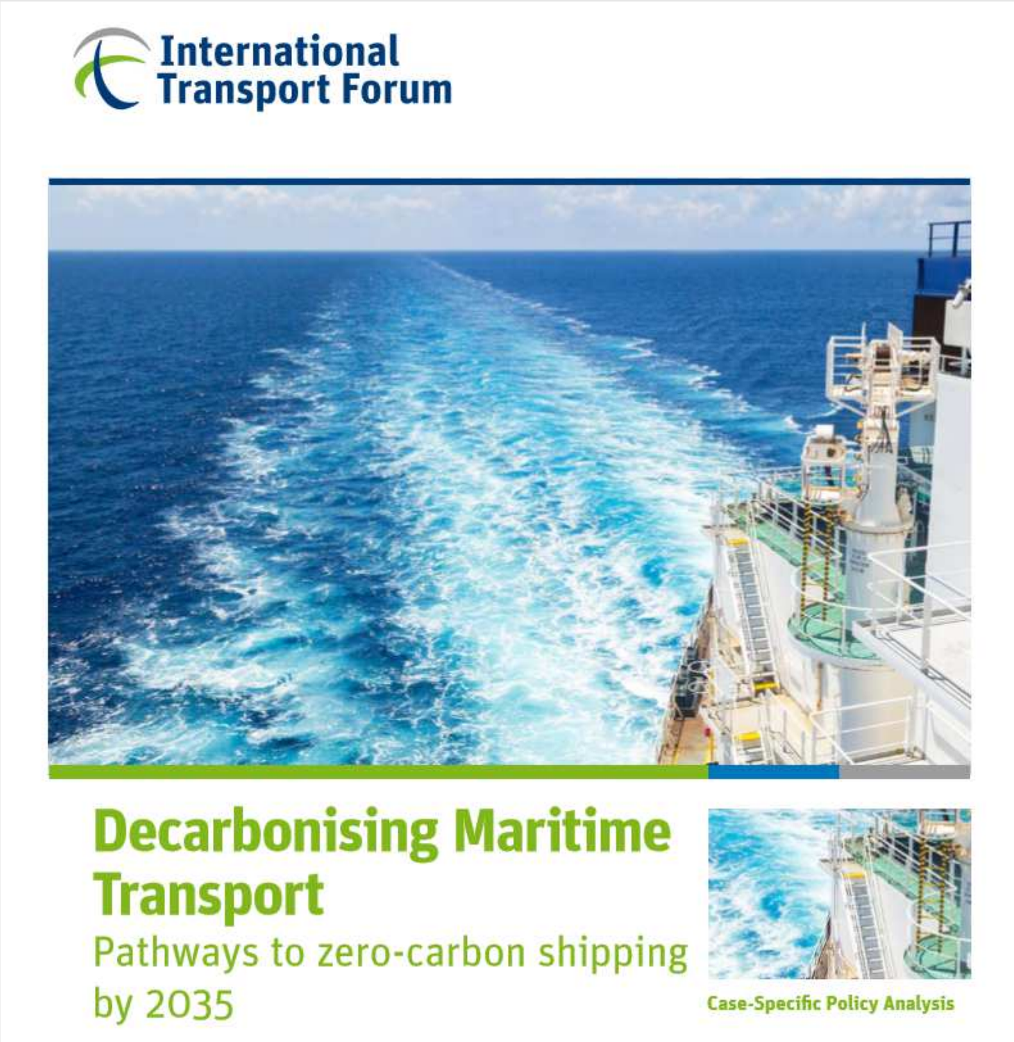


A 9000TEU containership would need a CO_2 price of at least 300USD/ton to be cost competitive against the HFO baseline vessel.

at 3.11 ton CO2/tonHFO, this means an additional cost of ~USD933 per ton of HFO. Tripling the current HFO price.

WHAT OTHERS ARE SAYING, BASED ON SCENARIOS FOR THE FUTURE

WHAT OTHERS ARE SAYING, BASED ON SCENARIOS FOR THE FUTURE


International Transport Forum

Decarbonising Maritime Transport

Pathways to zero-carbon shipping by 2035

Case-Specific Policy Analysis

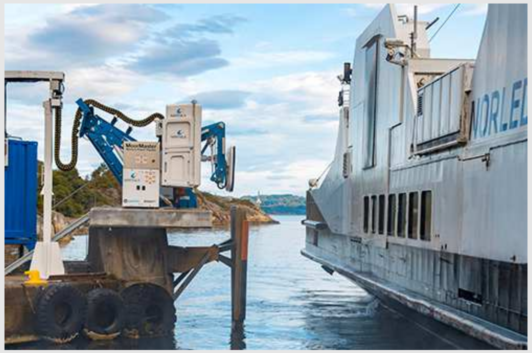
WHAT OTHERS ARE SAYING, BASED ON SCENARIOS FOR THE FUTURE

Alternative fuels and renewable energy can deliver much of required reductions. Advanced biofuels are already available in limited quantities. Gradually, they should be complemented by other natural or synthetic fuels such as methanol, ammonia and hydrogen. Wind assistance could reap additional reductions. The first electric ships provide transport for short-distance routes. Technological measures to improve energy efficiency of ships could yield a substantial part of the needed emission reductions. Market-mature options include, among others, hull design improvements, air lubrication and bulbous bows. Finally, operational measures such as ship speed reductions, smoother ship-port interfaces and increased ship size could achieve further important emission reductions.

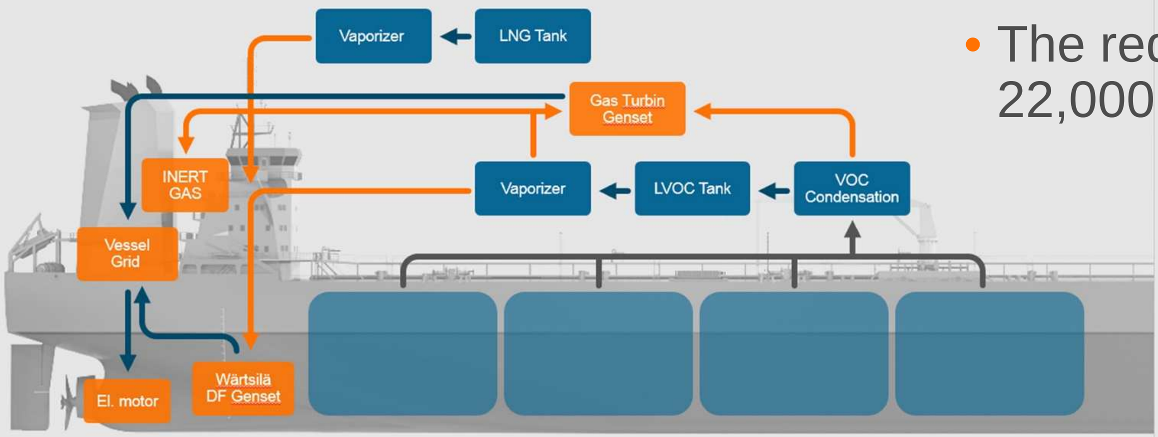
WHAT WE HAVE BEEN DOING

- Design of a Zero family of ferries
- Zero emission sailing for up to 30 minute voyages
- Automated mooring and induction charging (>1MW)
- Longest charging time by fast connection and late disconnection
- Reduced maintenance cost
- Combined with auto mooring the propulsion can be shut down during docking

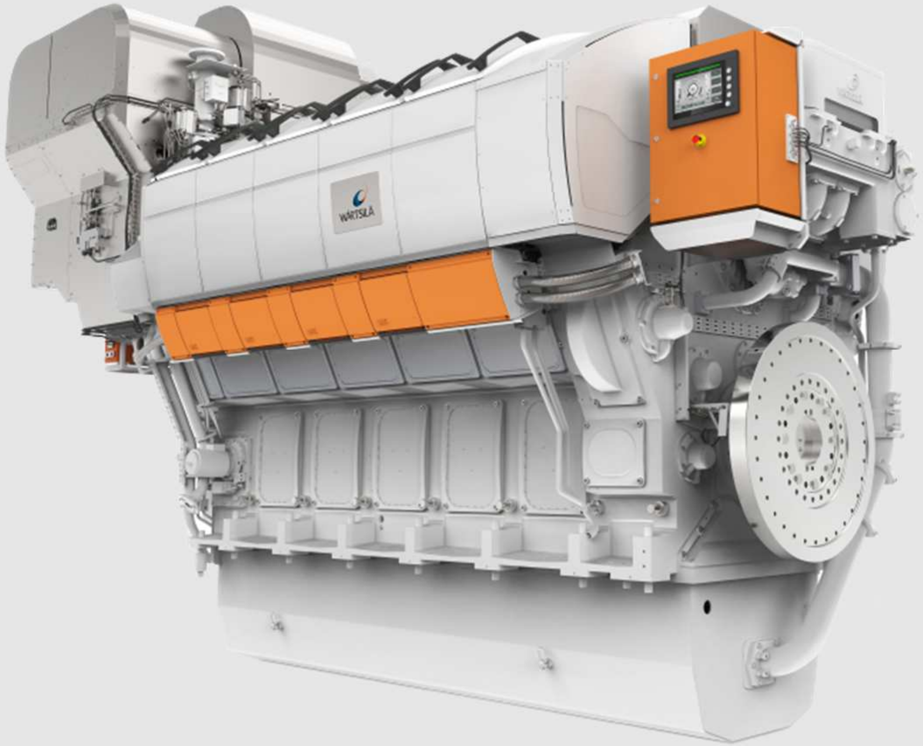
Induction charging and auto docking demonstrated on “Folgefonn” ferry in Norway



- A new crude oil shuttle tanker concept allows tankers to operate both on LNG, as the primary fuel, and Volatile Organic Compounds (VOC) from the oil cargo tanks – as secondary fuel.
- This reduces annual emissions of CO_{2eq} by up to 42% compared to conventional shuttle tanker.
- The reduction equals the emissions from 22,000 cars per vessel per year.



WÄRTSILÄ



- Wärtsilä 31, the worlds most efficient four stroke engine
- HFO, MGO and gas operation in one platform with maximum commonality and flexibility (futureproof against fuel changes!)
- 4-10MW output
  - 165g/kWh SFOC in diesel (51% efficiency)
  - >50% electrical efficiency on gas (SG)

References

Rimorchiatori Riuniti
(biggest tug owner/operator in the Mediterranean Sea)

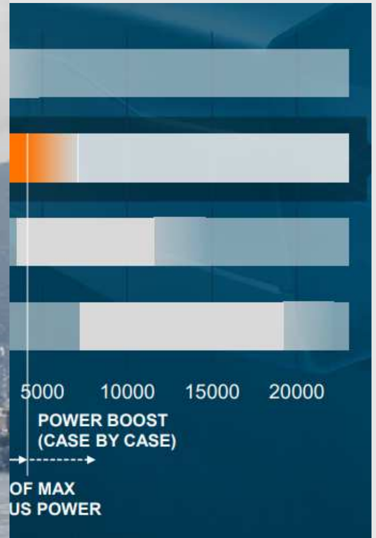
Contract signing at launch ceremony
during NOR-shipping in Oslo (June 2017)

70 tbp harbour tug
80 tbp on boost mode

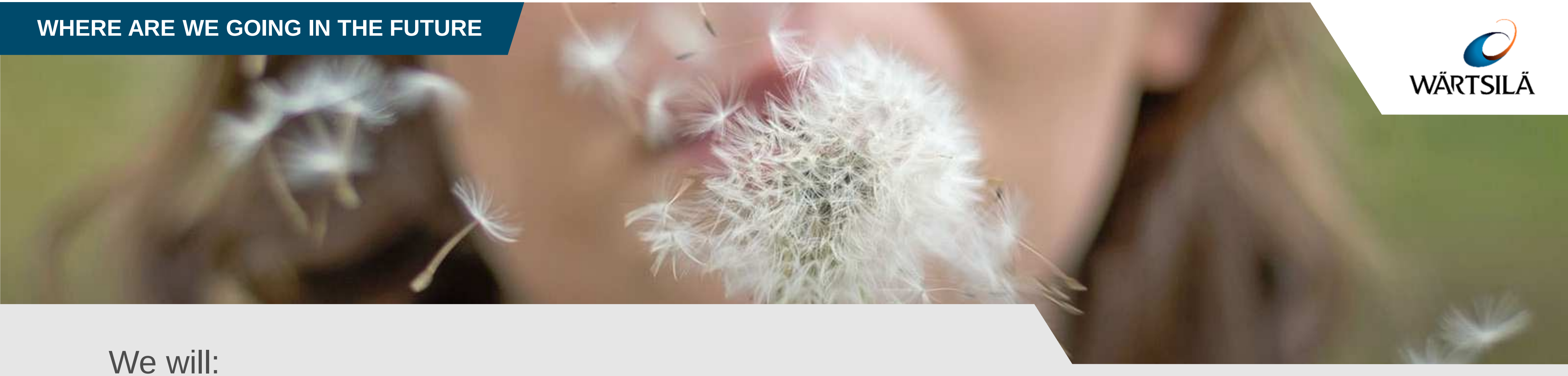
Wärtsilä HY 220

Delivery in Q3 2018

Start of operations in Q1 2019



WHERE ARE WE GOING IN THE FUTURE



We will:

- Further increase component, system and vessel efficiency
- Specifically for gas engines: we will reduce greenhouse gas emissions by 15% from 2015 to 2020. (Status 2017: -7%)
- Provide (fuel) flexible and futureproof system solutions
- Integrate with the transport ecosystem to gain further benefits

WÄRTSILÄ

BRANDSTOFFEN IN DE SCHEEPVAART VAN DE TOEKOMST

| Jorrit Harmsen

TNO innovation for life

ONTWIKKELING VAN NIEUWE BRANDSTOFFEN GAAN SNEL…

ULSFO bunker fuel price soars to record level o strong futures market

London (Platts)--28 Sep 2017 820 am EDT/1220 GMT

Ultra low sulfur bunker fuel in Rotterdam has hit the highest assessed level since the S&P Global Platts assessment began in September 2015, supported by strong gains in futures the last few weeks.

THE OXFORD INSTITUTE FOR ENERGY STUDIES

A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD

UNIVERSITY OF OXFORD

Updated and revised:
March 2018

The LNG Shipping Forecast: costs rebounding, outlook uncertain

SHOWCASE 12 oktober 2015

Biobrandstof voor elk schip in de Rotterdamse haven

GoodFuels Marine, Boskalis en Wärtsilä bundelen hun krachten en bieden schepen de mogelijkheid om op biobrandstof te varen. De drie bedrijven zijn een tweejarige pilot gestart in de haven van Rotterdam: 's werelds grootste biobased cluster.

Een schip dat vaart op gebruikt frituurvet? Als het aan GoodFuels Marine ligt is dit niet

Eerste cruiseschip op waterstof is dichterbij dan je denkt

Viking Cruises werkt aan de introductie van waterstof-brandstofceltechnologie op zijn cruiseschepen. Het bedrijf wil 's werelds eerste scheepvaartbedrijf zijn dat een cruiseschip op vloeibaar waterstof naar de markt brengt.

Order Placed for 4 More Methanol Bunker-Powered Vessels

Wednesday February 14, 2018 Share Share Tweet Follow 6,170 followers

A group of industry stakeholders has come together to invest in **four 49,000 dwt** tankers that will be capable of being powered by methanol bunkers.

A joint announcement by **Waterfront Shipping Company Ltd.** (WFS), **Marinvest/Skagerack Invest** (Marinvest), **IINO Kaiun Kaisha, Ltd.** (IINO), **Mitsui & Co., Ltd.** (Mitsui), and the **NYK**

The 4 newbuilds will be powered by

… VEEL ONDUIDELIJKHEID OVER EFFECT EN GESCHIKTHEID

1. Grote onzekerheid over bijdrage van verschillende brandstoffen aan klimaatdoelstelling en welke brandstof het meest geschikt is voor verschillende modaliteiten

2. In opdracht van Havenbedrijf Rotterdam heeft TNO een afwegingkader opgesteld:

    1. Opstellen scoresysteem ter beoordeling van alternatieve brandstoffen
        1. Opgesteld voor verschillende modaliteiten
        2. Uitgangspunt zijn vier hoofdcriteria
    2. Invullen van scoresysteem om tot speerpunt brandstoffen te komen (shortlist)
    3. Acties voor ontwikkeling van speerpunt brandstoffen tot marktrijpe brandstof

LIJST VAN 40 MOGELIJKE BRANDSTOFFEN OPGESTELD

Feedstock	Energy carrier
Alternative fossil	CNG
	LNG
	Methanol
	MTBE
	GTL
	ULSFO
	DME
	Electricity
	Hydrogen (thermal)
	Hydrogen ((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 local nuclear installation

Feedstock	Energy carrier
Biomass/biogas	FAME 100%
	HVO
	HVO-kerosine
	PPO (pure plant oil)
	bio-ethanol
	bio-methanol
	bio-MTBE
	bio-DME
	Compressed bio-methaan (CBG)
	Liquid bio-methaan (LBG)
	Electricity (wood)
	bio-H2 (thermal, wood)
	bio-H2 (electrolysis, wood)
Biomass/algae	Biodiesel algae

SCORINGSSYSTEEM

1/3

Technische status voor de toepassing en productie

Level 1: R&D
Level 2: Innovatie
Level 3: Scale up
Level 4: Commercieel

Milieu en Duurzaamheid

CO_2-performance
Vervuilende emissies
Circulariteit

Score

Fit toeleverancier

Beschikbaarheid feedstock
Fit met bestaande productiefaciliteiten
Toegevoegde waarde havenbedrijf
Etc.

Fit met de gebruiker

CAPEX
OPEX
Impact op operatie (range)
Robuustheid, Veiligheid, etc

1/3

1/3

UITKOMST SCORE PER CRITERIA

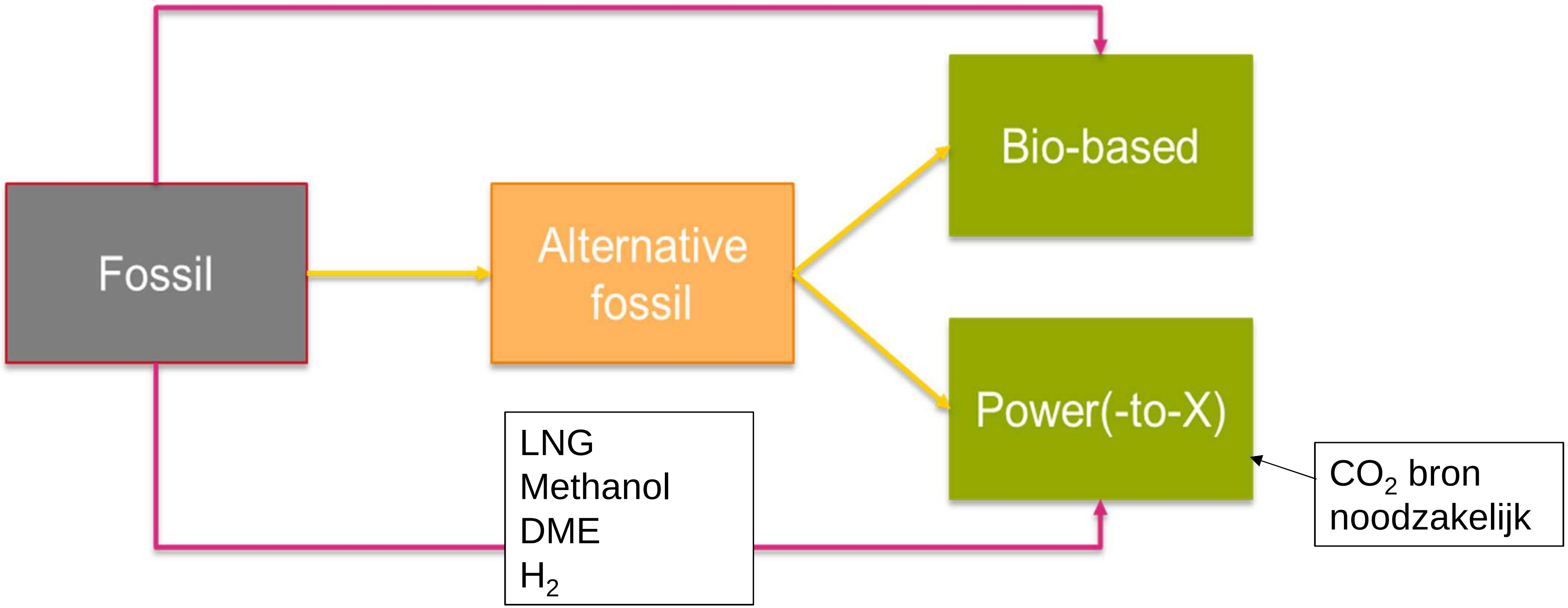
- Biofuels scoren goed, zeker als de fit met haven wordt meegenomen.
- Elektrische en waterstof varianten hebben een minder goede fit met de haven
  - Goed op milieu en duurzaamheid
  - Belangrijk voor de toekomst
- Alternatieve energiedragers moeten zeer goed scoren op milieuaspecten om gunstiger uit te komen dan fossiele brandstoffen
  - Rechts enkele met een fit met de haven en de gebruiker.

Weighing method	Type of feedstock	Energy carrier	Environment and sustainability	Fit with port of Rotterdam	Fit with transport user	Average
Equal weight of 3 main criteria	Biomass/biogas	Bio-methanol				
	Wind/solar Power-to-X	Power-to-kerosene				
	Biomass/biogas	Bio-MTBE – pure				
	Biomass/biogas	HVO (diesel/kerosene)				
	Biomass/biogas	PPO (pure plant oil)				
	Wind/solar Power-to-X	Power-to-methanol				
	Biomass/biogas	Compressed bio-methane (CBG)				
	Biomass/biogas	Liquid bio-methane (LBG)				
	Biomass/biogas	FAME 100%				
Fit with port excluded	Wind/solar Power	Green electricity				
	Wind/solar Power-to-X	Formic acid				
	Biomass/biogas	Electricity (wood)				
	Wind/solar Power-to-X	Power-to- hydrogen (electrolysis)				

UITKOMST SCORE PER MODALITEIT

Weighing	Type of feedstock	Energy carrier	Road	Shipping	Aviation	Average
Equal weight of 3 main criteria	Biomass/biogas	bio-methanol	3.0	3.1	2.9	3.0
	Wind/sun Power to X	Power to kerosine	-	-	3.0	3.0
	Biomass/biogas	bio-MTBE - pure	2.9	3.0	2.7	2.9
	Biomass/biogas	HVO	2.8	2.8	-	2.8
	Biomass/biogas	PPO (pure plant oil)	2.6	2.9	2.9	2.8
	Wind/sun Power to X	Power to Methanol	2.8	2.9	2.6	2.8
	Biomass/biogas	Compressed bio-methaan (CBG)	2.9	2.7	2.6	2.7
	Biomass/biogas	Liquid bio-methaan (LBG)	2.8	2.8	2.6	2.7
	Wind/sun Power to X	Green-electricity	2.7	2.6	-	2.6
	Biomass/biogas	FAME 100%	2.6	2.6	2.6	2.6
Fit with port excluded	Wind/sun Power to X	Green-electricity	3.1	2.9	-	3.0
	Biomass/algae	Biodiesel algae	2.8	2.9	2.9	2.8
	Wind/sun Power to X	Formic acid	2.8	2.9	-	2.8
	Biomass/biogas	Electricity (wood)	2.9	2.7	-	2.8
	Wind/sun Power to X	Power to H2 (electrolysis)	2.8	2.7	-	2.8

POTENTIAL TRANSITION PATHS TOWARDS LOW CARBON FUELS



MOTIVATIE & BARRIERES

Fuel	Motivation	Development points/gaps
Liquid Biofuels: ***Methanol (P to X)*** ***Ethanol*** ***HVO*** ***FAME*** ***PPO***	• Practical fuels with high energy density • Feasible engine adaptations • Promising available volumes	• Fuel price • Need for implementation in fuel specifications • Some issues with fuel storage
Gaseous Biofuels or Power to X: ***CBG*** ***LBG***	• Low WTW CO_2 emissions • Compatible with fossil CNG and LNG	• Fuel price and available volumes • Powertrain / fuel storage costs
Power to X: **- Formic Acid** **- H_2** **- Green electricity**	• Lowest WTW CO_2 emissions • No competition with food • Scalable production volumes	• Fuel price and available volumes • Long development process for fuel cell powertrains • Powertrain / fuel storage size & costs • Abundant supply needed of solar & wind power

BELANGRIJKE VERVOLGSTAP IS STARTEN MET PRAKTIJKPROEVEN MET METHANOL

- Methanol lijkt een kansrijke brandstof voor ontwikkeling op de korte termijn
  - Draagt bij aan CO_2 vermindering
  - Voldoet aan SECA en NECA
  - Past in bestaande layout schip

- Twee belangrijke ontwikkelpunten zijn:
  - De technische ontwikkeling van de aandrijflijn;
  - De economische/ technische competitiviteit ten opzichte van de alternatieven.

- MKC, TNO en TU Delft zal 31 mei een TKI concept voorstel indienen over Methanol binnen short sea shipping. Het consortium wordt nu strategisch uitgebouwd. Vraag bij interesse.


BEDANKT VOOR UW AANDACHT
Voor meer inspiratie:
TIME.TNO.NL
TNO innovation for life