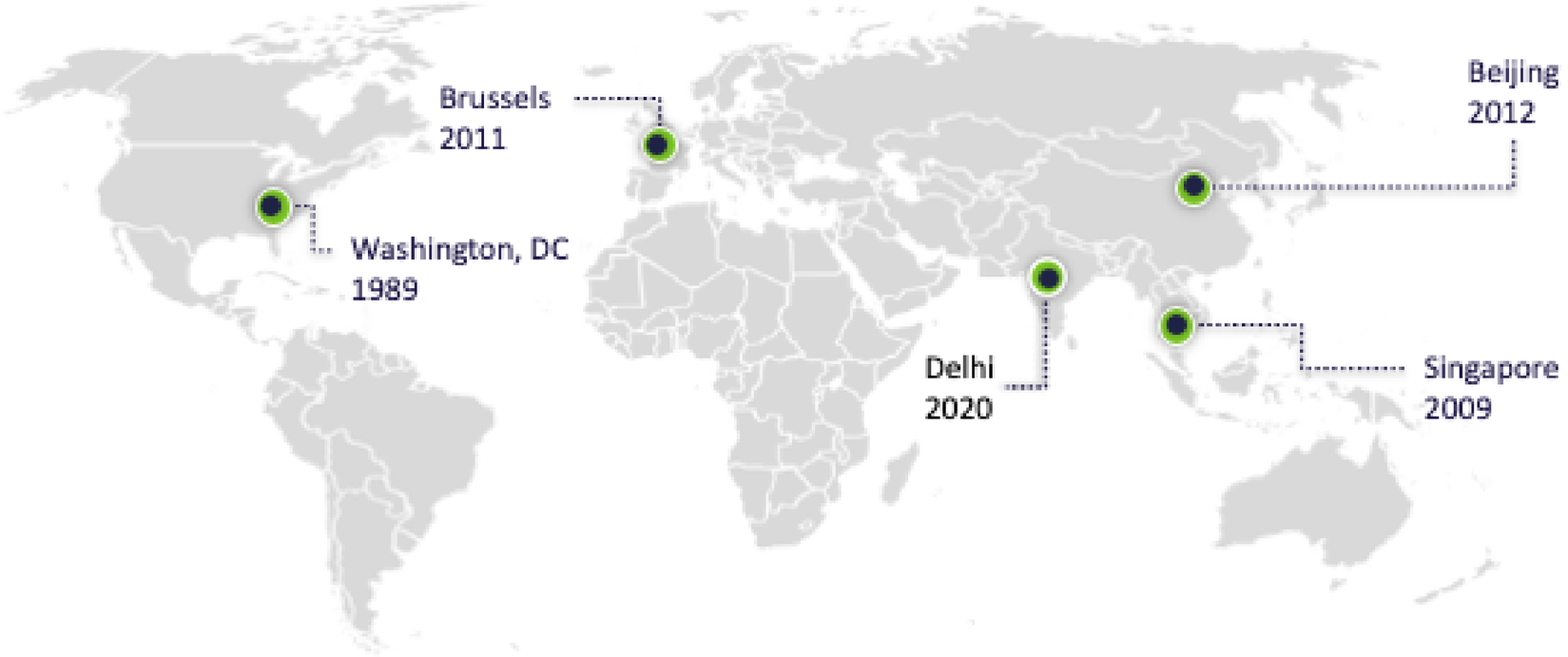
METHANOL INSTITUTE

Methanol on the Water

March 2022

History

- The Methanol Institute (MI) was established in 1989
- Three decades later, MI is recognized as the trade association for the global methanol industry
- We facilitate methanol's increased adoption from our Singapore headquarters and regional offices in Washington DC, Brussels, Beijing and Delhi



Members

Tier 1

PROMAN

methanex
the power of agility

سابك
sabic

OCI

Tier 2

KOCH
METHANOL ST. JAMES

MITSUBISHI GAS CHEMICAL

MITSUI & CO.

ATLANTIC METHANOL

PETRONAS

شركة عمان للميثانول ش.م.م.
Oman Methanol Company S.A.O.G.

Tier 3

eni
ecofuel

QAFAC
شركة قطر للإضافات البترولية المحدودة
Qatar Fuel Additives Company Limited

Mitsubishi Corporation

سبكيم
Sipchem
EXCELLENCE everywhere

JM
Johnson Matthey
Inspiring science, enhancing life

Tier 4

Enerkem

ADVENT

ClearFlame
ENGINE TECHNOLOGIES

CLARIANT

Advanced Chemical Technologies Inc.

CASALE

OLDENDORFF 1921 2021

CARBON RECYCLING INTERNATIONAL
carbonrecycling.is

Stena Bulk

FUELSAVE
GREEN TECHNOLOGY

solvadis
we do chemistry

Palcan

HALDOR TOPSOE

Oiltanking

HELM PROMAN METHANOL

Liquid Wind

TRICON ENERGY

Element 1
Powering Innovation

IMTT

GLOCAL GREEN

RH2C
Renewable Hydrogen Canada Corporation

Blue World Technologies

Nebraska Public Power District
Always there when you need us

SOUTHERN GREEN GAS

FiTech
Fuel Injection

mmsa
Global Insight, Asian Perspective

msc

RIX

MOL Mitsui O.S.K. Lines

GANE ENERGY

MAERSK

RUSCHEM
eco synthesis

WASTEFUEL

KAIZEN
Clean Energy

Lake Charles Methanol

danans
Carbon Neutral Consulting

WVM
West Virginia Methanol, Inc.

ARGO

eFuel alliance

Swiss Liquid Future

ALFA LAVAL

ABEL ENERGY

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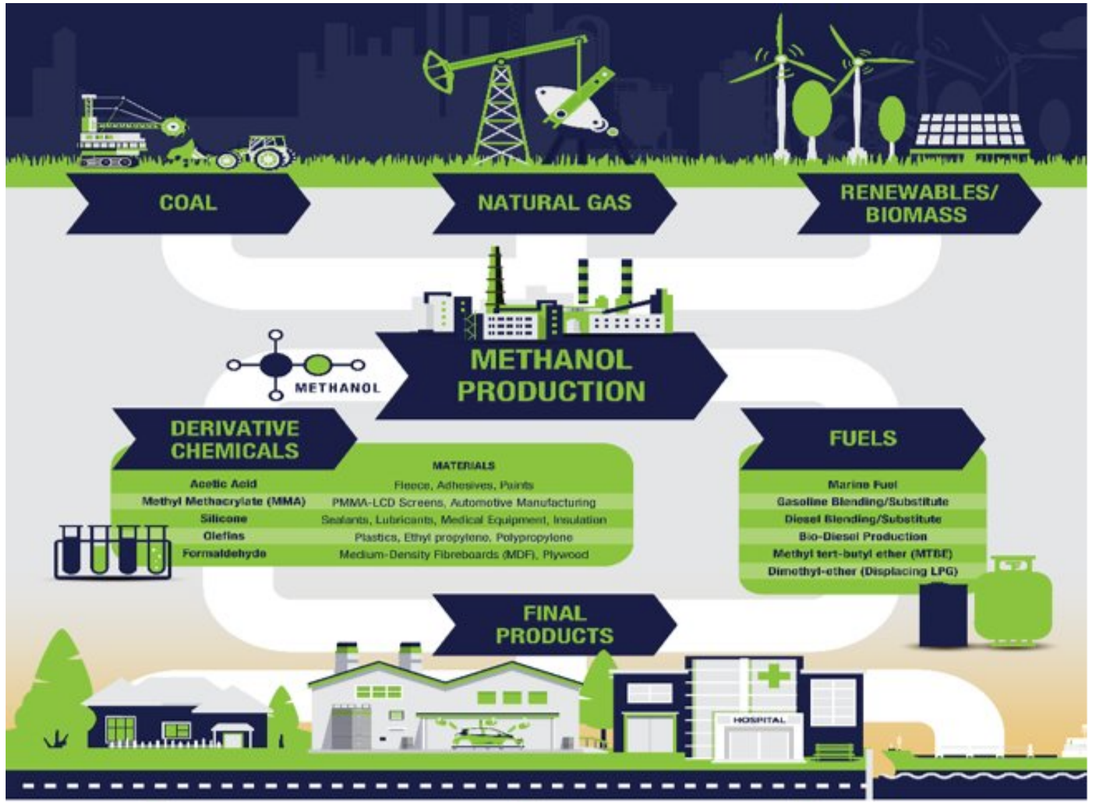
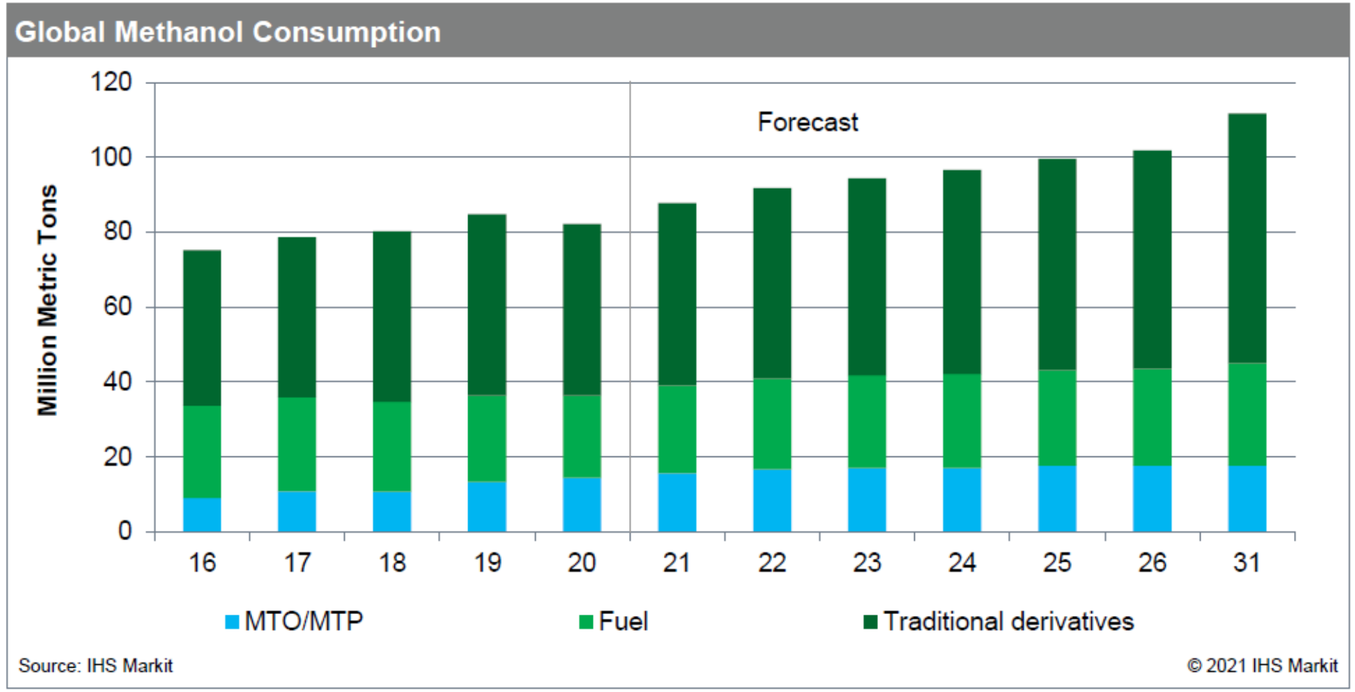
TotalEnergies

CONTROLROOMS.AI

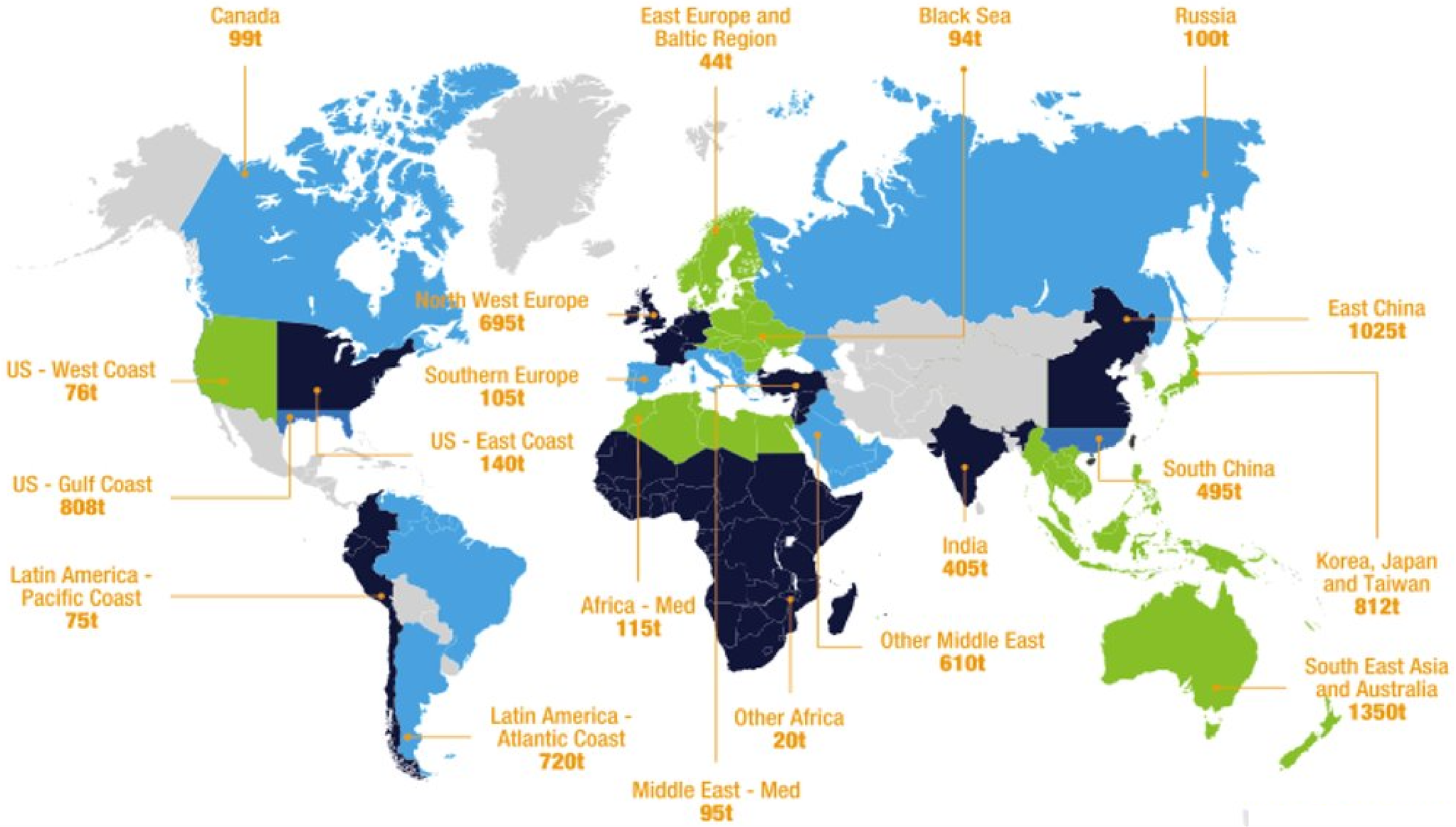
OQ

Essential Methanol





Methanol Trading Hubs



Brown, Grey, Blue and Green

- Renewable CO; from bio-origin and through direct air capture (DAC)
- Non-renewable CO2: from fossil origin, industry

While there is not a standard co/our code for the different types of methanol production processes. This illustration of various (pes of methanol according to feedstock and energy sources is an initial proposal that is meant to be a basis for further discussion with stakeholders

Biomass → Gasification/ reforming → Syngas

Renewable electricity → Electrolysis → H_2 Green hydrogen

Natural gas → Reforming → Syngas

Coal → Gasification → Syngas

Carbon capture and storage (CCS) → H_2 Blue Hydrogen

Syngas → CH_3OH Green methanol

Syngas → Bio-methanol

Syngas → Bio-e-methanol

CO_2 Renewable → E-methanol

CO_2 Non-renewable → CH_3OH Blue methanol

Renewable CO_2 Non-renewable → CH_3OH Blue methanol

Syngas → CH_3OH Grey methanol

Syngas → CH_3OH Brown methanol

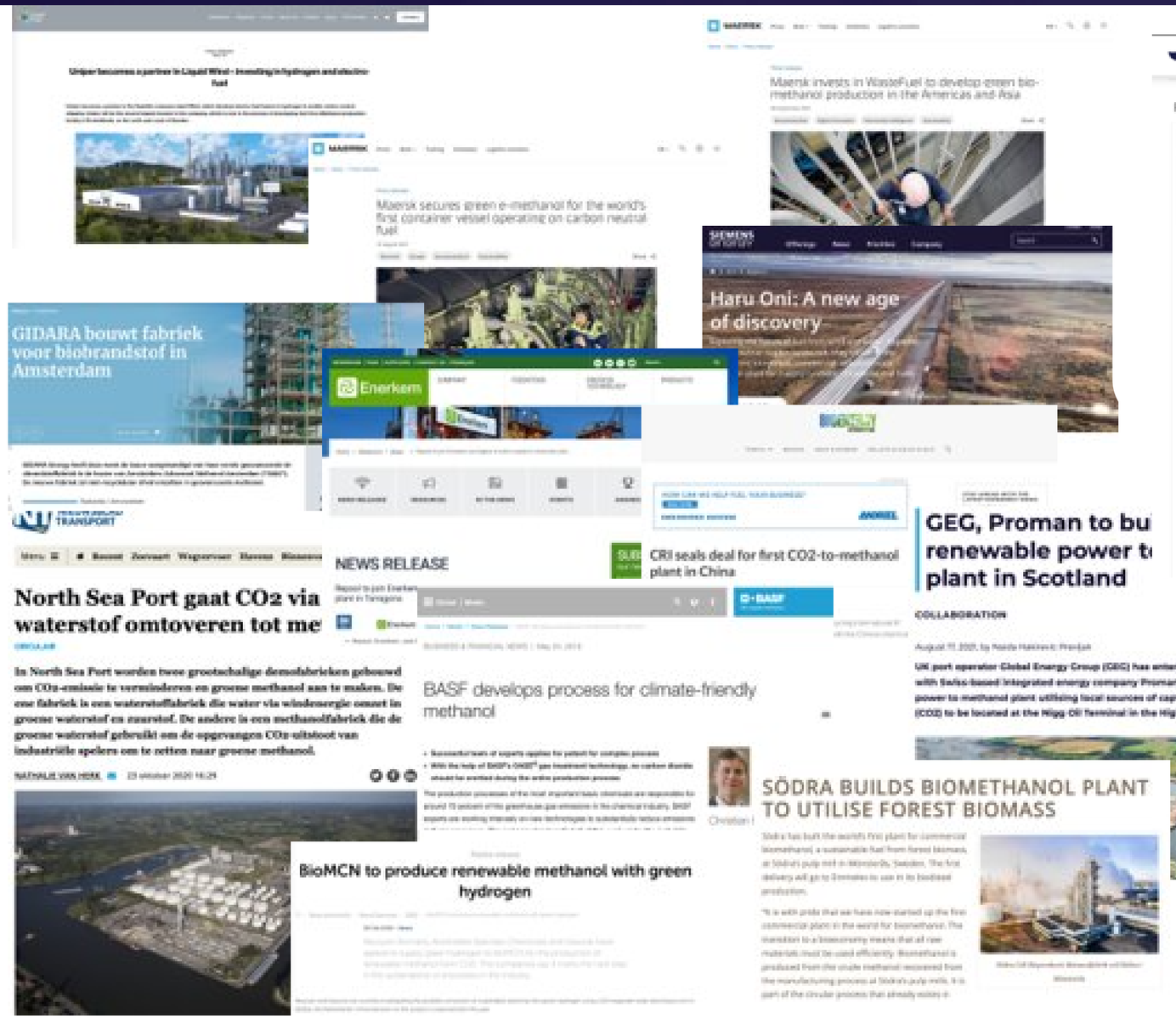
Renewable

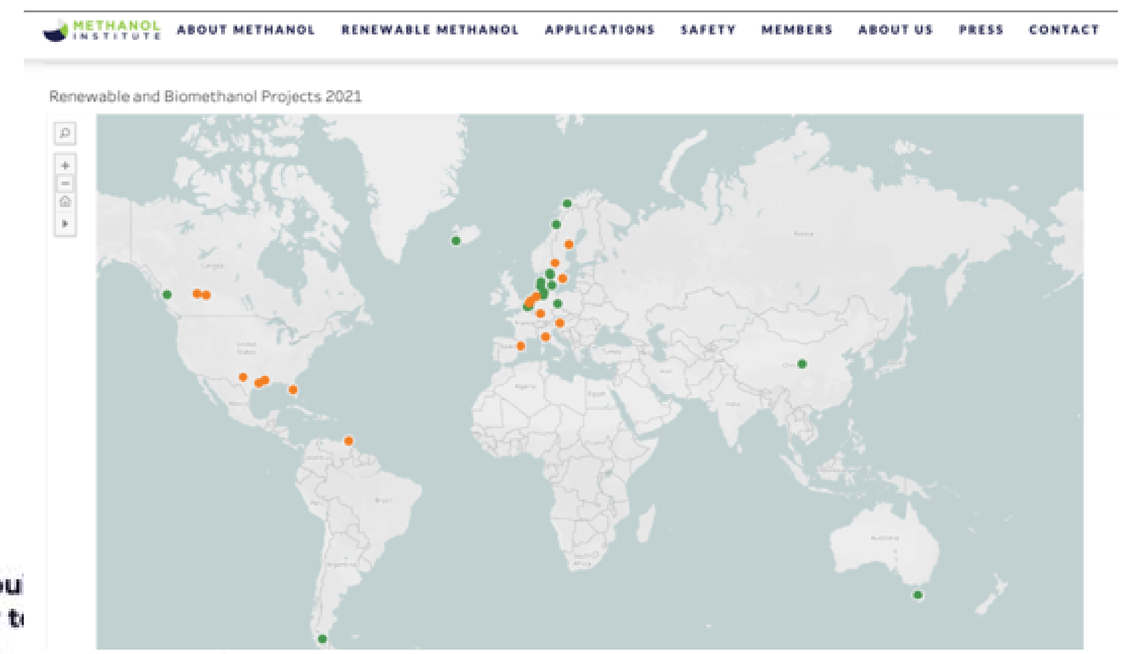
Non-renewable

Low carbon intensity

High carbon intensity

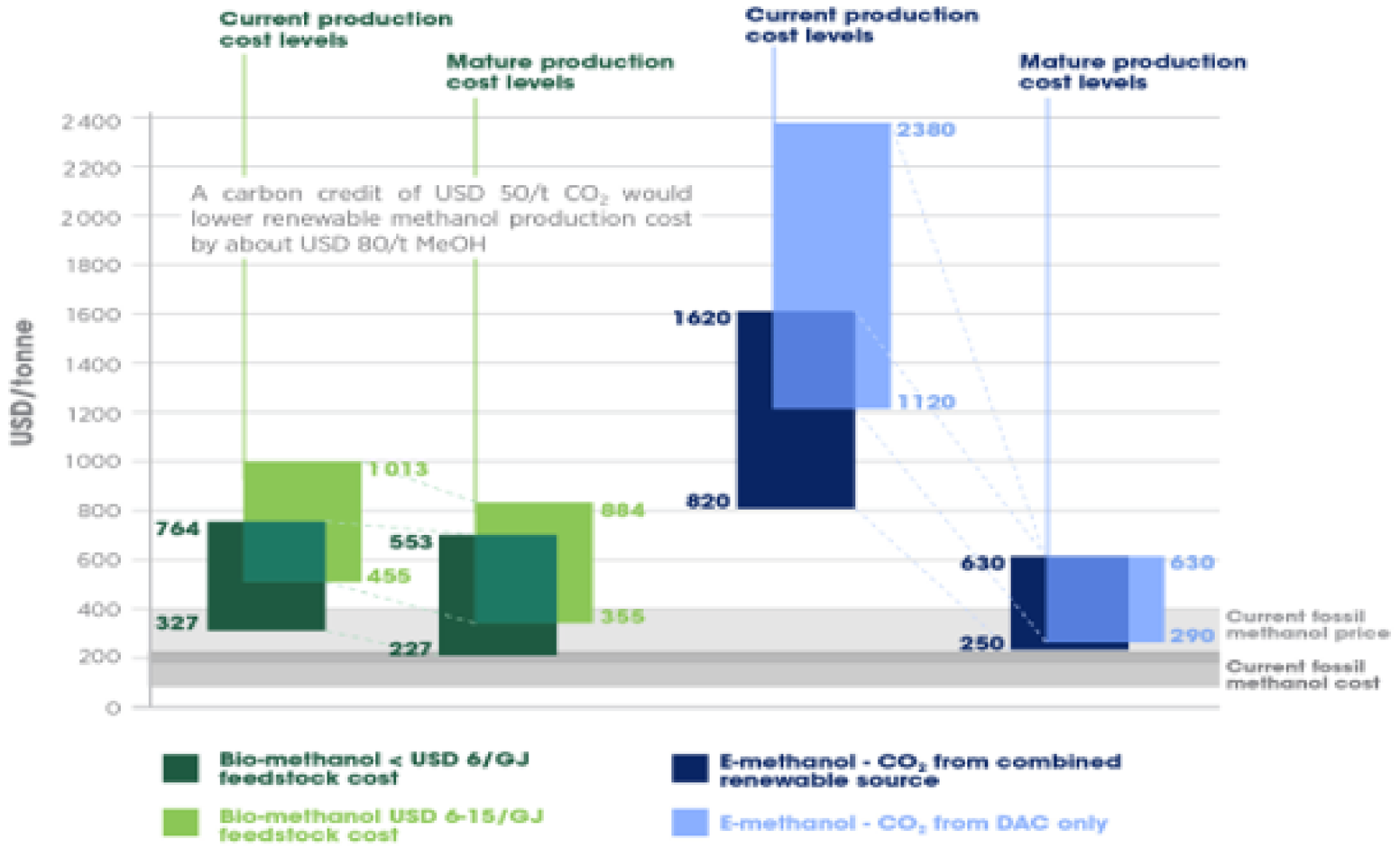
More & More Renewable Project





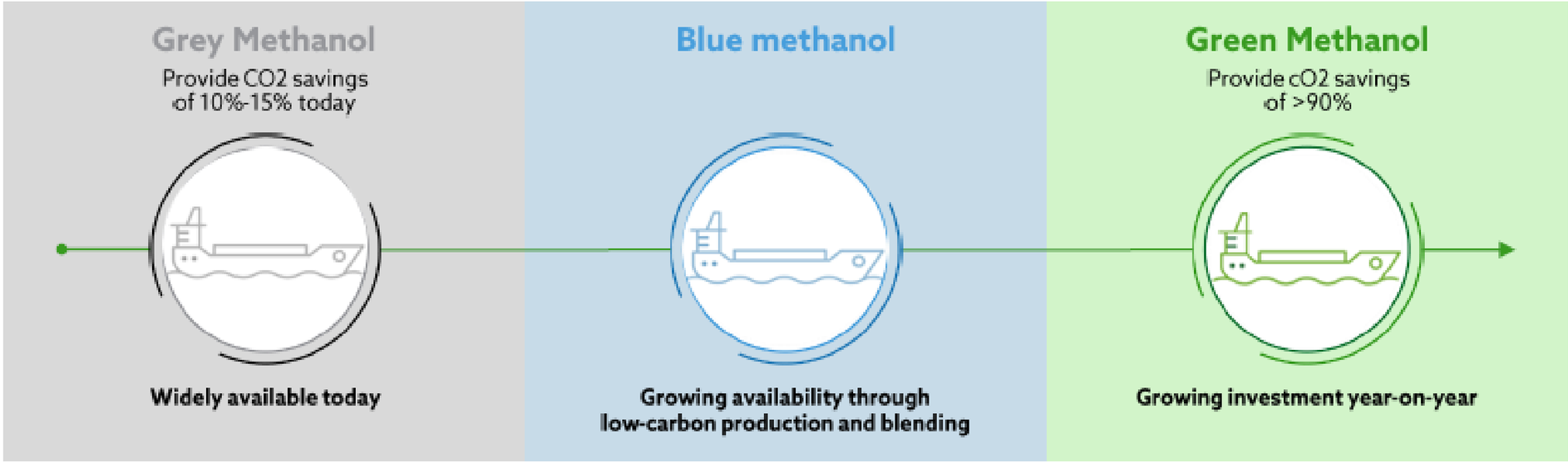
Cost of Production

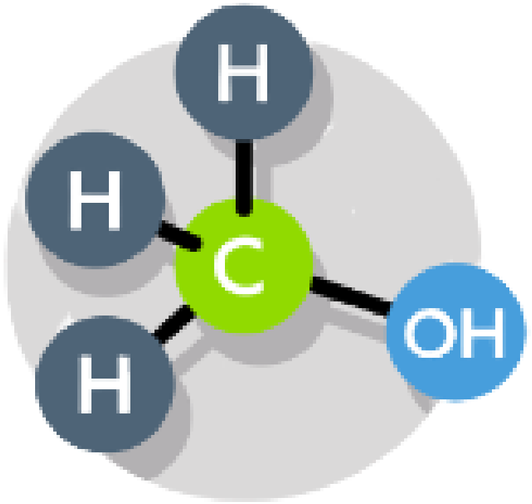
Figure 3. Current and future production costs of bio- and e-methanol



Notes: *MeOH = methanol. Costs do not incorporate any carbon credit that might be available. Current fossil methanol cost and price are from coal and natural gas feedstock in 2020. Exchange rate used in this figure is USD 1 = EUR 0.9.*

The Methanol Molecule



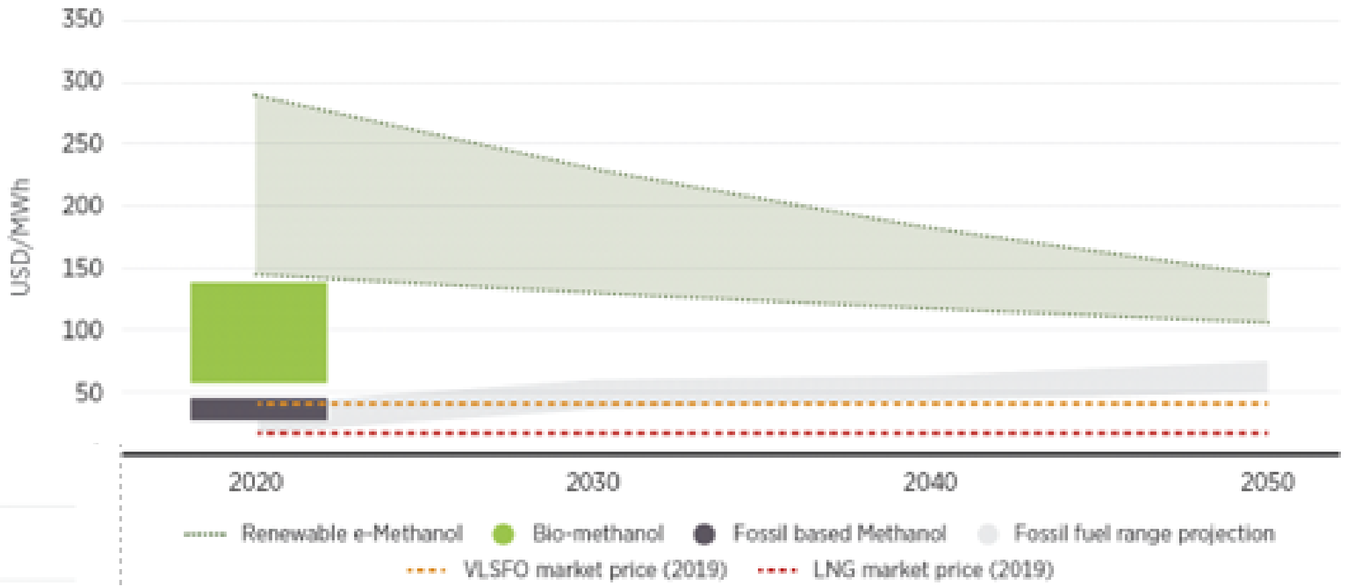


- Methanol molecule is the same energy and chemical characteristics no matter how it is produced
- Completely fungible from grey to blue to green facilitating blending with reduced carbon intensity as low carbon and net carbon-neutral supply grows
- Immediate benefits in reducing SOx, NOx, and PM
- Methanol runs well in existing engines with few modifications and significantly lower CAPEX when compared with other available alternative fuels

Projections – Methanol vs Ammonia

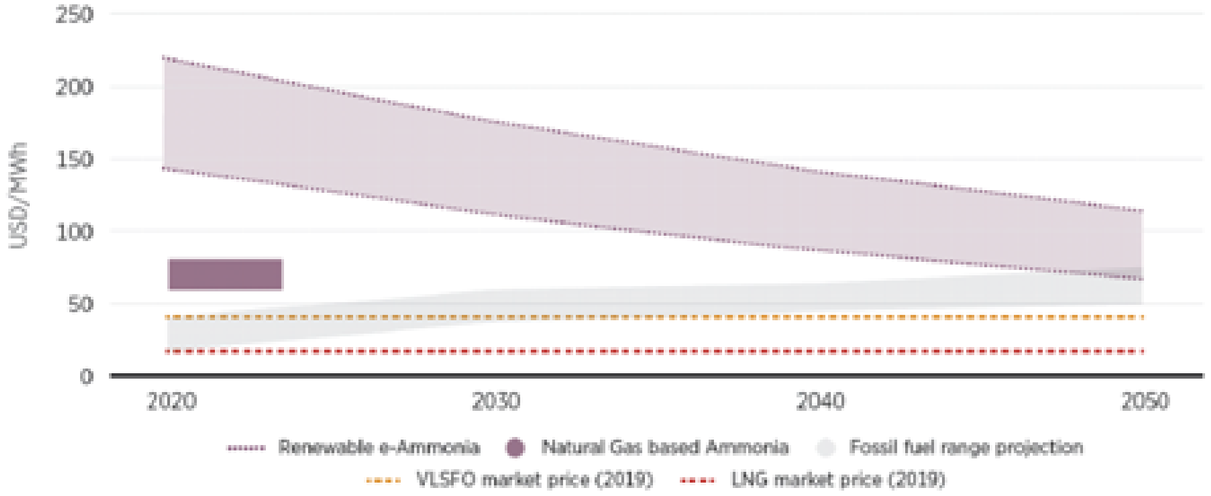
- IRENA "Decarbonise the Shipping Sector"
- Short-term, advanced biofuels play key role
- Medium and long-term e-methanol and e-ammonia more promising green hydrogen-based fuels
- By 2050, shipping uses 38 million tonnes of renewable methanol and 183 million tonnes of renewable ammonia

Methanol cost projections



A Pathway to Decarbonise the Shipping Sector by 2050 (International Renewable Energy Agency, 2021)

Ammonia cost projections



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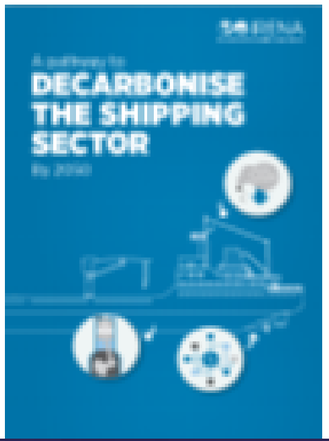
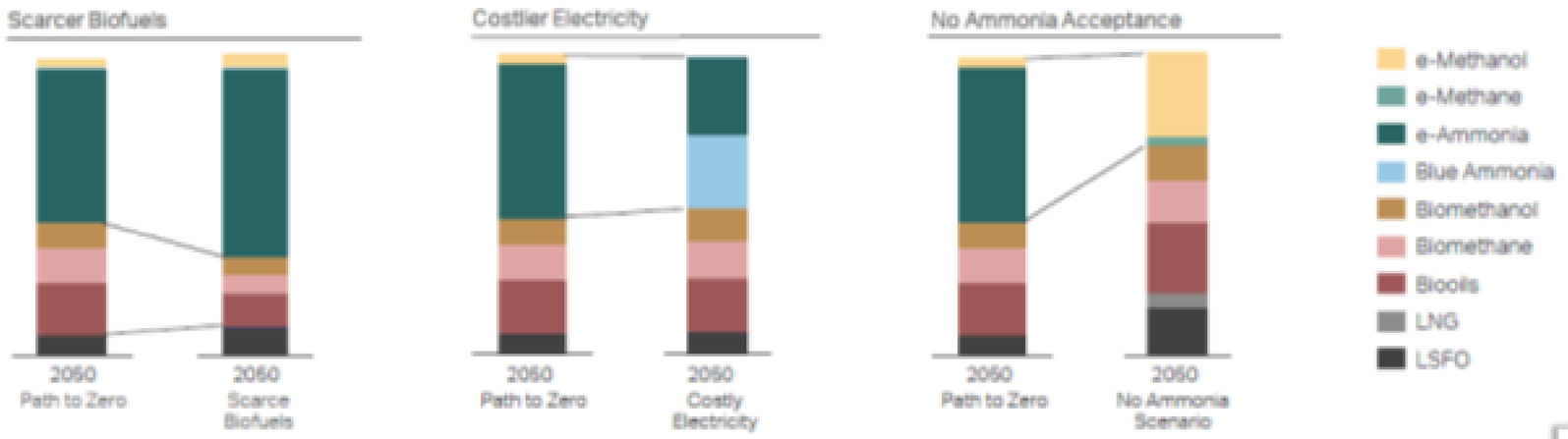


Multiple Pathways

There are multiple viable pathways to decarbonize by 2050, and several fuel blend combinations could deliver the solution



Less biomethane and bio-oils, more electro-fuel

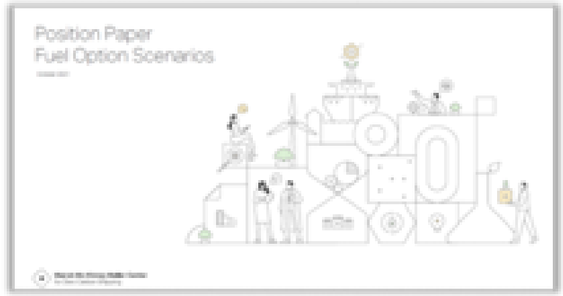
+$15/ton CO2 tax eq.1)

More blue ammonia, less electro-fuels

+$45/ton CO2 tax eq.1)

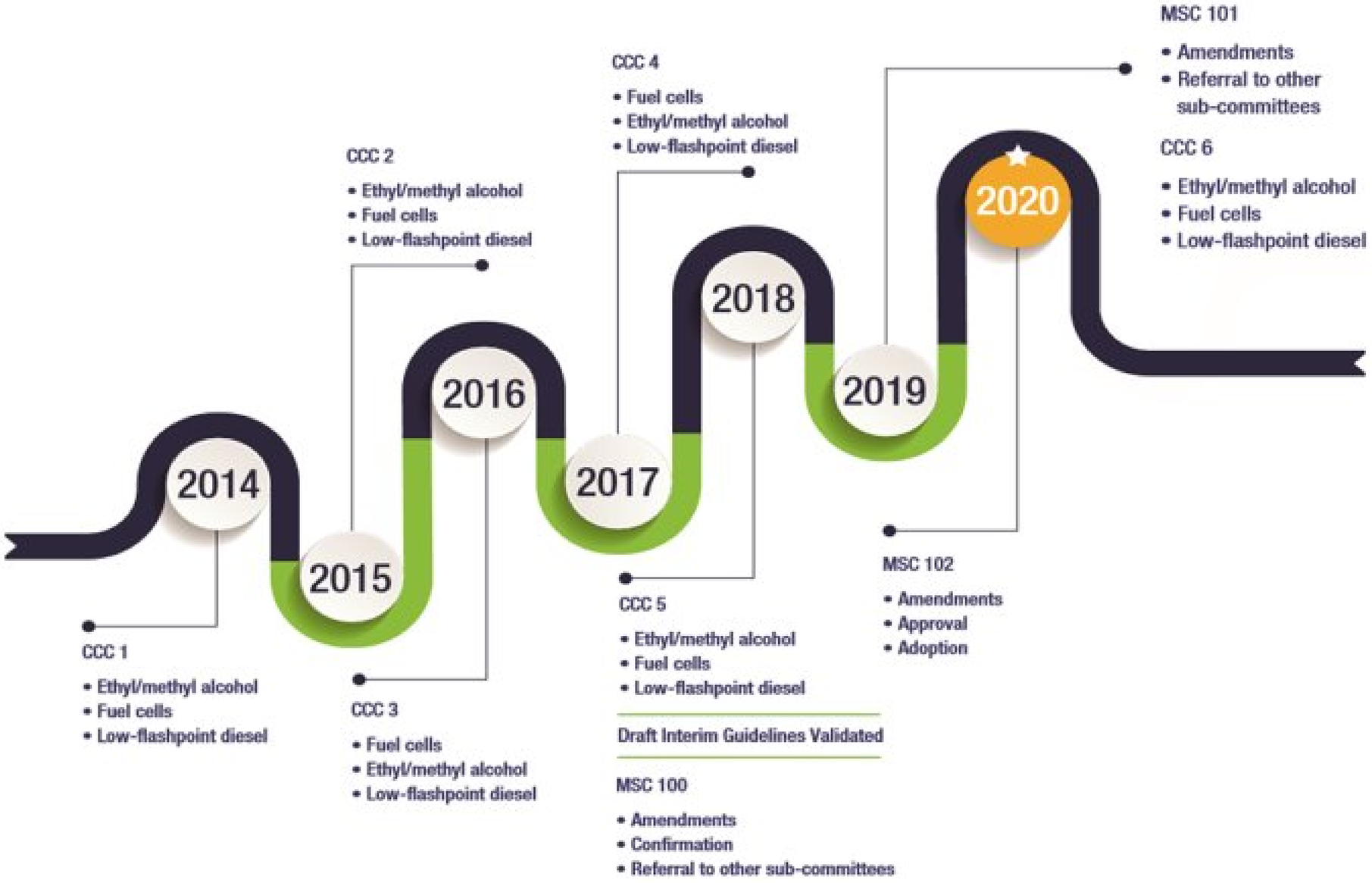
E-methanol and e-methane, instead of e-ammonia

+$70/ton CO2 tax eq.1)

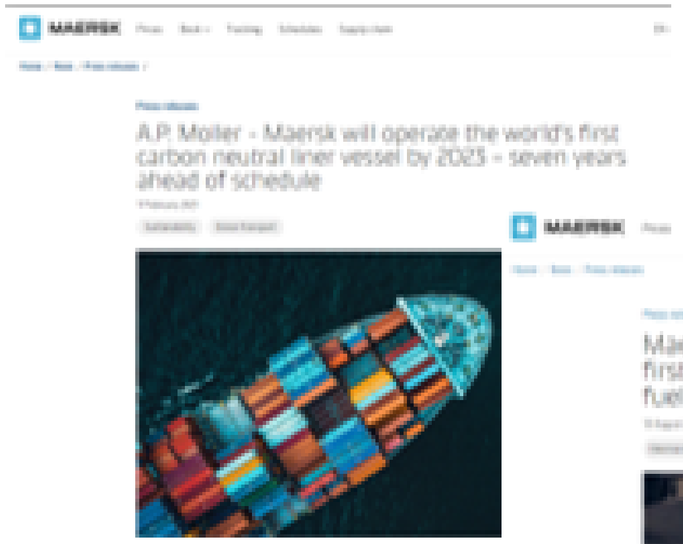


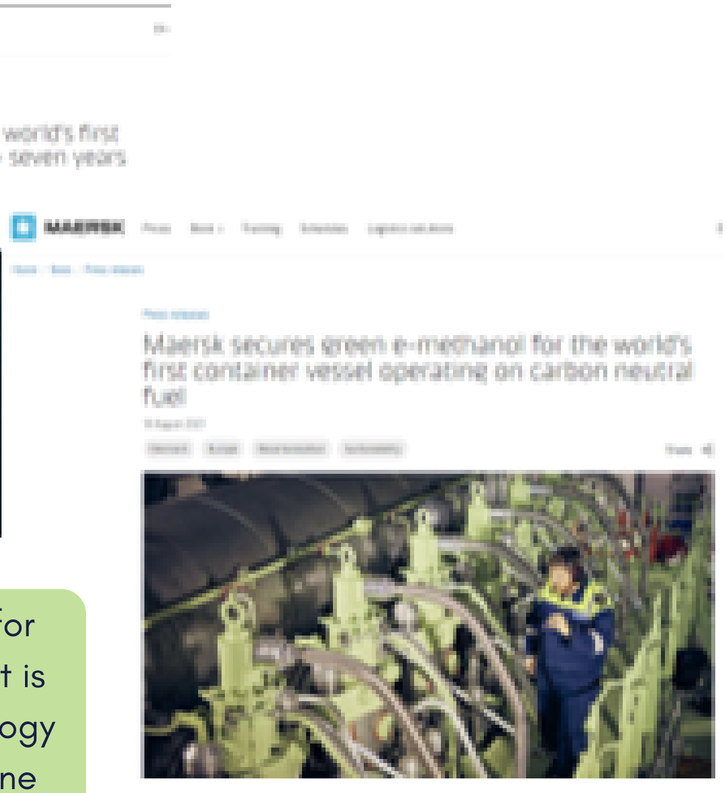
1) Additional CO2 tax required to achieve the same emissions level as in Path to Zero, while still enabling uptake of more costly alternatively fuels in the respective scenarios where constraints on scarcity of biofuels, more costly electricity, and no uptake of ammonia are applied.

Game Changer 1: IMO IGF Code Methanol Approval



Game Changer 2: Maersk Methanol Vessel Orders



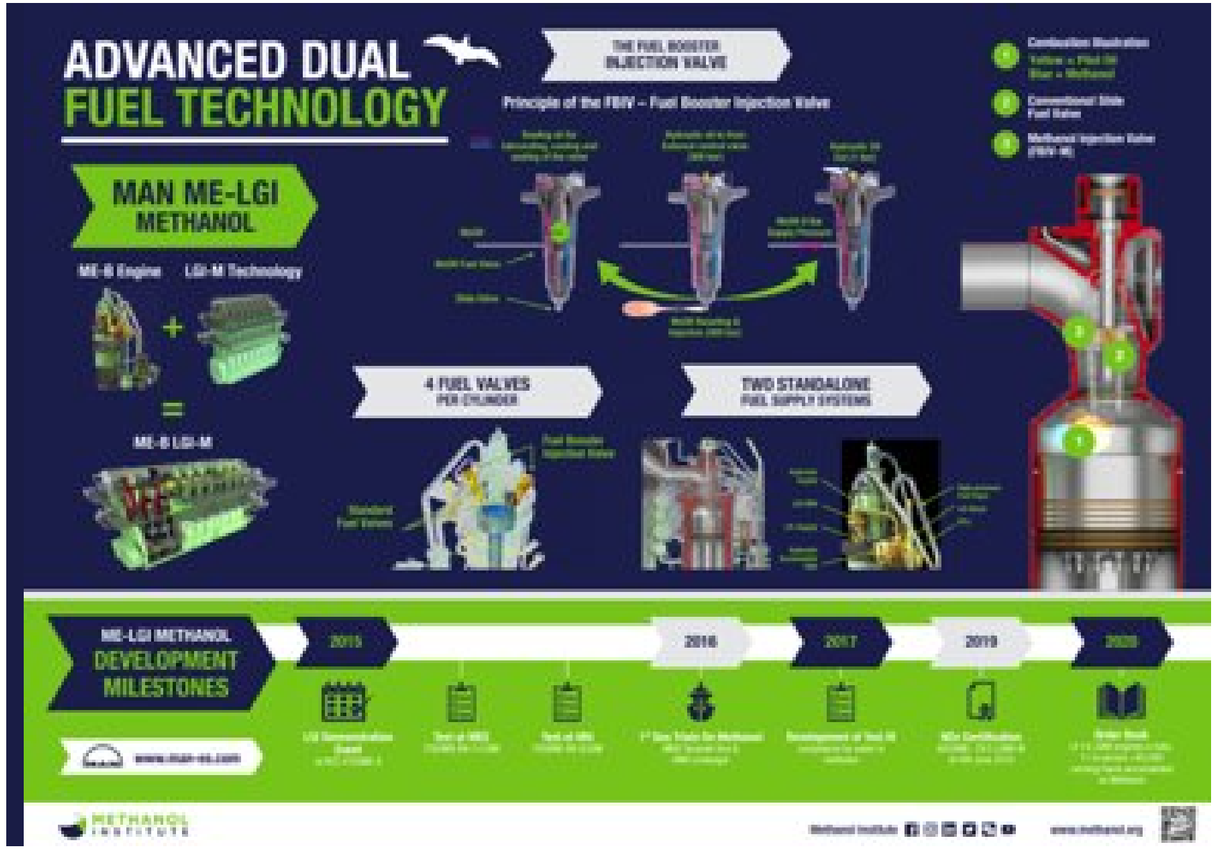


"The reason that we have gone for methanol on the first one is that it is the most mature from the technology perspective; we can get an engine that can burn it." Morten Bo Christiansen, head of decarbonization at Maersk

"That means that if we end up finding exactly the right solution then there will be a big retrofit opportunity for us." Maersk CEO Soren Skou speaking during Maersk's on 10 February earnings call

- 21 Feb 2021: Maersk announces that the world's first carbon neutral container vessel by 2023 will operate on dual-fuel methanol
- Maersk has now ordered 2,100 TEU methanol duel-fueled feeder vessels from Korean shipyard
- 19 Aug 2021: Maersk secures 10,000 tons green e-methanol from Reintegrate in Denmark, using biogenic CO2 and solar power
- 24 Aug 2021: "Maersk accelerates fleet decarbonization with 8 large ocean-going vessels to operate on carbon neutral methanol"
- More than half of Maersk's 200 largest customers have carbon targets for their supply chains
- 16,000 container (Twenty Foot Equivalent – TEU) vessels
- Delivery in 2024, option for 4 additional vessels in 2025
- $1.4 billion order each vessel $175 million 10-15% more expensive
- **Each ship will require 35,000-40,000 tons of methanol annually or a total of 500,00 tons of methanol**

Engines Available and More Coming



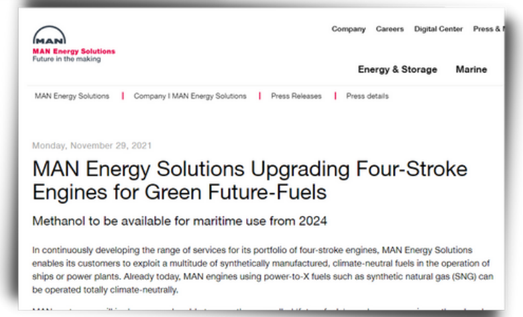
Rolls-Royce developing mtu methanol engines to make shipping greener

BUSINESS DEVELOPMENTS & PROJECTS

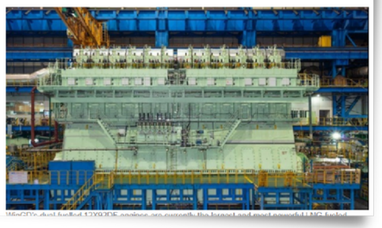
December 22, 2021, by Naida Hakirevic Prevljak

Focusing on methanol as a fuel for climate-friendly shipping, technology company Rolls-Royce aims to set standards in high-speed methanol engines.

Photo: Rolls-Royce



WinGD Expects Methanol and Ammonia-Fueled Engines By 2024 and 2025



On the Water and On the Way

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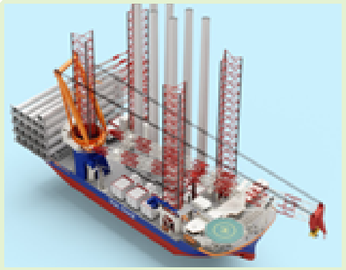
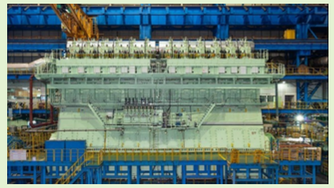
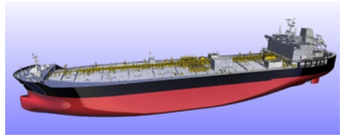





















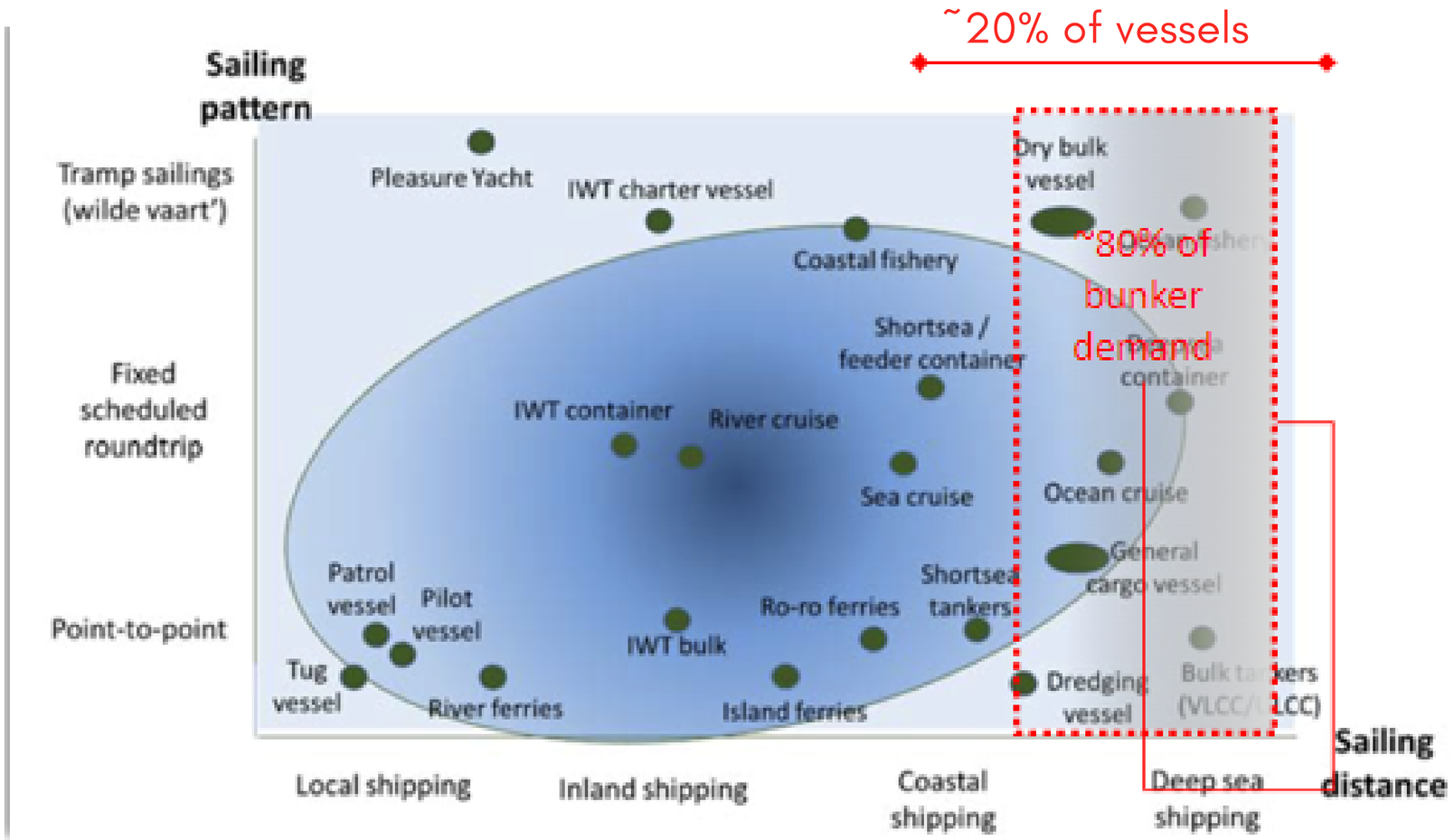
GMM and InvestNL MFS

- Green Maritime Methanol Consortium (Netherlands)
- WP1 Safety
  - Focus on evaporation, ventilation
    Event trees almost ready
- WP2 Engine testing
  - Test at naval R&D scheduled to start in February
- WP3 Design pilots
  - Rescheduled for next meeting
- WP4 Supply Chain
  - Draft policy paper ready mid-February

INVESTNL

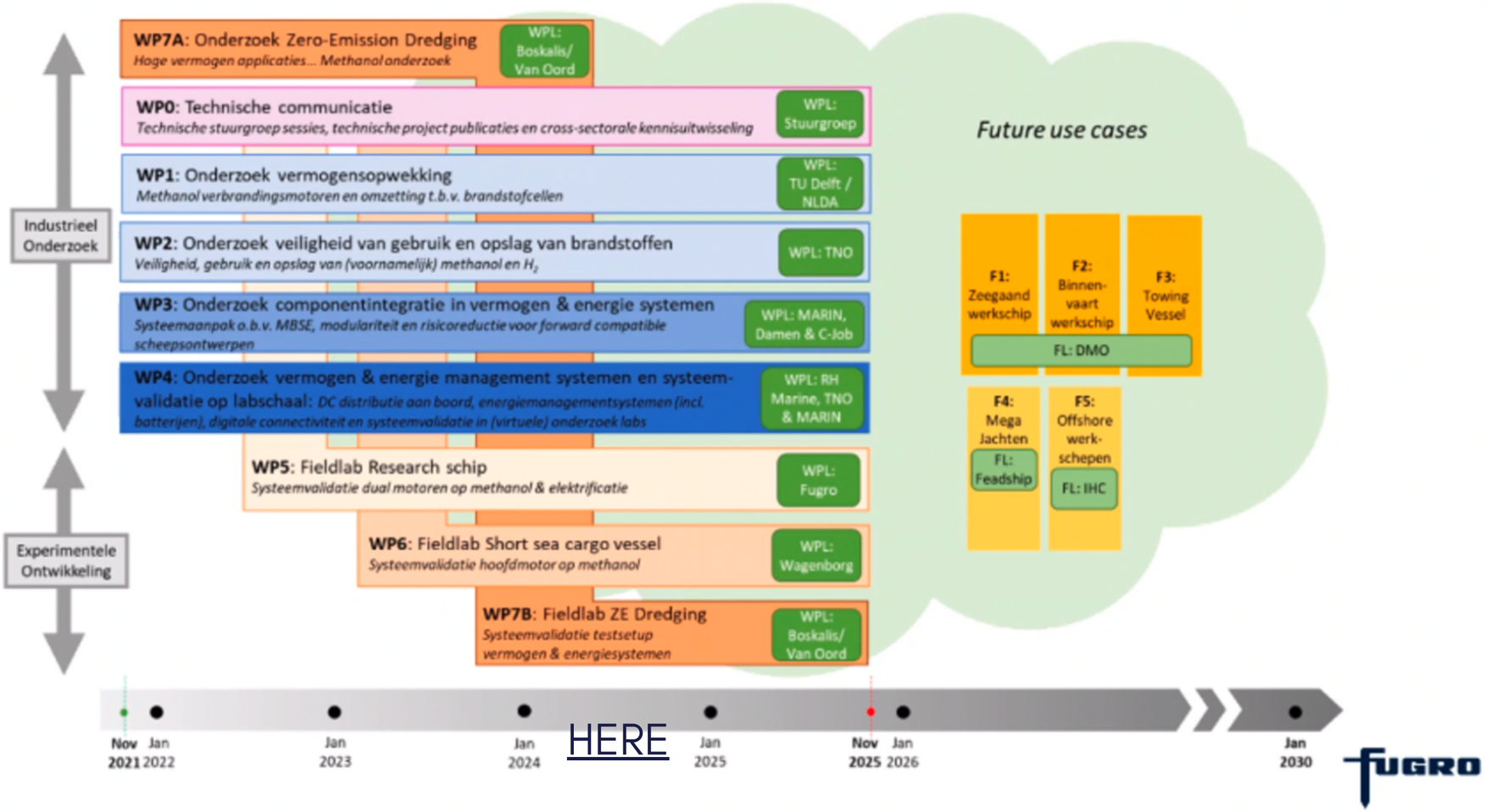
- EURO 1.8 mln subsidy awarded
- Goal to retrofit 3 inland waterway vessels
- 2-year project timeline
- Mitsubishi SR series (S6R and S12R) represents approx. 25% of the market
- Delay due to withdrawal of original shipping company – new partner identified; finalizing negotiations

TNO: Potential Vessel Segments



- For Green Maritime Methanol program, TNO conducted assessment of market potential for Dutch/EU market for methanol as a marine fuel
- Heatmap of "methanol-applicability of shipping segments"
- Most shortsea and inland shipping markets appear feasible in terms of operational profiles, fuel consumption, and sailing patterns
- But important to recognize that the ocean-going vessels make of 20% of vessels and fully 80% of bunker demand

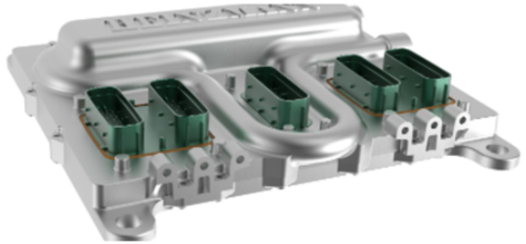
MENENS



- MENENS: Methanol als Energiestap naar Emissieloze Nederlandse Scheepvaart (*loosely translated 'energytransition towards emission free Dutch shipping'*)
- 4-year project timeline
- EURO 24 million subsidy from Dutch government
- 22 partner consortium
- Three vessel types:
  - Research vessel
  - Short sea cargo vessel
  - Dredge

FASTWATER.eu

Launched Dec 2021



Methanol engine retrofit solutions (WP1)

Work Package 1 mission is to provide turnkey methanol conversion kits as a retrofit solution for high speed and medium speed diesel engines (200kW-4000kW). more

Harbour tug demo (WP2)

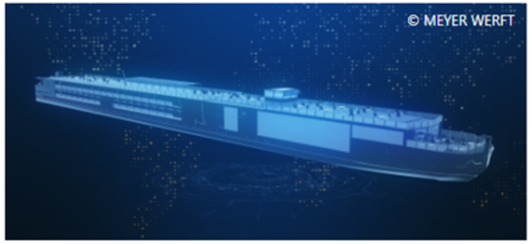
Work Package 2 mission is the complete conversion of a harbour tug (owned by PoA) for methanol/MGO dual-fuel operation incl. set up of supply chain and training of crew. more

Pilot boat demo (WP3)

Work Package 3 mission is to demonstrate methanol as a fuel for use in a smaller marine application for a longer period during true operational conditions. more

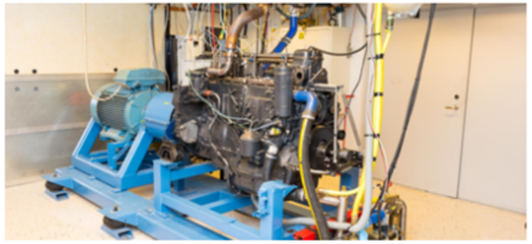
Coast guard vessel demo (WP4)

Work Package 4 mission is to demonstrate methanol operation on board an ERRV (Emergency Recovery and Rescue Vessel) coast guard vessel, built by Super Toys. more



Methanol river cruise ship conversion concept (WP5)

Work Package 5 mission is to develop the conversion concept for a River Cruise Ship for a fuel change from diesel to a methanol-driven propulsion system. more



Next generation methanol engines (WP6)

Work Package 6 mission is to develop the next generation of methanol engines, that fully exploit methanol's beneficial properties as an engine fuel, for increased efficiency and even lower emissions. more

LUND UNIVERSITY · BALance Technology Consulting · ANGLO BELGIAN CORPORATION · HEINZMANN

Port of Antwerp · GHENT UNIVERSITY · ScandiNAOS AB · SSPA

MEYER WERFT · Lloyd's Register · SUPER TOYS

methanex the power of agility · SWEDISH MARITIME ADMINISTRATION

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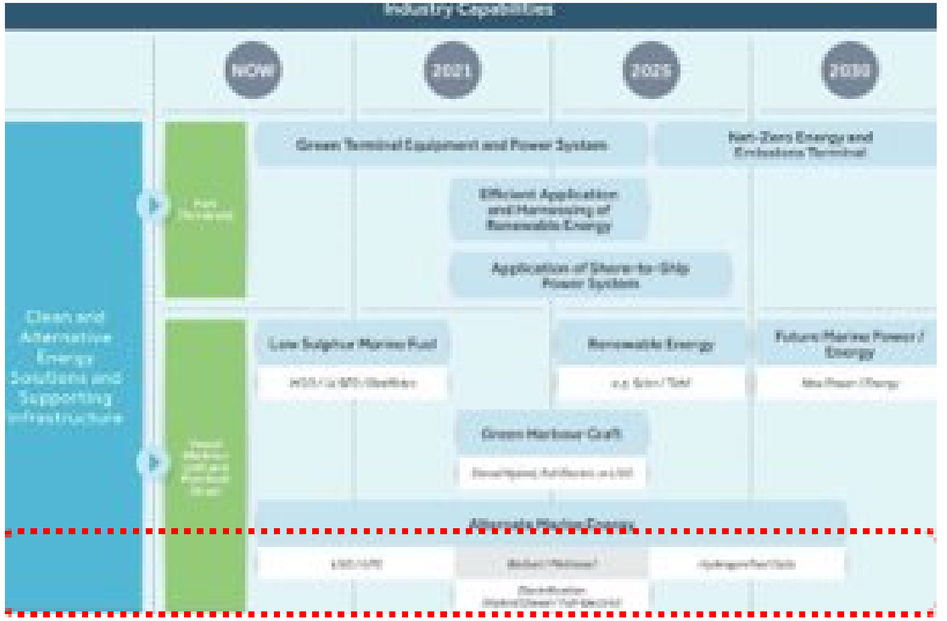
WTRI – China & Singapore

China

- China Waterborne Transport Research Institute (under Ministry of Transport) proposed study to provide a roadmap for the adoption of methanol as a marine fuel for China
- Techno-Economic Assessment; Policy analysis/recommendations
- China annually consumes 20-30 MMT of bunker fuel
- There are 630,000 vessels operating in China's coastal regions (including fishing fleet) and inland waterways (140,000 vessels)
- In terms of potential methanol demand, marine applications have the potential to be no less in size than the China market for boilers or cook stoves, or conservatively in the low single digits, in millions of tons demand, over the next five years
- Total Budget = USD$140,000, with MI as USD$50,000 sponsor, other sponsors Methanex, Sinopec, Shanghai Huayi Group

Singapore

- Singapore's Maritime Institute and MPA recently instructed the Marine Energy Test Bed Department of NTU to engage WTRI in a similar study as MI engaged WTRI
- Study to commence in September with MI participation
- Study will assess feasibility of methanol fuelled vessels in China and Singapore in line with MPA's Roadmap 2030



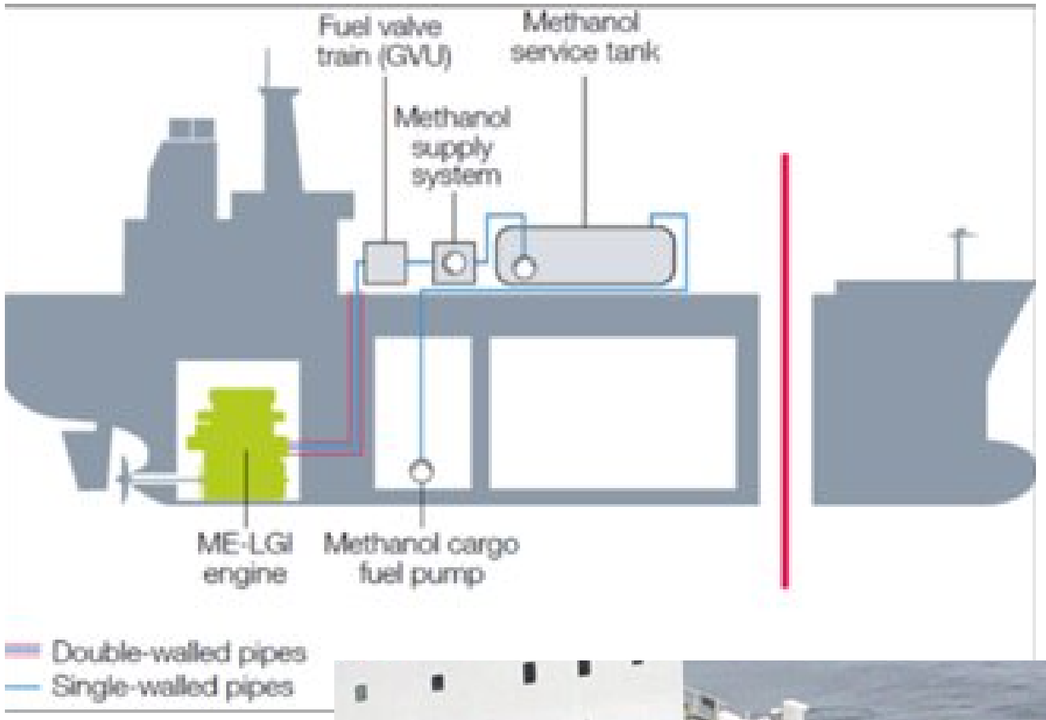
Currently:

- Reviewing final draft
- Circulated to MFC for feedback
- Planned Jul/Aug for formal release

Targeted outcome is to

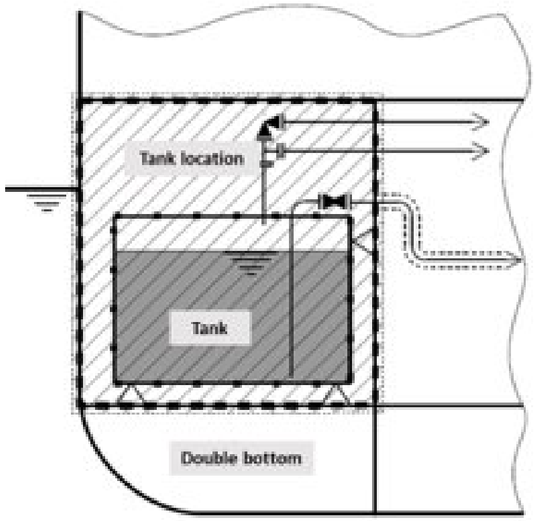
- obtain MSA endorsement
- allow CCS to begin to class methanol-fueled vessels
- create bunkering hubs
- begin to develop standardized methanol designed vessels

Practical Fuel Storage



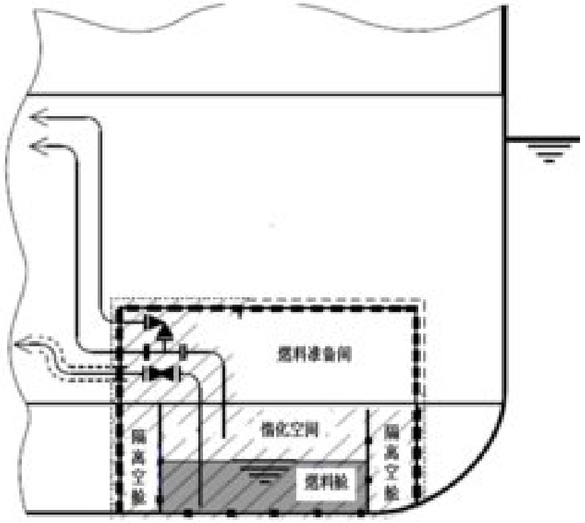
Source: Westfal-Larsen

Independent Tank

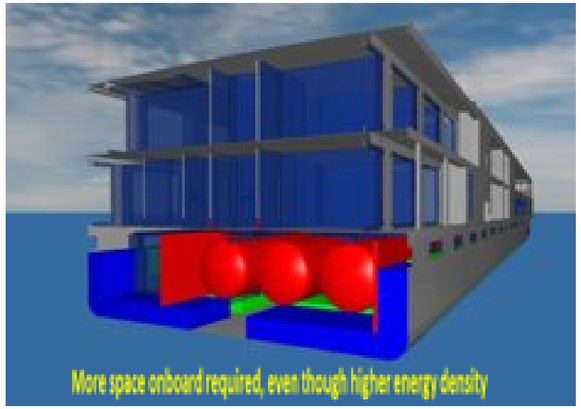


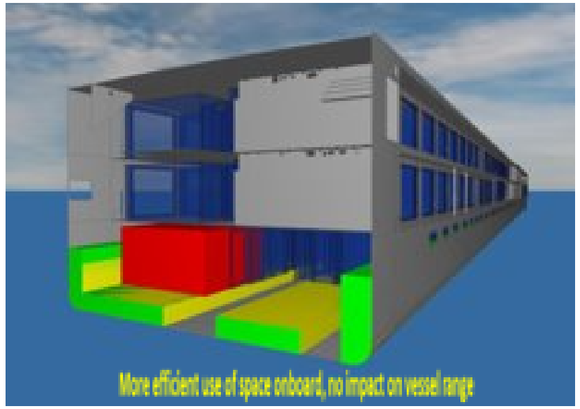
Methane at -162° C

Integral Tank

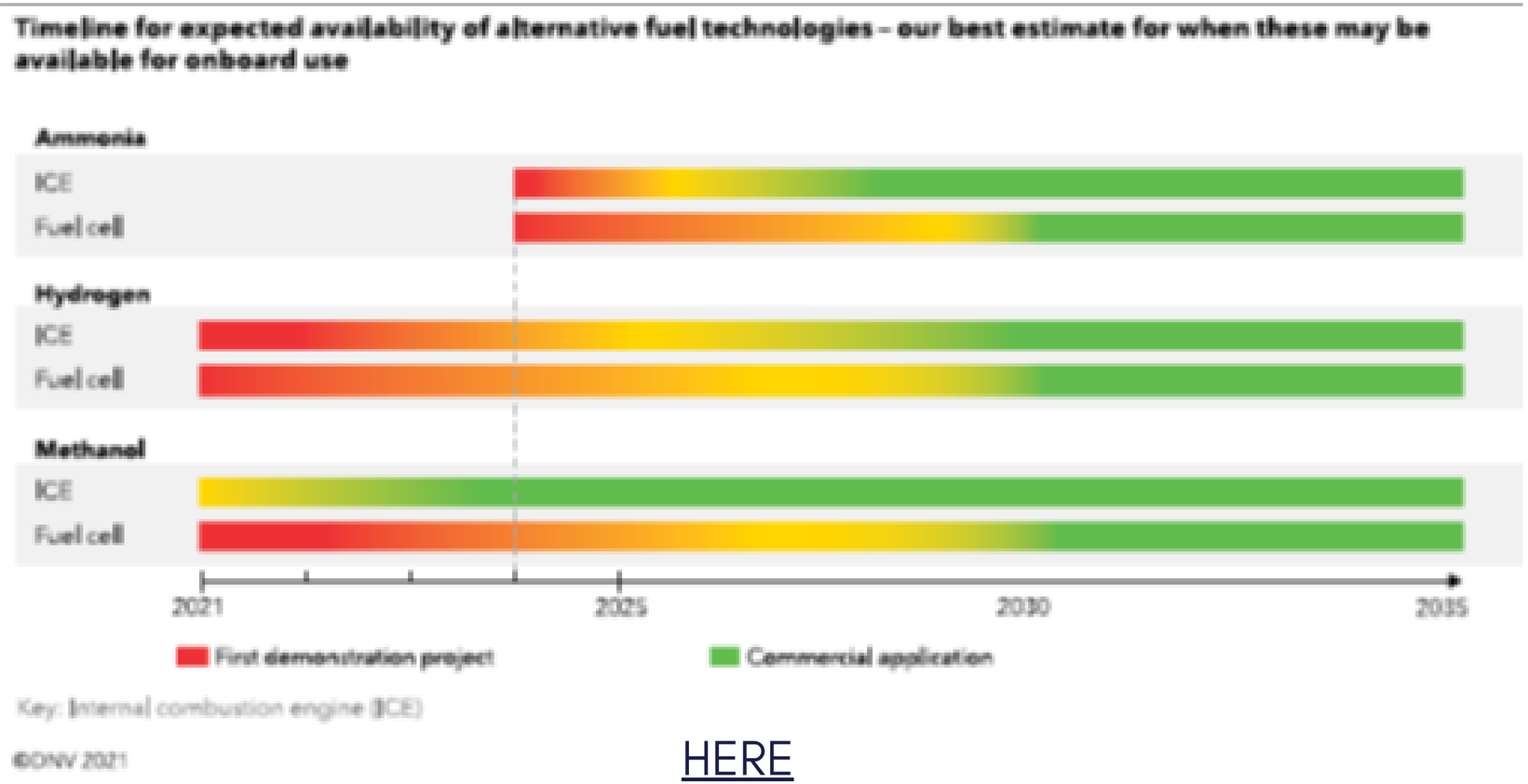


Methanol at ambient temperature





Technology Readiness



HERE

Readiness level of shipping fuels (● High - ● Medium - ● Low)

	FUEL TECHNOLOGICAL READINESS	ENGINE TECHNOLOGICAL READINESS	SCALABILITY & TIME TO MARKET	ENERGY DENSITY	GHG REDUCTION	ENGINE TECHNOLOGY	ADVANTAGES	CHALLENGES
Fuel Oil						ICE	Already used globally, has high efficiency and is low cost in comparison to alternative fuels.	HFO has high carbon emissions and particulate emissions from production and use in vessels.
LNG						ICE	Well-established supply infrastructure, high energy density and is currently used in vessels globally. Has a lower sulphur content than HFO.	LNG has fewer emissions compared with HFO but still significantly more emissions than low-carbon alternative fuels. Uses non-renewable resources.
Advanced Liquid Biofuels						ICE	Biofuels have an established infrastructure due to use in multiple sectors. Easy integration into current engines. Can be used as a drop-in fuel.	Growth of feedstock used in biofuel production may affect land use, which could impact global food security. High demand from multiple sectors makes scaling difficult.
Renewable Gaseous Fuels						ICE	Bunkering in ports can use LNG infrastructure, making implementation cheaper. Ships that use LNG can switch to liquefied biogas (LBG) as a drop-in fuel.	Limitations with storage capacity required for LBG. Can only be considered for short-distance vessels. Long-distance vessels would require large storage capacity.
Hydrogen						ICE FCs	Employing green H_2 would lead to nearly zero carbon emissions. A main option as an energy carrier in FCs. Multiple applications across sectors, which can increase the rate of research.	H_2 production and storage is costly, requiring cryogenic storage. Still an immature technology in the shipping sector but has high potential as an alternative fuel.
Ammonia						ICE FCs	Ammonia has existing production and transport infrastructure due to the agricultural industry. Green ammonia is carbon neutral and has one of the highest efficiencies when compared to alternative fuels.	Global demand for ammonia across multiple sectors can cause scalability issues. Ammonia has a high production cost and is highly toxic, requiring special storage and safety measures.
Methanol						ICE FCs	Currently used in a multitude of sectors and can be implemented within the shipping sector with relative ease. Using e-methanol and bio-methanol is 100% renewable.	Difficulties in acquiring sustainable and cost-effective carbon sources. Green methanol has high production costs.

A Pathway to Decarbonise the Shipping Sector by 2050 (International Renewable Energy Agency, 2021)

Stacking Up Green Competition

CHALMERS
UNIVERSITY OF TECHNOLOGY

Maria Grahn

Total cost of ownership (M€/yr). Base case.

Ship category: large ferries.
Three different utilization rates: short, medium, long distance.

Costs include: fuel production, fuel infrastructure, annuitized investments in propulsion technologies, energy storage and reduced income due to less cargo space.

The colour coding is within each fuel category and utilisation rate to highlight the cheapest option.

MGO and BE are coloured differently but are comparable in terms of costs to all other cases in the ship travel category.

Methanol shows lowest cost within all fuel categories.

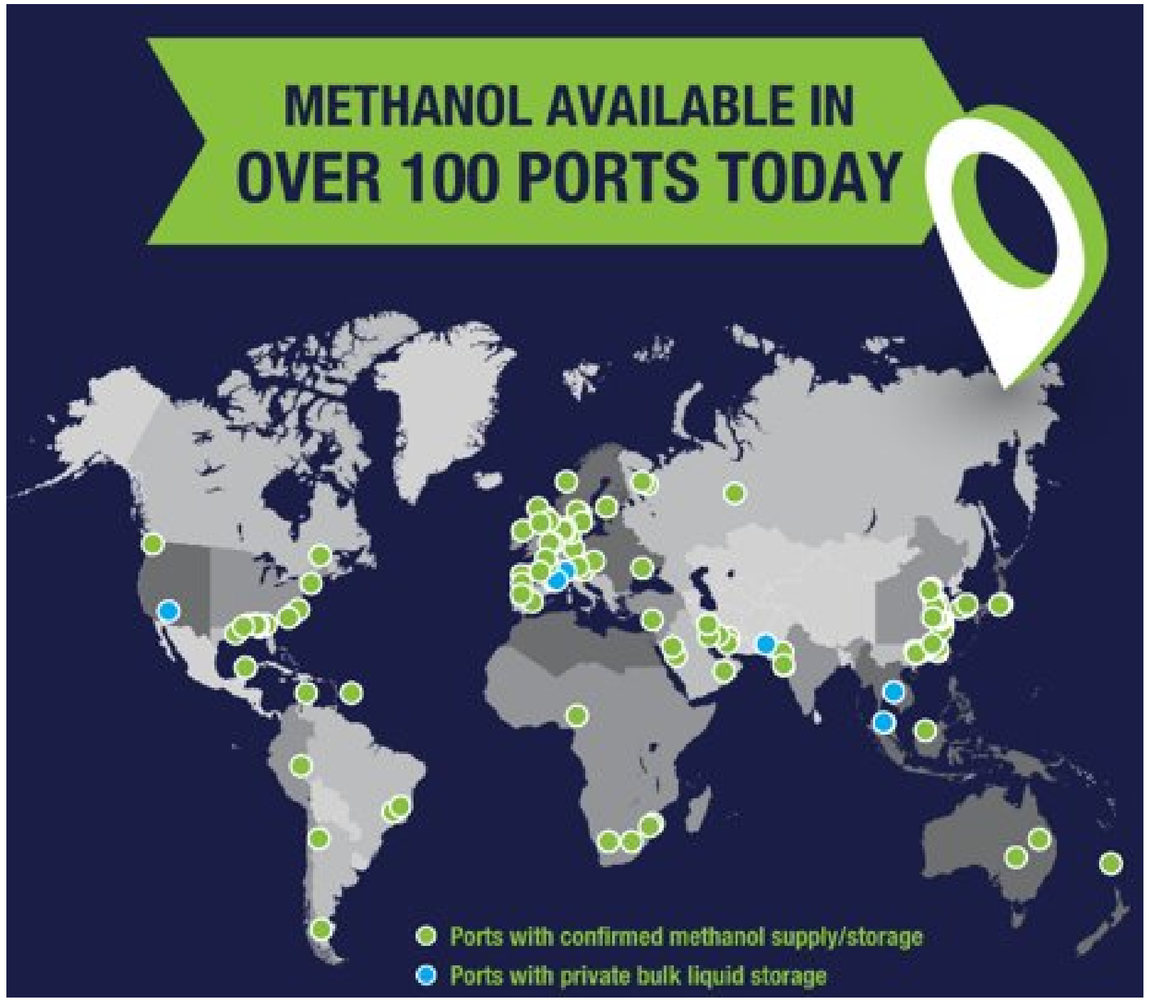
The three methanol production options

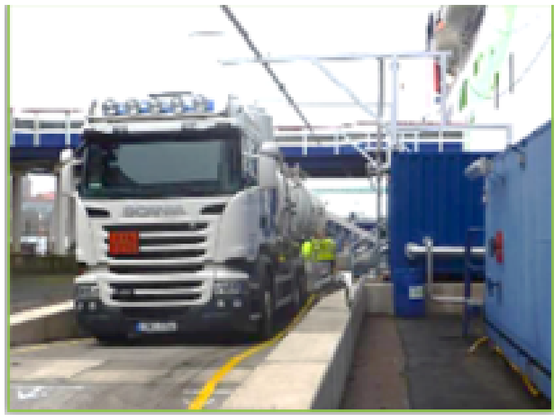
TCO [M€]		Short			Medium			Long		
		ICE	FC	BE	ICE	FC	BE	ICE	FC	BE
MGO		0.9			1.7			2.4		
Biofuels	Biomethanol	2.0	4.2		3.9	5.7		5.7	7.2	
	BioDME	2.3			4.2			6.2		
	Biodiesel	2.7			5.2			7.6		
	BioLMG	3.0	4.9		5.4	6.8		7.8	8.7	
	BioLBG	2.8	4.8		5.1	6.6		7.4	8.4	
	HVO	2.4			4.6			6.8		
Bio-electrofuels	E-biomethanol	2.6	4.7		4.9	6.6		7.3	8.5	
	E-bioDME	2.9			5.4			7.9		
	E-biodiesel	3.2			6.2			9.2		
	E-bioLMG	3.6	5.4		6.6	7.8		9.6	10.2	
	E-bioLBG	3.6	5.3		6.5	7.7		9.5	10.1	
Electrofuels	E-methanol	3.3	5.3		6.5	7.8		9.7	10.3	
	E-DME	3.7			7.0			10.3		
	E-diesel	4.3			8.4			12.5		
	E-LMG	4.3	5.9		8.0	8.9		11.8	11.9	
	Ammonia	3.7	5.5		6.9	8.0		10.2	10.6	
LH_2		4.7	5.3		8.8	8.6		13.0	11.9	
Electricity				2.8			5.5			8.3

Low — High

Insight 7. Methanol and E-methanol may be the lowest cost option from a TCO perspective in the shipping sector.

Available and Easily Bunkered





Methanol Barge Bunkering

- 300mt stem successfully delivered May 2021
- Stem placed per LR/MI Methanol Bunkering TR

Partners included:

- Methanex
- Port of Rotterdam
- Vopak
- NYK
- TankMatch

- Require more such demonstrations at leading ports
- Will support pilots and general uptake of methanol

Ports of interest:

- Antwerp, Rotterdam
- Zhoushan, Ningbo
- Singapore
- Panama
- Others

Methanol Pricing

S&P Global Platts Launches First Global Suite Of Methanol Bunker Fuel Price Assessments

Asia & U.S. Assessments complement Rotterdam pricing to value methanol as a marine fuel

Singapore, New York (October 25, 2021) – S&P Global Platts ("Platts"), the leading independent provider of information, analytics and benchmark prices for the commodities and energy markets, today announced the launch of two new daily methanol bunker fuel price assessments reflecting the value of methanol delivered to ships for marine fuel at the ports of Singapore and Houston, effective October 25, 2021.

The addition of two major hub ports in Asia and the United States Gulf Coast follows the launch of Platts' first-in-market Europe methanol bunker fuel assessment delivered Rotterdam on September 27, 2021, delivering the first global suite of methanol bunker assessments available to the market. Methanol is one of a number of alternative, low carbon marine fuels available to the global shipping industry.

Stergios Zacharakis, Head of Global Methanol Pricing, S&P Global Platts said: "Methanol has seen growing demand for use as a marine fuel, on the back of an increased build-out in vessels and related activities at major bunkering hubs around the world. Our new assessments and associated cost comparisons provide new transparency to market participants in the methanol value chain as well as the bunker community, as the shipping sector seeks to mitigate greenhouse gas emissions and demand cleaner marine fuels."

Argus: existing and upcoming price assessments

Overview		
Price assessment	**Timeline**	**Location/status**
LNG bunkering	Available	Calculated delivered prices for Singapore, Rotterdam, US Gulf Coast (Japan & China upcoming)
CO2	***Available***	***European Union***
Grey ammonia	Available	NWE
Green ammonia	***TBC***	***NWE***
FAME biofuel	Jun – Jul 2021	Market consultations
Green methanol, bio LNG	***TBC***	***Market consultations***
Biodiesel B5, B10, B20	June 2021	Calculated prices for Los Angeles & San Francisco

Practical Fuel Storage

- Potentially moving towards a volumetric assessment basis per the EU Energy Taxation Directive
- Carbon content factoring into price
- Degree of carbon neutrality

FUEL CONSUMPTION (ton/day)	MGO: 20.2	MGO: 20.2 MeOH: 39.8
CO_2 EMISSIONS at service speed (ton/day)	Diesel: 64.7	Diesel: 64.7 MeOH: 54.7

- Values used for CO2 per Kg:
  - 3.1 kg CO2/Kg MGO
  - 1.4 kg CO2/Kg Methanol
- This would give:
  - MGO 20.2 X 3.1 = 62.62 tons CO2
  - MeoH 39.8 X 1.4 = 55.72 tons CO2
  - **11.01% CO2 reduction against MGO**
- LSFO or HFO (closer to 15% reduction)

If on a CO2eq basis, then it is considerably more and even much better than LNG or NH3 as both suffer from slip

ALTERNATIVE VS CONVENTIONAL MARINE FUEL

Asia-Pacific and Middle East energy equivalent comparisons

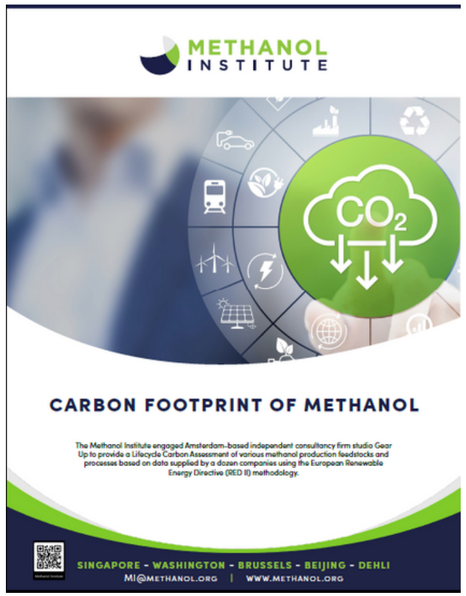
	$/mn Btu	$/t 0.5%S FOe	$/t MGOe	$/t 3.5%S FOe
Weekly average, week ending 8 Oct				
Ammonia ast Asia (excl Taiwan) cfr	36.11	1,426.28	1,464.26	1,377.67
Methanol Southeast Asia delivered, weekly assessment, 11 Oct	27.94	1,103.65	1,133.05	1,066.05
LNG es Southeast Asia (ASEA) half-month net calorific value-adjusted	40.49	1,599.32	1,641.92	1,544.83
Singapore 0.5%S fuel oil delivered	14.60	576.67	-	-
Singapore 0.1%S MGO delivered	16.69	-	676.97	-
Singapore 3.5%S fuel oil delivered	13.33	-	-	508.80
Biodiesel JCOME (used cooking oil) RED bulk China fob	49.94	1,965.61	2,062.50	-
LNG des China half-month net calorific value-adjusted	41.83	1,646.25	1727	-
Zhoushan 0.5%S fuel oil delivered	15.30	602.36	-	-
Zhoushan 0.1%S MGO delivered	17.28	-	714	-
Ammonia Middle East fob spot	32.95	1,305.93	1,344.97	-
Fujairah 0.5% fuel oil delivered	14.59	578.00	-	-
Fujairah 0.1% MGO delivered	17.46	-	712.50	-
Monthly average				
Japanese LNG cocktail (JLC) preliminary, net calorific value-adjusted, Aug	11.21	472.35	-	-
Tokyo 0.5%S fuel oil delivered, Sep	13.23	557.60	-	-

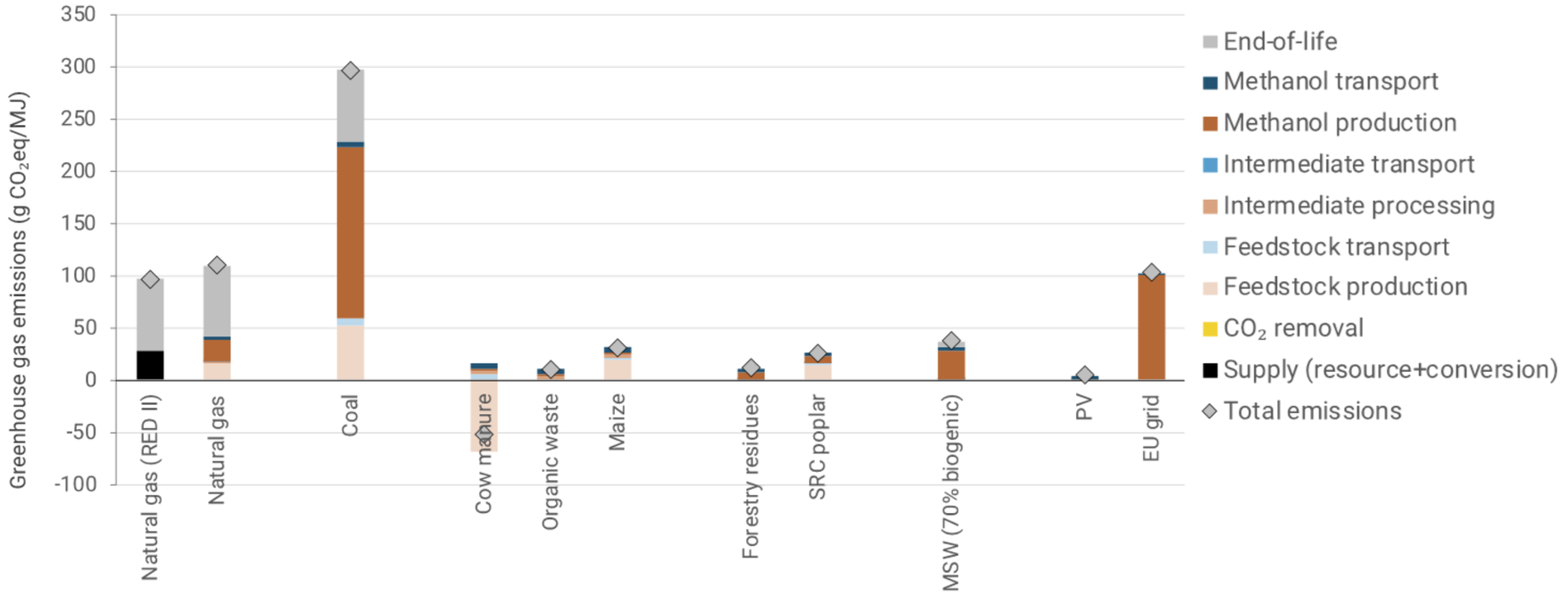
NW Europe energy equivalent comparisons

	$/mn Btu	$/t 0.5%S FOe	$/t MGOe	$/t	CO2 % price increase
NWE ammonia wholesale duty paid, cfr, weekly assessment, 7 Oct*	40.65	1,596.96	1,640.69	-	-
NWE green ammonia modeled value, wholesale, duty paid, cfr, monthly avg Sept†	67.87	2,666.04	2,739.05	-	-
RED Advanced Fame 0C CFPP fob ARA range, weekly avg, week ending 8 Oct	73.58	2,890.22	2,969.38	-	-
Rotterdam methanol delivered, weekly assessment, 11 Oct	27.68	1,087.15	1,116.92	-	-
NWE LNG bunker, delivered on board, weekly assessment, 7 Oct	35.56	1,396.82	1,435.07	-	-
NWE small-scale LNG, free on truck, weekly assessment 7 Oct	34.03	1,336.87	1,373.48		-
ARA 0.5%S fuel oil retail, delivered, weekly avg, week ending 8 Oct	14.25	559.75	-	-	-
ARA 0.1%S MGO retail, delivered, weekly avg, week ending 8 Oct	16.47	-	672.55	-	-
CO2 added cost, weekly avg, week ending 8 Oct††					
EU CO2	-	-	-	70.84	-
Rotterdam methanol delivered including CO2 cost, weekly assessment, 11 Oct	32.84	1,290.00	1,325.33	-	19%
ARA 0.5%S fuel oil retail, delivered including CO2 cost	19.93	782.96	-	-	40%
ARA 0.1%S MGO retail, delivered including CO2 cost	22.29	-	899.65	-	34%

**weekly assessment cfr NW Europe ammonia duty paid*
†Monthly calculated price. For more information about ammonia inquire about the Argus Ammonia report
††1t of 0.5%S fuel oil emits 3.151t of CO2, 1t of MGO emits 3.206t of CO2, according to IMO's 2014 guidelines. For news and analysis on the EU Emission Trading Scheme market inquire about the Argus European Emissions Market report.

Carbon Footprint of Methanol

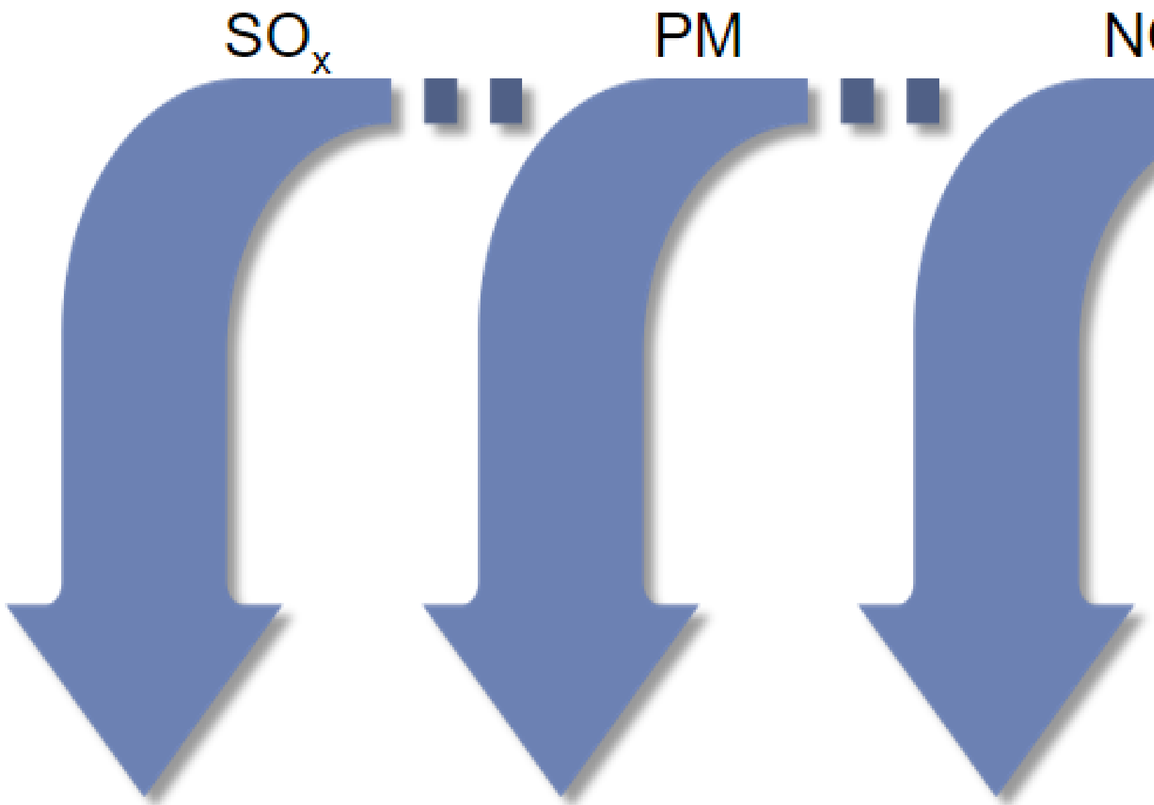




- Most methanol is currently produced from natural gas. Modern facilities today produce methanol with an estimated carbon footprint of about 110 g CO_2eq/MJ, which is higher than what was considered state-of-the art two decades ago, of about 97 g CO_2eq/MJ, most likely because the insight has improved with data in the current study.
- Production from coal only takes place in China and has a high carbon footprint, of nearly 300 g CO_2eq/MJ, due to large emissions associated with both the mining of coal and the methanol conversion process.
- Production from renewable sources, such as from biomethane, solid biomass, municipal solid waste (or MSW, which contains a considerable fraction of organic waste), and renewable energy, has a low carbon footprint. Most of these pathways achieve 10-40 g CO_2eq/MJ, and some pathways even have negative emissions (-55 gCO_2eq/MJ for methanol from biomethane from cow manure) which means effectively that CO_2 is removed from the atmosphere or that the pathway avoids emissions from other processes.

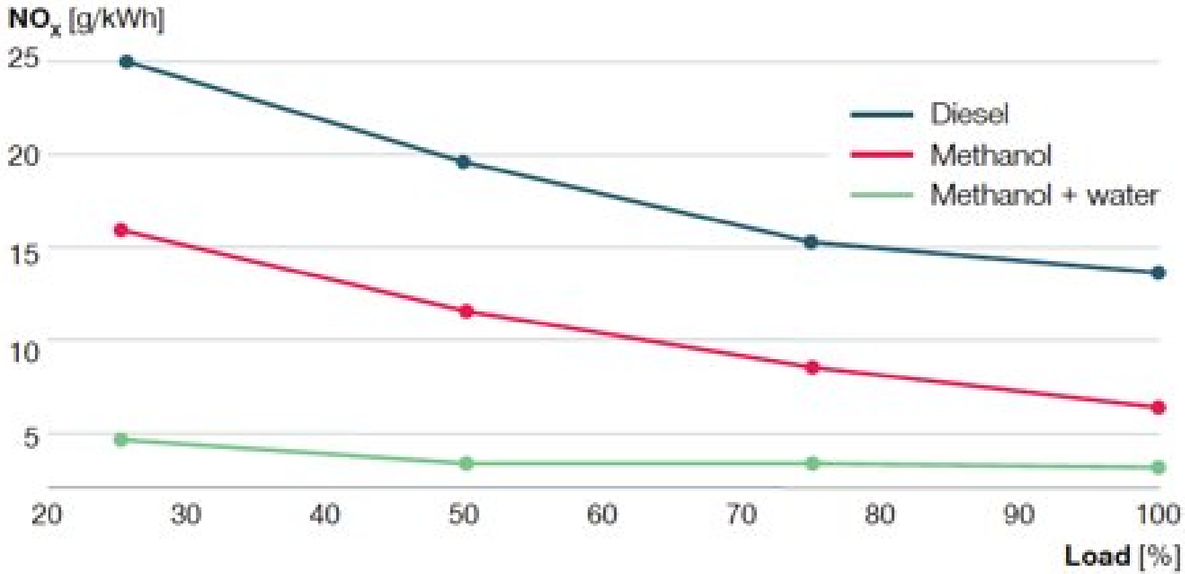
Improving Local Air Quality

Emission reduction potential:



source: Stena Line

source: Stena Line



source: MAN ES

Significant CO2 Reduction Potential

European Sustainable Shipping Forum
Sustainable Alternative Power for Shipping

MARIN

Home | Data table | Energy carriers | **Well-to-Wake** | Pathways

Data to display:

GWP100 | WTW (WTT+TT

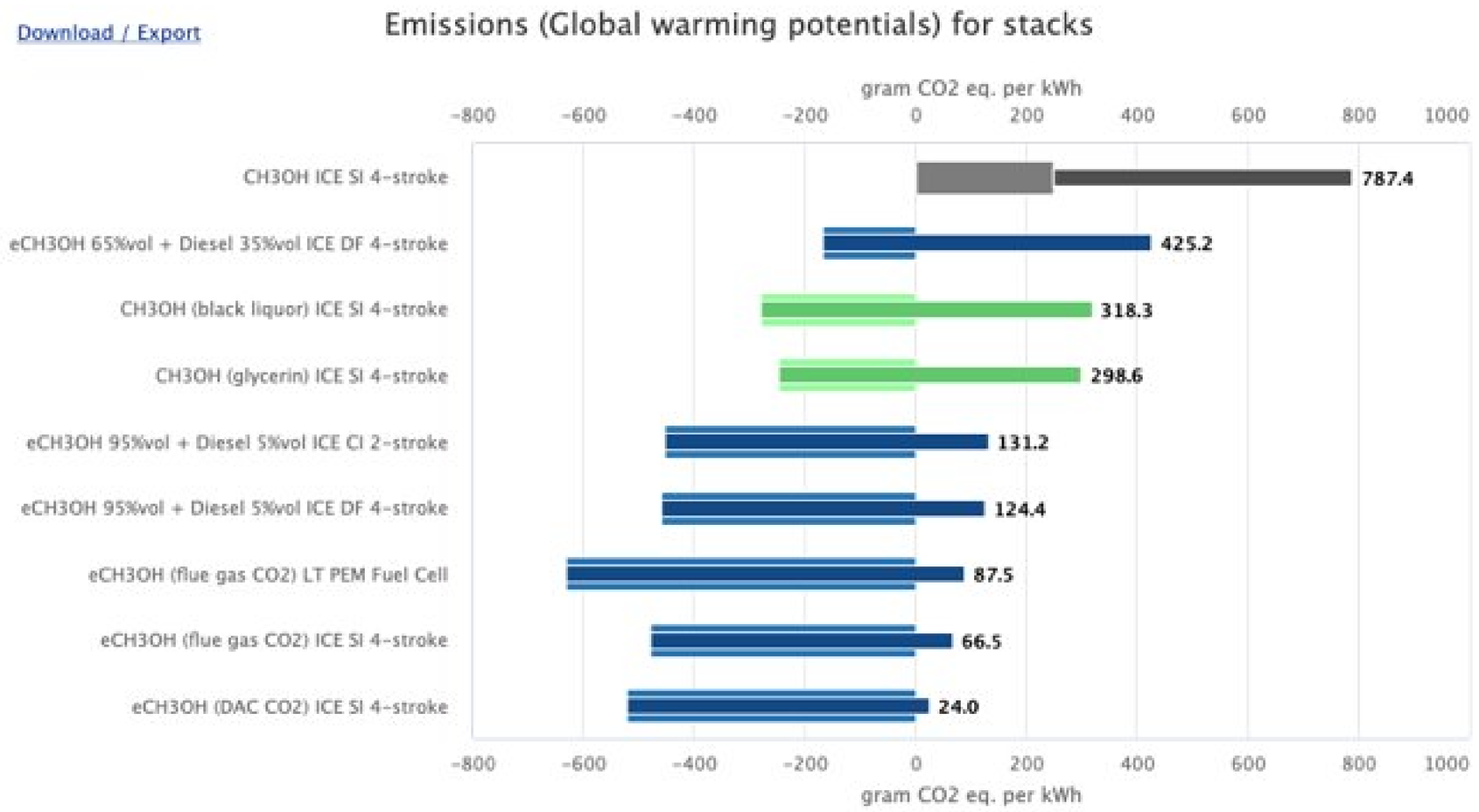
Categories to filter by: Methan...

Color by: Resour

Show/hide stacks:

- [x] CH3OH ICE SI 4-stroke
- [x] eCH3OH 65%vol + Diesel 35%vol ICE DF 4-stroke
- [x] CH3OH (black liquor) ICE SI 4-stroke
- [x] CH3OH (glycerin) ICE SI 4-stroke
- [x] eCH3OH 95%vol + Diesel 5%vol ICE CI 2-stroke
- [x] eCH3OH 95%vol + Diesel 5%vol ICE DF 4-stroke
- [x] eCH3OH (flue gas CO2) LT PEM Fuel Cell
- [x] eCH3OH (flue gas CO2) ICE SI 4-stroke
- [x] eCH3OH (DAC CO2) ICE SI 4-stroke
- [ ] NH3 LT PEMFC

Download / Export

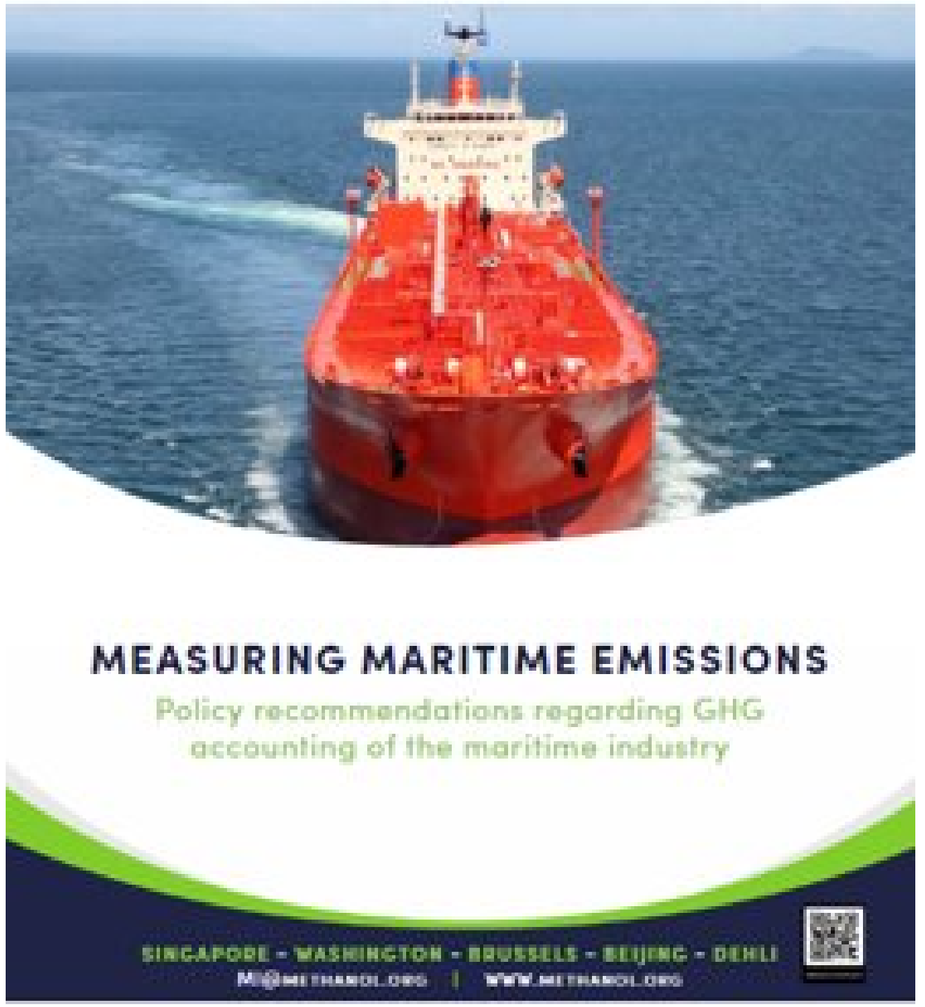


source: https://sustainablepower.application.marin.nl

Measuring Maritime Emissions

The Methanol Institute (MI) is calling on maritime policy-makers to adopt a 'well-to-wake' approach in GHG accounting of fuels to support the decarbonization of maritime transport. MI believes an approach that accounts for GHG emissions of the fuel's entire value chain is essential to stimulate the uptake of renewable fuels that can drive the maritime industry's energy transition.

METHANOL INSTITUTE



Hazard Comparison

	METHANOL	DIESEL	GASOLINE
Hazard pictograms (CPL)			
Signal word: (CPL)	Danger	Danger	Danger
Hazard statements (CPL)	H225 Highly flammable liquid and vapour. H301 Toxic if swallowed. H311 Toxic in contact with skin. H331 Toxic if inhaled. H370 Causes damage to organs.	H225: Flammable liquid and vapour. H304: May be fatal if swallowed and enters airways. H315: Causes skin irritation. H332: Harmful if inhaled. H351: Suspected of causing cancer. H373: May cause damage to organs through prolonged or repeated exposure. H411: Toxic to aquatic life with long lasting effects.	H225: Extremely flammable liquid and vapour. H304: May be fatal if swallowed and enters airways. H315: Causes skin irritation. H340: May cause genetic defects. H350: May cause cancer. H361: Suspected of damaging fertility or the unborn child. H65: May cause drowsiness or dizziness. H411: Toxic to aquatic life with long lasting effects.
Precautionary statements (CLP)	P210 - Keep away from heat. - No smoking. P280 - Wear protective gloves, protective clothing, eye protection, face protection. P301+P310 - IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P302+P352 - IF ON SKIN: Wash with plenty of soap and water. P403+P233 - Store in a well-ventilated place. Keep container tightly closed.	P201: Obtain special instructions before use. P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking. P233: Keep container and receiving equipment P240: Use explosion-proof electrical/ventilation/lighting equipment. P242: Use only non-sparking tools. P243: Take precautionary measures against static discharge. P260: Do not breathe dust/fume/gas/mist/vapours/spray. P264: Wash hands thoroughly after handling. P270: Do not eat, drink or smoke when using this product. P273: Avoid release to the environment. P280: Wear protective gloves/clothing/eye protection. P301+P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P302+P352: IF ON SKIN: Wash with plenty of soap and water. P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. P304+P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. P308+P313: IF exposed or concerned: Get medical advice/attention. P312: Call a POISON CENTER or doctor/physician if you feel unwell. P331: Do NOT induce vomiting. P332+P313: If skin irritation occurs: Get medical advice/attention. P370+P378: In case of fire: Use water spray or foam for extinction. P391: Collect spillage. P403+P233: Store in a well-ventilated place. Keep container tightly closed. P403+P235: Store in a well-ventilated place. Keep cool. P405: Store locked up. P501: Dispose of contents/container in accordance with local/regional/national/international regulation.	P201: Obtain special instructions before use. P202: Do not handle until all safety precautions have been read and understood. P210: Keep away from heat/sparks/open flames/hot surfaces. - No smoking. P233: Keep container tightly closed. P240: Ground/bond container and receiving equipment. P241: Use explosion-proof electrical/ventilation/lighting equipment. P242: Use only non-sparking tools. P243: Take precautionary measures against static discharge. P260: Do not breathe fume/gas/mist/vapours/spray. P264: Wash hands thoroughly after handling. P271: Use only outdoors or in a well-ventilated area. P273: Avoid release to the environment. P280: Wear protective gloves/clothing/eye protection. P301+P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. P302+P352: IF ON SKIN: Wash with plenty of soap and water. P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. P304+P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. P308+P313: IF exposed or concerned: Get medical advice/attention. P312: Call a POISON CENTER or doctor/physician if you feel unwell. P331: Do NOT induce vomiting. P332+P313: If skin irritation occurs: Get medical advice/attention. P370+P378: In case of fire: Use water spray or foam for extinction. P391: Collect spillage. P403+P233: Store in a well-ventilated place. Keep container tightly closed. P403+P235: Store in a well-ventilated place. Keep cool. P405: Store locked up. P501: Dispose of contents/container in accordance with local/regional/national/international regulation.

Methanol classified as “not more dangerous” than other fuels such as gasoline or diesel – fuels largely familiar to most people

Oil Spills Still Happen….

Oil Spills Still Happen....

Methanol [5]
15,400 mg/l

- Methanol is a more environmentally-benign fuel in marine environments
- In a waterbody, nearly 200 times more methanol is needed to kill half the number of fish than marine heavy fuel oil

LC 50: Lethal Dose: Fish

Gasoline [1]	Methane [2]	Diesel [3]	Heavy Fuel Oil [4]	Ammonia [6]
8,2 mg/l	49,9 mg/l	65 mg/l	79 mg/l	0.068 mg/l

Sources:
[1] Petrobras/Statoil ASA, Safety Data Sheet, ECHA registration dossier Gasoline
[2] ECHA, European Chemicals Agency, registration dossier Methane
[3] ECHA, European Chemical Agency, registration dossier Diesel
[4] GKG/ A/S Dansk Shell, Safety Data Sheet
[5] ECHA, European Chemical Agency, registration dossier Methanol
[6] ECHA, European Chemical Agency, registration dossier Ammonia

Spill & Salvage Economic Impact

Economic Impact – HFO vs Methanol :

	Maritime accident	Maritime accident	Simulation
Ship	**Erika**	**Tanio**	-
Fuel	Heavy Fuel Oil	Heavy Fuel Oil	Methanol
Released amount	19000 t	13500 t	10000t
Affected coastline	400km	200km	0km
Total damage	$914M	-	-
Cleaning	$100M	$50M	$0
Fishing industry	$98,3M	-	-
Tourist industry	**$400-500M**	-	-
Claim for damages	**$120M**	**$17M**	-
Killed birds	~ 60,000	~ 40,000	->0

MeOH spill simulations

Simulation 1[8]:

- **Release of 10,000 tons Methanol at open Sea**

Concentration of 0,36% after 1 hour

Simulation 2[8]:

- **Release of 10,000 l/h from a coastal pier**

Concentration of 0,36% after 1 hour
Concentration of 0,13% after 3 hours

[8] Malcolm pirnie, Inc, Technical Memorandum

Sources : Economic, Social & Environmental Effects of the "Prestige" Oil Spill, Meyer-Werft

- Less toxic then gasoline or diesel
- Methanol poisoning is not carcinogenic and requires simple treatment
- No additional GHG potential (methane slip)
- Miscible in water – large spill concentration will rapidly decrease with only very short-term effects
- Far less hazardous to the environment
- Methanol is fully miscible with water and dissolves readily
- It is biodegradable and does not bioaccumulate
- Methanol is not rated as toxic to aquatic organisms using the GESAMP rating system (Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) (acute and chronic toxicity measures)

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