WIN GD | 1898 - 2023 125 YEARS ENGINE INNOVATION

Synthetic Fuels for International Shipping

SATW Forum “Wasserstoff und synthetische chemische Energieträger für die Mobilität und Energiespeicherung“

German Weisser

23.4.2024

Presentation outline

1	The merchant marine business
2	WinGD in a nutshell
3	Regulatory environment
4	Development for the application of synthetic fuels
5	Impact of unprecedented tight schedules on development approach
6	Relevance for Switzerland
7	Summary

WinGD in a nutshell

From Sulzer to WinGD

2015 → WIN GD

1997 → WÄRTSILÄ

1990 → New Sulzer Diesel

1898 → 1st Sulzer Diesel Engine

1834 → SULZER

China State Shipbuilding Corporation

CSSC was established in 1999.
It re-merged with CSIC in October 2019 to form the world's largest shipbuilding group.

310,000 employees globally.

147 companies within the group.

In January 2015, WinGD became a part of the CSSC group.

Shipbuilding capability of 18 million dwt a year

In July 2016, CSSC became sole shareholder of WinGD, the only non-Chinese company within the group.

Full vertical integration including ship design, building and repair yards, research & design institutes, equipment manufacturers and financing.

WinGD Facts & Figures

WinGD Global

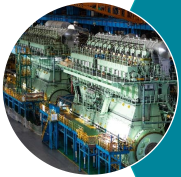
- 6 global offices
- 440 employees worldwide
- 315 employees in Winterthur
- 30 nationalities

Two-Stroke Market Share

- Global market share: 30%
- Dual-fuel market: 30%
- LNG carrier market: 50%

Operations

- 3582 engines in operation
- 287 engines in production
- > 4,600,000 dual-fuel engines running hrs
- > 325,000,000 diesel engines running hrs



Research & Development

- 370’000 man hours on product development and product care (int. and ext.)
- 120’000 man hours on technology development and innovation (int. and ext.)
- 339 patents and patent applications

Our Global Network

Headquarters:
Winterthur, Switzerland

Subsidiaries:
China, Korea, Japan,
Singapore, Dubai

Test facilities:
Switzerland, China, Italy, Japan

Training facilities:
Switzerland, Greece, China, Korea,
Philippines, India, Poland, Singapore

Engine manufacturing:
China, Korea, Japan

WIN GD

The merchant marine business

WIN GD

The merchant marine business

Vessel types involved in international shipping

Passenger and recreational vessels


Cruise vessels


Car ferries


Pass. ferries


Superyachts

Fishing vessels


Large


Medium-size


Small

Cargo vessels and their contribution along the value chain

raw materials, energy carriers → finished, consumer goods


Oil tankers


LNG carriers

Bulk carriers


General cargo vessels


Chemical / product tankers

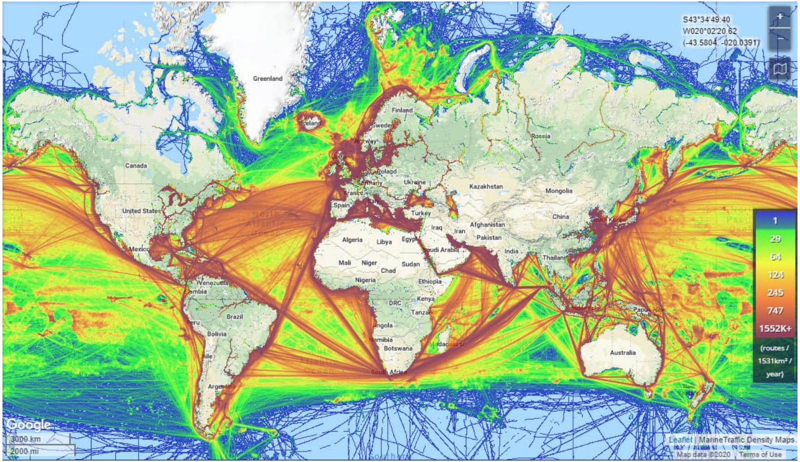

Container vessels


Reefers


Car carriers


The merchant marine business

Global shipping traffic density



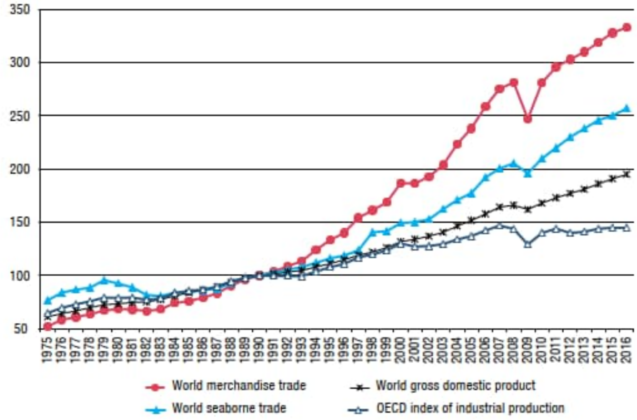
Data for the full year 2017,

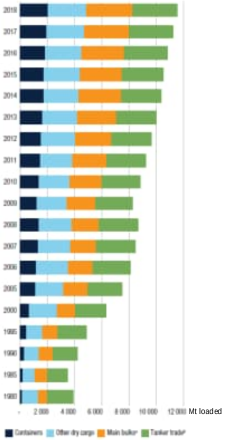
- All marine traffic
- Tracking of vessel positions by satellite based on automatic identification system (AIS) signals

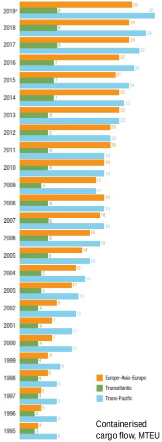
source:
https://www.marinetraffic.com/

The merchant marine business

Correlation of world economy and goods transport indicators





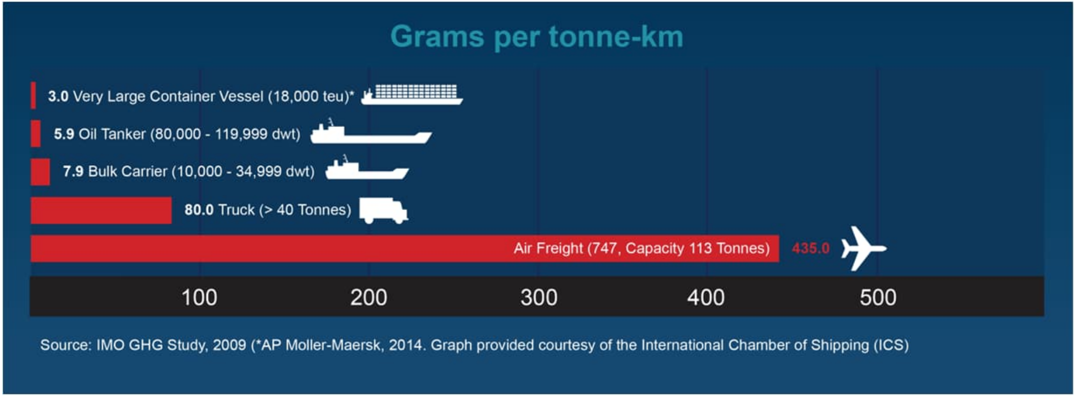


source: UNCTAD: Review of Maritime Transport, 2017 / 2019

The merchant marine business

Efficiency of shipping transport

CO_2 emissions of different transport modes



Source: International Chamber of Shipping, https://www.ics-shipping.org

Regulatory environment

WIN GD

Regulatory environment

Boundary conditions

United Nations bodies and instruments to combat climate change

Paris Agreement by Parties under the United Nations Framework Convention on Climate Change (UNFCCC):

- Hold the increase of global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit it to 1.5°C
- Agreement scope:
  Nationally determined contributions
- Out of scope:
  Contributions from international transport (shipping and aviation)

The International Maritime Organisation (IMO), the United Nations' specialised agency responsible for regulating shipping has initiated actions to contribute towards the reduction of global warming to an extent similar to the Paris agreement:

- First steps were taken in 2011 by implementing an Energy Efficiency Design Index (EEDI) for new-built vessels
- An Initial Greenhouse Gas Reduction Strategy was adopted in 2018
- This strategy was revised and strengthened in 2023

Regulatory environment

IMO’s strategy on reduction of greenhouse gas (GHG) emissions from ships

Revised strategy (2023) – levels of ambition:

1 **carbon intensity** of the ship to decline through further improvement of the energy efficiency **for new ships**
to review with the aim to strengthen the energy efficiency design;

2 **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, compared to 2008;

3 **uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources** to increase:
uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources to represent at least 5%, striving for 10%, of the energy used by international shipping by 2030; and

4 **GHG emissions from international shipping** to reach net zero
to peak GHG emissions from international shipping as soon as possible and to reach net zero GHG emissions by or around, i.e. close to 2050, taking into account different national circumstances, whilst pursuing efforts towards phasing them out as called for in the Vision consistent with the long-term temperature goal set out in Article 2 of the Paris Agreement.

Indicative checkpoints to reach net-zero GHG emissions from international shipping:

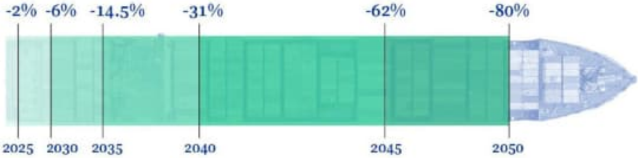
1. to reduce the total annual GHG emissions from international shipping by at least 20%, striving for 30%, by 2030, compared to 2008; and
2. to reduce the total annual GHG emissions from international shipping by at least 70%, striving for 80%, by 2040, compared to 2008.

Regulatory environment

EU / EEA instruments / initiatives

Fuel EU maritime:

- Establishing limits on the annual average GHG intensity of the energy used on board, starting from reference value of 91.16 gCO_2eq/MJ
- Specific provisions for promoting the use of renewable fuels from non-biological origin (RFNBO)

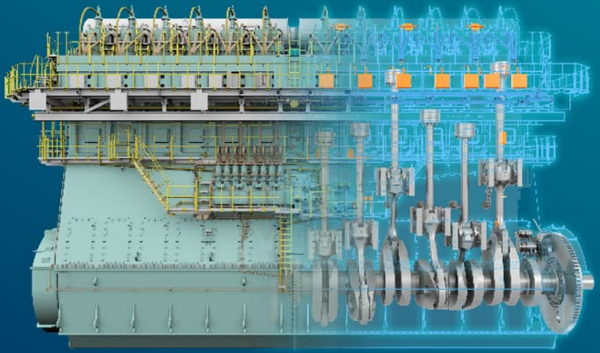


- Zero emissions at berth requirement from 2030 onward for passenger and container ships

Inclusion of emissions in EU emissions trading system (ETS):

- Applicable to all vessels sailing to, from and between European Economic Area (EEA) ports
- EU Allowances – carbon credits – to be purchased and surrendered for 100% of emissions for all voyages between EEA ports, and 50% of voyage emissions between EEA and non-EEA ports
- Tank-to-wake CO_2 equivalent emissions, including methane and nitrous oxide
- Data to be collected and reported from 2024 on, phase-in of inclusion in ETS up to 2026

Development for the application of synthetic fuels



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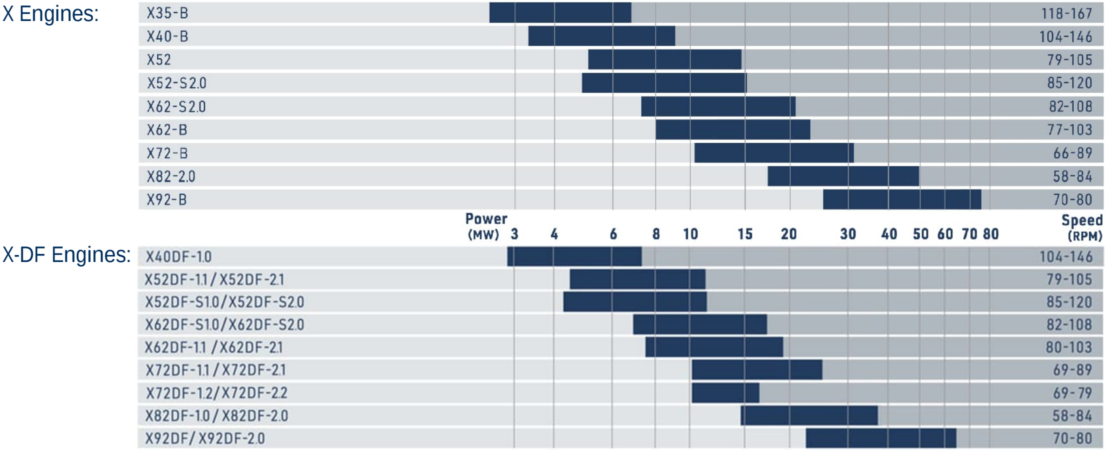
Development for the application of synthetic fuels

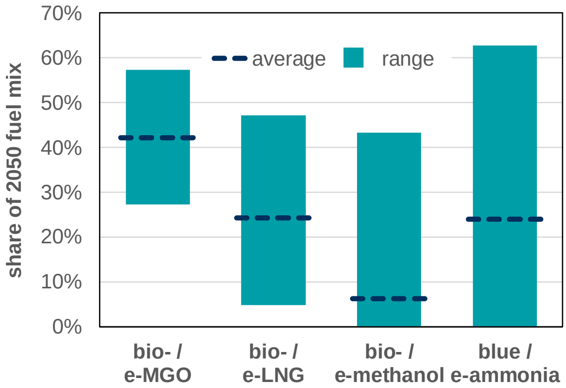
Power and speed range covered by existing WinGD product lines



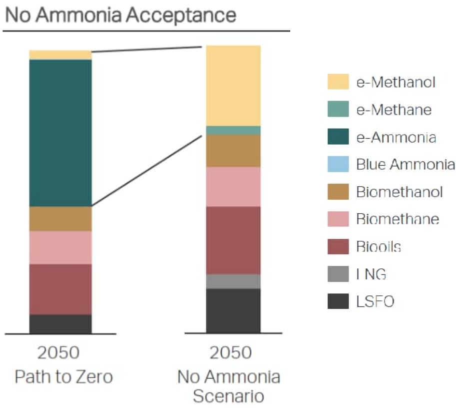
Development for the application of synthetic fuels

Future fuel mix – expected shares of main fuel types in decarbonisation scenarios

Evaluation of DNV Maritime Forecast to 2050 (2022) scenarios



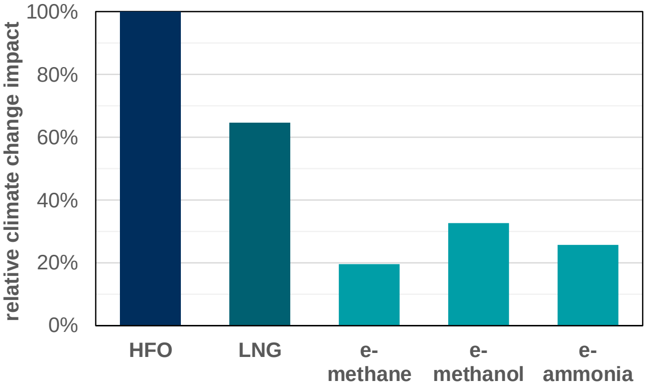
MMMC Path to Zero scenarios (2021)



Development for the application of synthetic fuels

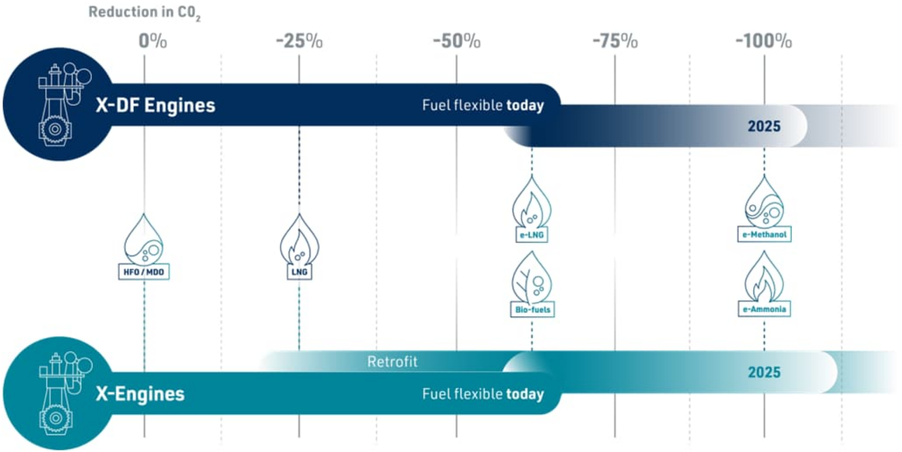
Overall climate change impact of the transition from HFO to alternative fuels

Total lifecycle analysis performed in collaboration with ZHAW (example of a large container vessel)



Development for the application of synthetic fuels

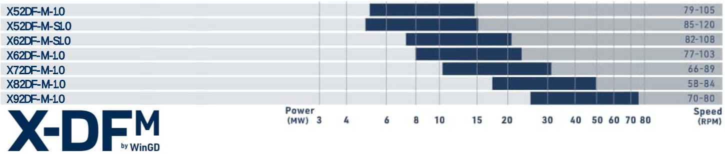
The WinGD decarbonisation roadmap



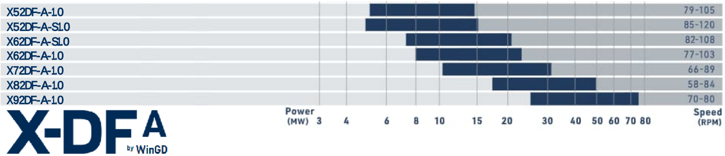
Development for the application of synthetic fuels

Additional product lines added to the WinGD portfolio

Methanol dual-fuel engines



Ammonia dual-fuel engines



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Development for the application of synthetic fuels

Order intake status as per January 2024

Methanol dual-fuel engines:

- 4 x 10X92DF-M engines for a series of 16'000 TEU container vessels (for COSCO Shipping), to be delivered in Q2-3/2025
- 6 x 6X82DF-M engines for a series of 9'000 TEU container vessels (for MAERSK), to be delivered between Q3/2025 and Q3/2026
- Shipyard contracts for four additional series of vessels (including other ship types) signed, extending also the size range down to X62DF-M engines

Ammonia dual-fuel engines:

- 2 x 6X52DF-A engines for a series of two 46'000 m3 LPG/ammonia carriers (for Exmar LPG), to be delivered in Q2/2025
- 2 x 6X72DF-A engines for a series of 210'000 DWT bulk carriers (for CMB.TECH), to be delivered in 2025/26
- Further projects committed, extending the size range to include X62DF-A engines

Development for the application of synthetic fuels

Further development of technology irrespective of fuel type

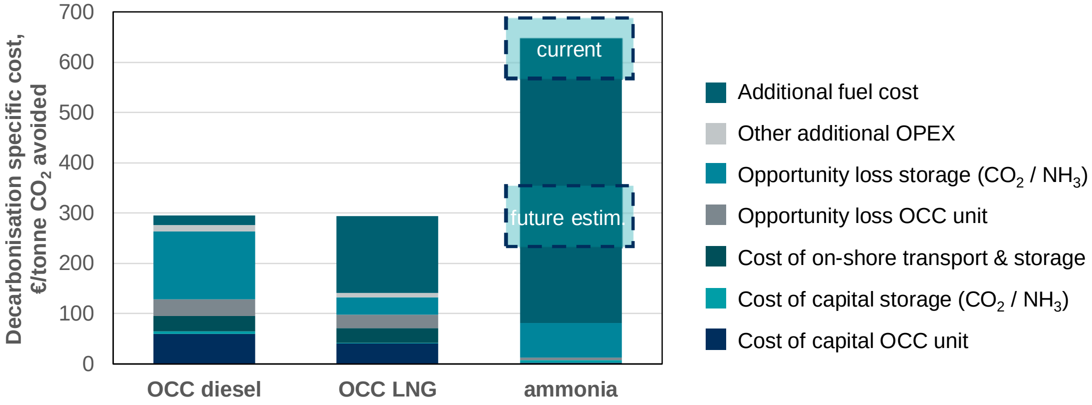
Examples of technology development for existing products and for extending the scope:

- Further development of technology for natural gas fuelled engines:
  - X-DF2.0 – second generation involving exhaust gas recirculation for higher performance and lower emissions
  - X-DF next generation development for realising significant further performance benefits
- Variable compression ratio (VCR) technology allowing performance optimisation throughout the operating range
- Making use of data for overall system optimisation:
  - Application of AI tools for maximising asset utilisation
  - Integration with other data sources as well as overarching management systems for optimising asset efficiency and fleet / freights transport logistics
- Hybrid systems and advanced system integration for improving the utilisation of energy on board

Development for the application of synthetic fuels

On-board carbon capture (OCC) - initial assessment of viability

Role in decarbonisation scenarios: Competing technology or building block of comprehensive solution?



Impact of unprecedented tight schedules on development approach

Development approach in view of tight schedules

Comparison of timelines

Regulatory development at the IMO		Activities at WinGD
	2017	Investigations into fuel flexibility and potential of alcohol fuels (various funded projects)
Initial GHG reduction strategy	2018	
Annual fuel consumption reporting obligation entering into force	2019	Conceptual investigations into future fuels (technology options, production pathways)
Global limit for fuel sulphur content of 0.5%	2020	Decision for investment into future fuels technology and product development
4^{th} GHG study Short-term GHG reduction measures (EEXI, CII)	2021	First ammonia combustion tests at FHNW
Work on mid-term GHG reduction measures	2022	Selection of concept, collaboration agreements with major stakeholders
First collection of CII data Revised GHG reduction strategy	2023	Technology development, infrastructure build-up
	2024	Validation of technologies, realisation of prototypes
		Delivery and installation of prototypes

Development approach in view of tight schedules

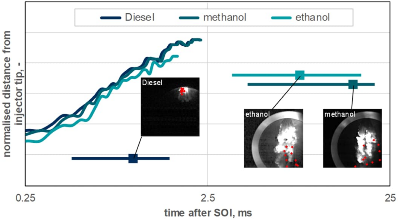
Process moving from concept selection to engine verification – alcohols example

Perspective on methanol/ethanol as future fuels

Methanol / ethanol investigations in the context of Hercules - 2

Selected results (Spray combustion chamber tests):

- Spray propagation and ignition behaviour of methanol and ethanol compared to Diesel

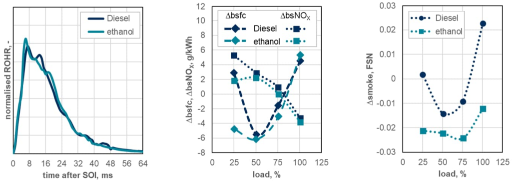


Perspective on methanol/ethanol as future fuels

Methanol / ethanol investigations in the context of Hercules - 2

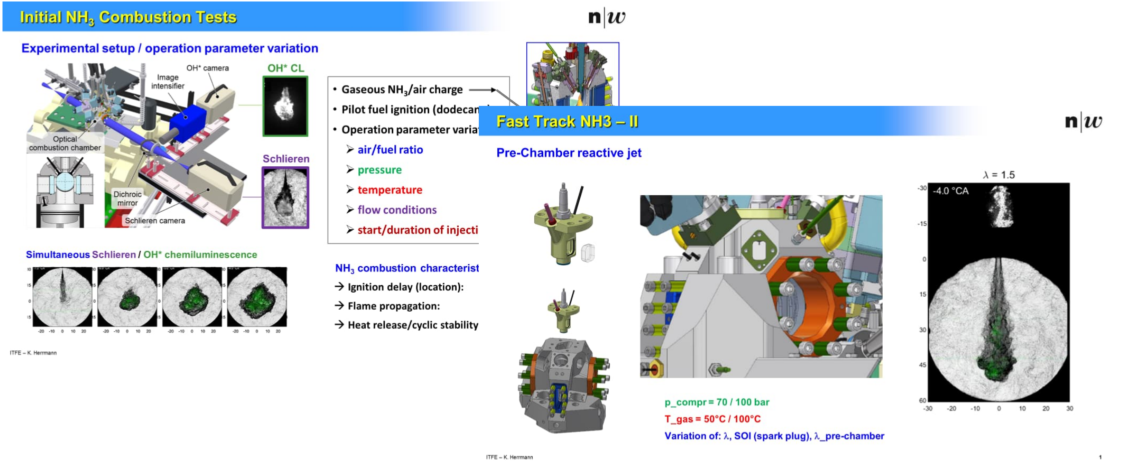
Selected results (RTX-6 lab engine tests):

- Rate of heat release (ROHR) characteristics at full load (left) and bsfc / bsNO$_X$ impact throughout load range (middle) and smoke emissions across the load range (right) when applying ethanol in combination with adapted combustion system features



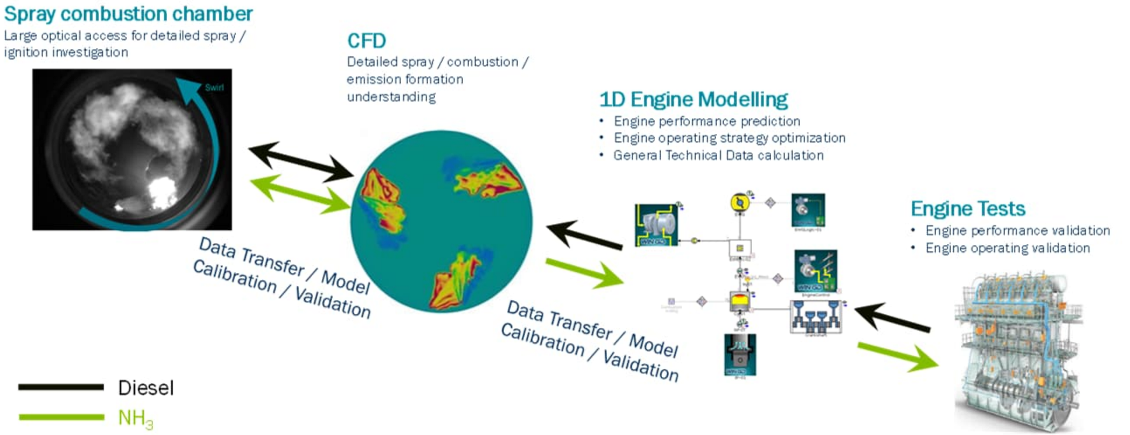
Development approach in view of tight schedules

Establishment of basic understanding of ammonia combustion – confidence building



Development approach in view of tight schedules

Process moving from concept selection to engine verification – ammonia application



Development approach in view of tight schedules

Extension of testing infrastructure – lab engines

Lab engines:

RTX-5 (existing):
WIT, IT (partner)
6 cyl, 50 cm bore
Gas LP-DF

RTX-6 (existing):
ERIC CH
4 cyl, 50 cm bore
Diesel, methanol

RTX-8 / RTX-7 (new):
GTC Shanghai CN
4 cyl, 52 cm bore
Methanol, ammonia / Gas LP-DF

SCE (brand new):
ERIC CH
1 cyl, 50 cm bore
All fuels / concepts

6X72DF (existing):
MES DU, JP (partner)
6 cyl, 72 cm bore
Gas LP-DF

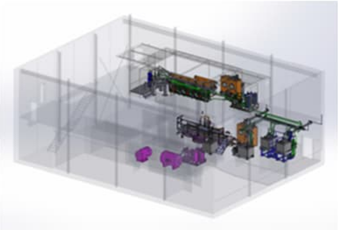
Development approach in view of tight schedules

Extension of testing infrastructure – lab engines, cont. / component /system testbeds

Lab engines:

SCE92 (in build-up):
CMD, CN (partner)
1 cyl, 92 cm bore
All (methanol)

Component / sytem testbeds:



Future Fuel Lab (in build-up):
ERIC, CH
Injection key components / system validation facility for methanol, ammonia
Complementary testbeds in planning for GTC Shanghai, CN

Relevance for Switzerland

Relevance for Switzerland

Maritime Strategy

For the first time in history, a maritime strategy for Switzerland was adopted (approval by Federal Council on June 2, 2023, see corresponding press release for further information)

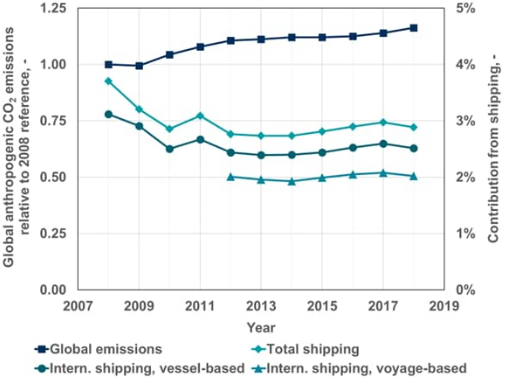
structured around five thematic focus areas, for which measures and targets are set:

- International law
- Maritime economy
- Environmental concerns for marine life and society
- Maritime science and research
- Swiss-flagged vessels

The maritime strategy for the years 2023–27 is based on the objectives set out in Switzerland's foreign policy strategy and shall contribute to greater coherence of foreign policy in maritime issues

Relevance for Switzerland

Potential impact



source: own analysis of data from IMO's Third (2014) and Fourth (2020) GHG Studies

Total shipping accounting for ca 3% of global anthropogenic CO_2 emissions

International shipping covering the largest part, between 2 and 2.5%

Share of non-propulsion contributions to inter-national shipping emissions in single digit range

WinGD positioned as strong No. 2 in three-player market of two-stroke propulsion engine designers

➡ An impact out of Switzerland in the range of 1% is fully realistic considering WinGD alone

This potential is almost an order of magnitude higher than the effect of a hypothetical complete decarbonisation of Switzerland

Total impact even higher in view of large number of successful Swiss maritime equipment companies

Relevance for Switzerland

Swiss maritime community

The very active group of Swiss maritime equipment companies and associated academic institutions

SWISSMEM

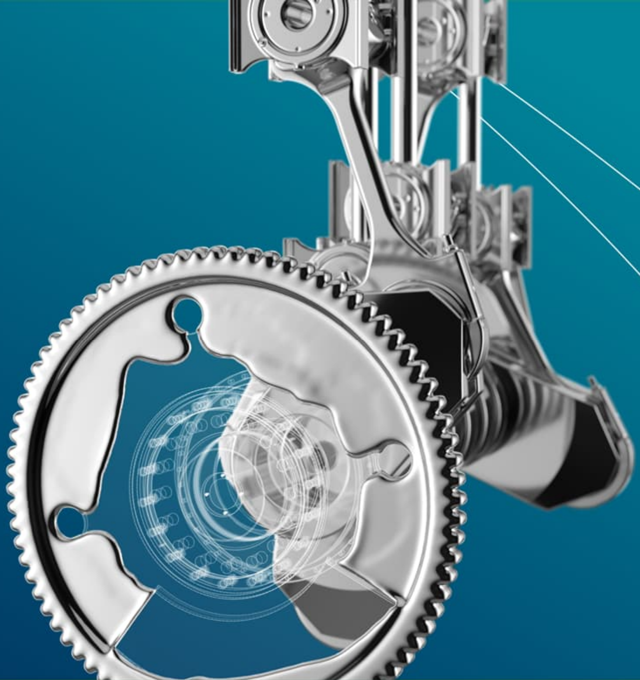
Fachgruppe Verbrennungsmotoren

CIMAC

INTERNATIONAL COUNCIL ON COMBUSTION ENGINES

managed to bring the most important conference in the industry to Switzerland (May 19-23, 2025)

Summary



Summary

International shipping is the backbone of world economy and its relevance has increased further with progressing globalisation

The development of the regulatory framework towards decarbonisation has gained considerable speed with the introduction of the Revised greenhouse gas strategy by the International Maritime Organization (IMO), with regional action by the EU acting as additional promotion

This is a clear confirmation of the decisions taken earlier by companies such as WinGD to invest into decarbonisation technology development

Considerable efforts and resources are invested in the establishment of solutions and new products capable of dealing with future renewable / synthetic fuels such as ammonia and methanol – without neglecting the further development of technologies applicable to the existing product portfolio

Alternative decarbonisation pathways such as on-board carbon capture are explored in parallel

The role that Switzerland can play in contributing to the decarbonisation of international shipping must not be underrated

Thank you!

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WIN GD