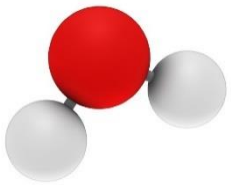
Plenary Session

Panel II : The future in marine engines



HERCULES–2

FUEL FLEXIBLE, NEAR-ZERO EMISSIONS, ADAPTIVE PERFORMANCE MARINE ENGINE

GA 634135

Panel II Members

Panel II: The future in marine engines	
Name	**Organization**
Gunnar Stiesch	MAN ES AUG
Niels Kjemtrup	MAN ES CPH
Mikael Wideskog	WFI
Konrad Räss	WinGD
Nikolaos Kyrtatos (Moderator)	NTUA

MAN Energy Solutions
Future in the making

The Future in Marine Engines

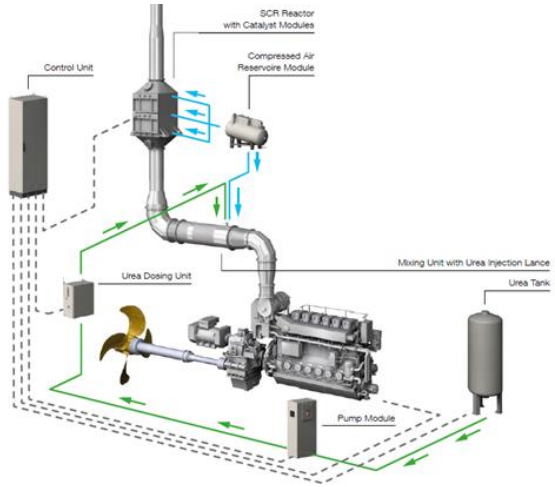
HERCULES-2 Final meeting & Forum: Panel II

Dr. Gunnar Stiesch
Senior Vice President - Engineering Engines
10.10.2018

Major Achievements (since ~2005)

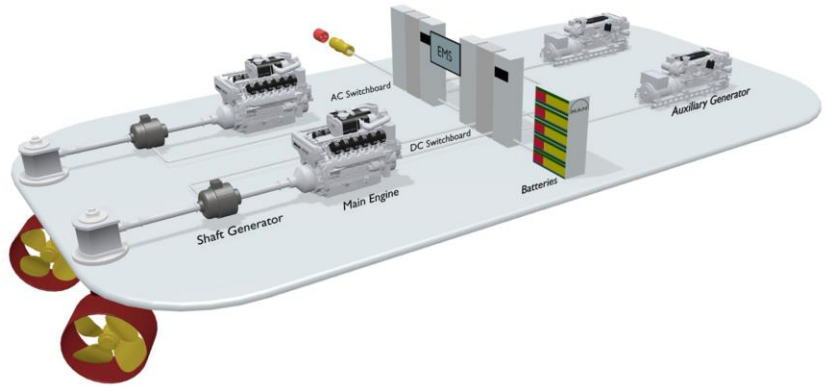
Medium Speed Marine Engines

- **Efficiency Increase** (~3%-pts.) / sfoc Reduction (~10…12 g/kWh)
  - Firing pressure 250+ bar
  - 2-stage turbocharging, Miller, variable valve train
  - High pressure, flexible fuel injection
  - Tribology and friction
- **Emission Reduction**
  - NOx-reduction -80% (SCR)
  - Sulfur (fuels, scrubber)
  - Smoke (injection, combustion, var. valve train)
- **Fuel Flexibility**
  - LNG with DF-technology
  - Tier III compliance in gas mode
  - Highest efficiency

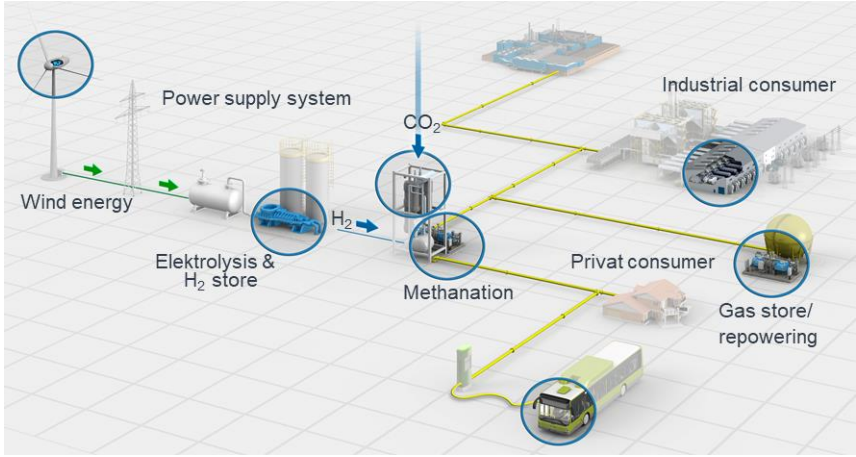


Expected Future Trends (2020 - 2030)

Medium Speed Marine Engines



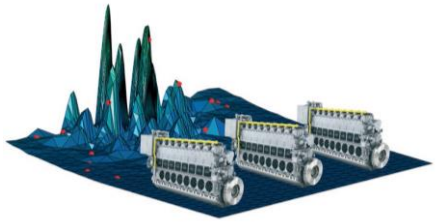
- **Additional Efficiency Improvements**
  - Further improvements and penetration of new technologies into fleet
- **Continued Emission Reduction**
  - NOx, SOx, Black Carbon, CH4
- **System Optimization incl. Hybrids**
  - Plant layout and operational optimization
  - Battery hybrids
- **Decarbonization**
  - Carbon reduced and carbon neutral fuels (PtX)
- **Digitization & Autonomous Operation**
  - Operational optimization
  - Maintenance and availability
  - Remote controlled or autonomous operation?



System Optimization incl. Hybrids

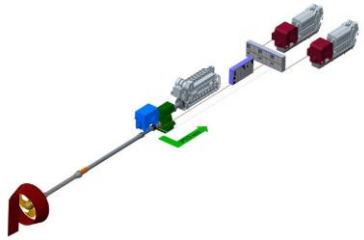
Reduced Fuel Consumption & Emissions & OPEX

EcoLoad



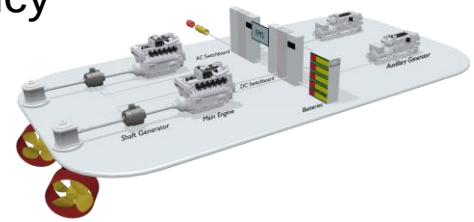
- Multiple engine plants
- Keep individual engines at optimum load
- Include route planning and component demands, e.g. SCR regeneration

HyProp Eco



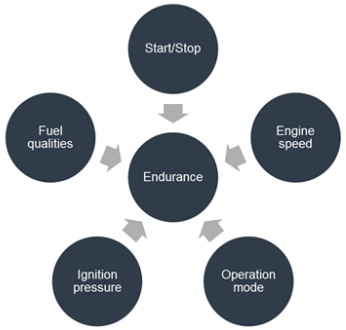
- Highest propulsion efficiency
- Variable engine & propeller speed

Battery Hybrids



- Peak shaving and max. efficiency
- Spinning reserve
- Reduced running hours
- Zero emission harbor operation

Condition Based Maintenance



- Online monitoring of engines
- Extent maintenance intervals
- Further enhance availability
- Efficiency optimization

Decarbonization

Decarbonized Fuels

From low-carbon fuels to carbon-neutral fuels:

- Methane CH_4 (CNG, LNG) ✅
- Methanol CH_3-OH, LPG
- Hydrogen H_2 ??
- Ammonia NH_3 ??
- Renewable synthetic fuels – Power-to-X
  - Synthetic Natural Gas (SNG) ✅
  - Synthetic Methanol ✅

=> Regulations necessary to credit renewable fuels

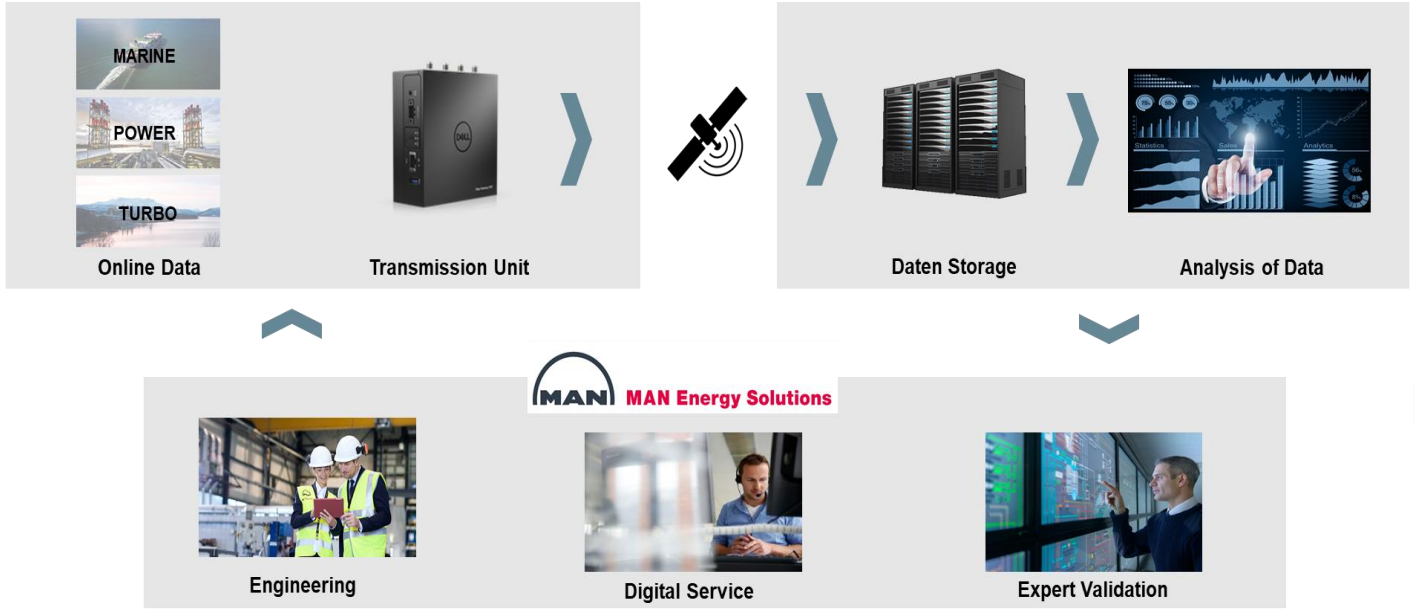
MES methanation reactor for the Power-to-Methane plant in Werlte (world's largest methanation plant)

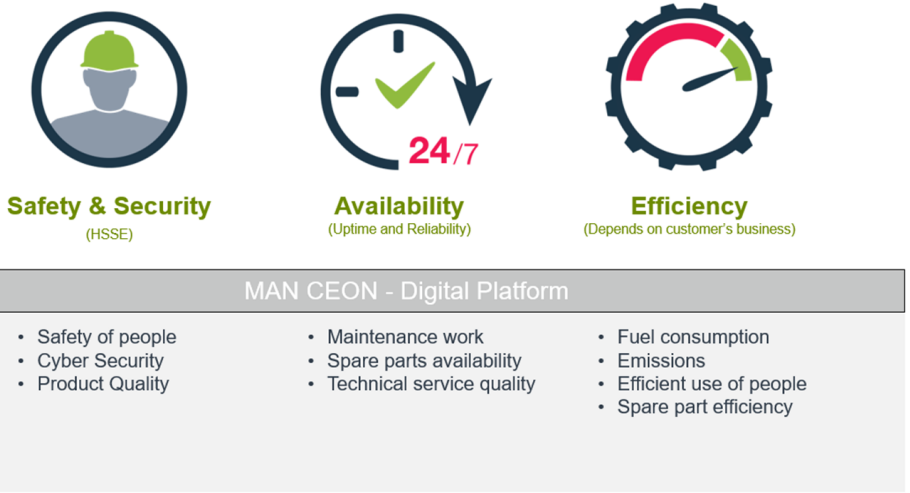
ALTERNATIVE LOW-CARBON-FUELS (PtX)

Basic technology available – Utilization of existing infrastructure

Digitalization & Autonomous

From Engine Data to Customer Service

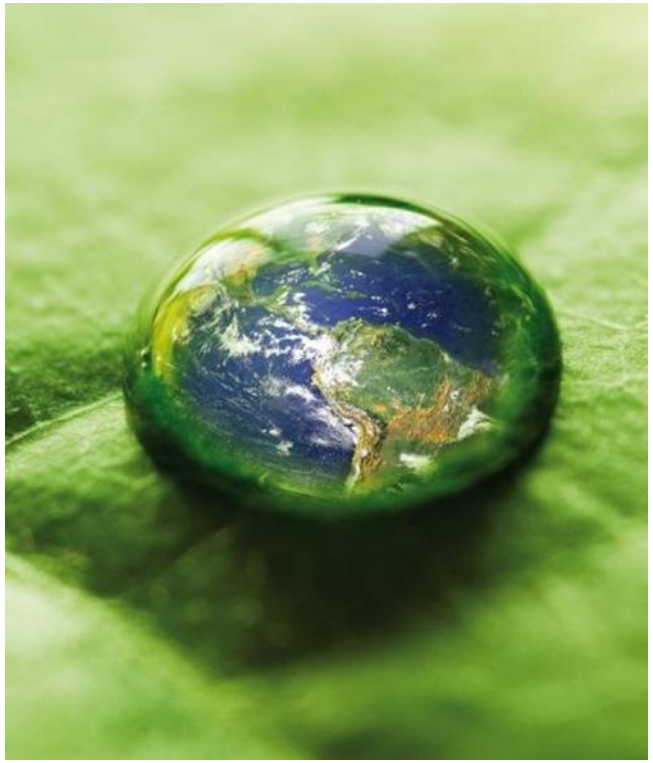




Summary

Future in Marine Medium Speed Engines

- Significant improvements in efficiency and emissions achieved since ~2005
- Fleet penetration as well as
  further optimization of efficiency and emission reduction
- System integration and optimization incl. hybrids
- Decarbonization with low carbon and carbon-neutral fuels
- Digitization



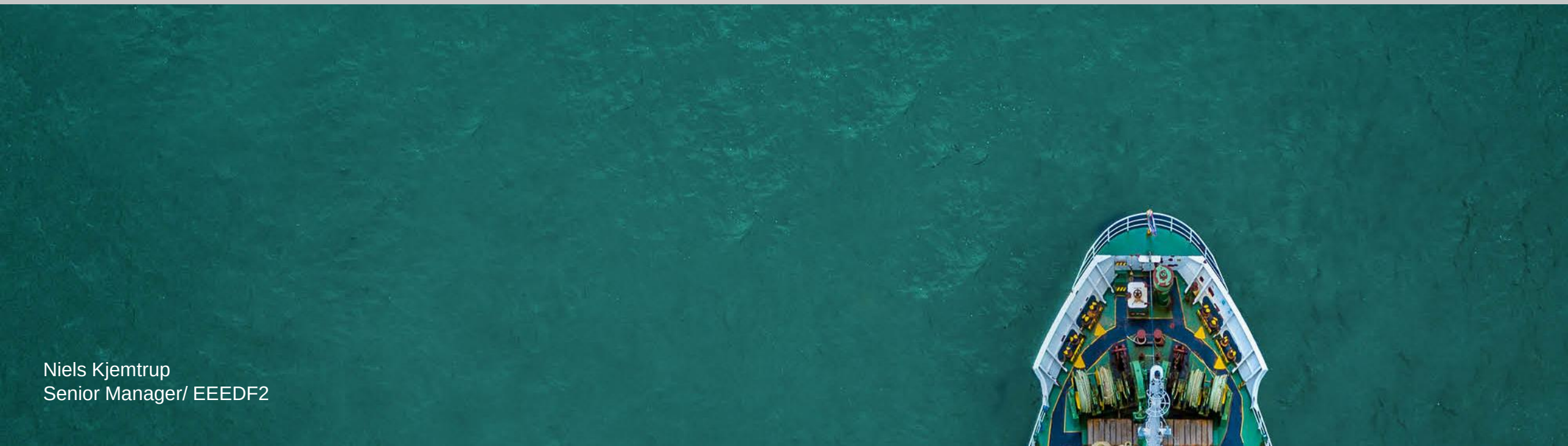
(Engine) optimization becomes more holistic – The innovation speed will not slow down!

MAN Energy Solutions
Future in the making

Marine engines in the future

MAN ES 2-stroke engines

HERCULES-2 Final meeting & Forum: Panel II

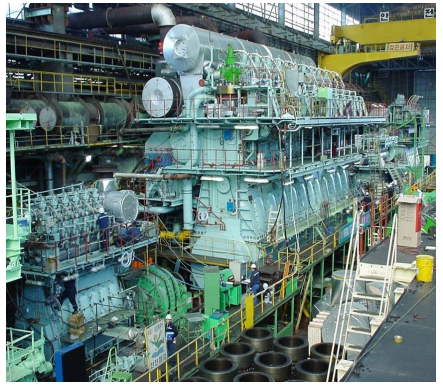


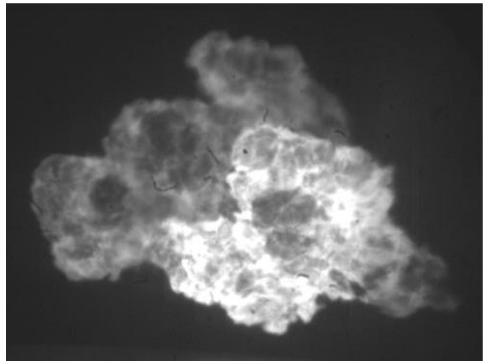
Niels Kjemtrup
Senior Manager/ EEEDF2

Main Achievements in Hercules timeframe

- **Knowhow**
  - Increased knowledge on combustion, friction---
- **Overall Propulsion efficiency improved significantly via**
  - Improved engine efficiency
  - Improved propulsion efficiency (Super Long Stroke engines)
  - Full implementation of Electronic controlled engines
  - Derating and Part/Low load optimization
  - Utilization of Tier III equipment for Tier II SFOC reduction (ECO-EGR/ECO-SCR)
- **Emission Reduction**
  - Tier III compliance via EGR/SCR and …
  - Sulfur (MDO,MGO,ULSF,LNG,LPG,MeOH,LEG,scrubber)
- **Fuel Flexibility with same high fuel efficiency**
  - Standard engines for HFO/MDO/MGO
  - Slightly modified standard engines for Bio Fuels
  - GI-engines for gaseous Gas engines Methane/Ethane
  - LGI-engines for liquid Gas engines Methanol/Propane

Super long stroke engines

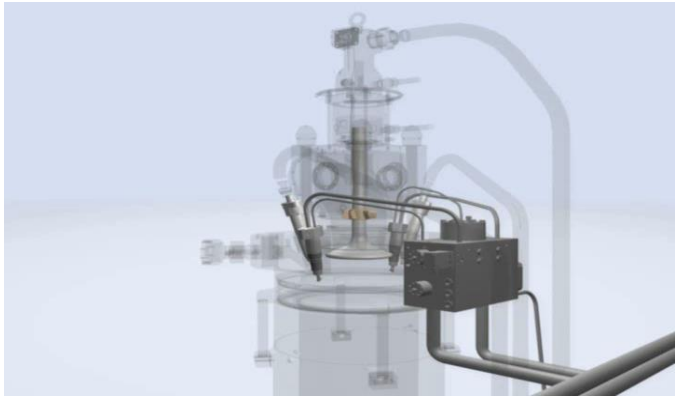




High Speed imaging

EGR Unit

GI/LGI Dual Fuel



Why continue with “diesel” engines ?

Low Speed Marine Engines

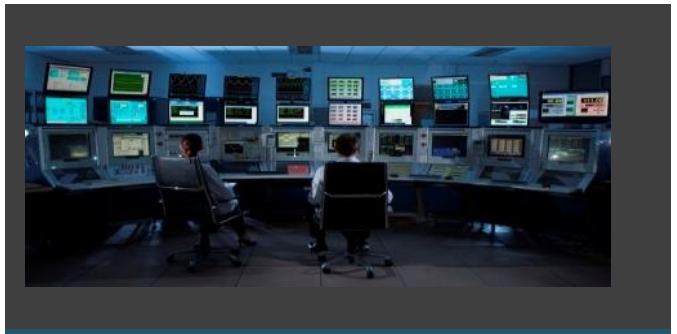
- **High efficiency (low CO2/GHG footprint)**
  - Continued development of the engine
  - Combined Cycle/WHR development
  - PTO/PTI/battery integration
- **The “clean” Diesel engine**
  - No ------ NOx, SOx, Black Carbon, CH4, internal process development/aftertrestment
- **Fuel Flexibility Including carbon neutral fuels**
  - Development for fossil clean fuels “breaking the ice” for same fuels in bio version
  - MeOH, Ammonia ?, H2 ?
- **Digitization**
  - Operational optimization
  - On line software updating
  - Development via significant increase dataflow
  - Maintenance/overhaul based on digital dataflow

Digital

Implementation of a maritime industry infrastructure for data sharing

machine and process data

+



24/7 human intelligence

to optimize

Energy Efficiency
Emission reduction

Operation and maintain

Support Product Design

New Services

The Future

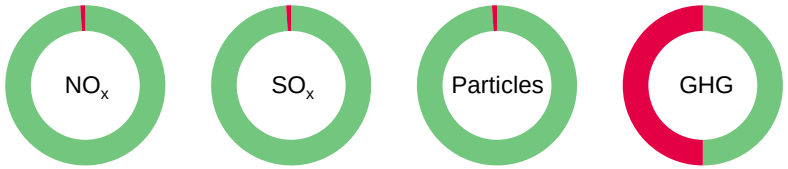
Low Speed Marine Engines

The engine

- **Full fuel flexibility**
- **No unplanned maintenance**
- **Seamless integration** with onboard and onshore systems

The Climate

- **Engine-integrated** emission reduction technologies



Digital operation

- **Virtual** assistance
- **Recognizes reacts and guide** operator on problem handling
- Data analyzed **across the fleet** to optimize operation

Why “diesel” engines ?

Marine low Speed Engines

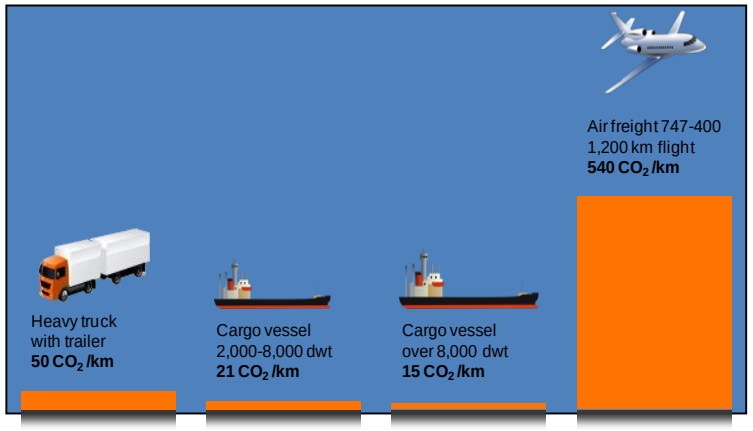
- Efficient, simple, reliable, reliable, reliable and “cheap”
- Even more fuel flexible in the future, the multi-fuel engine
- Clean in combination with clean fuels and integrated after treatment systems
- Ready for carbon free fuels
- Digitization and electronic control secure optimal operation under all conditions

The future in marine engines

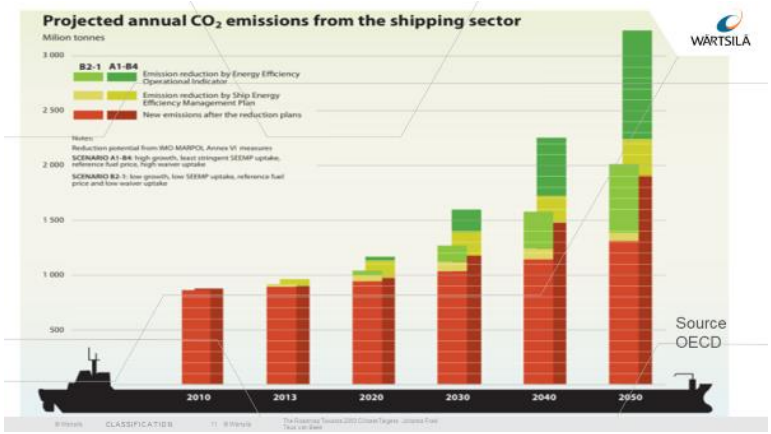
- Future fuels
- Smart marine ecosystem
  - What are the future fuels?
  - How do we utilize as little as we can of them?

The Internal Combustion Engine is an important building block on the journey towards a sustainable society

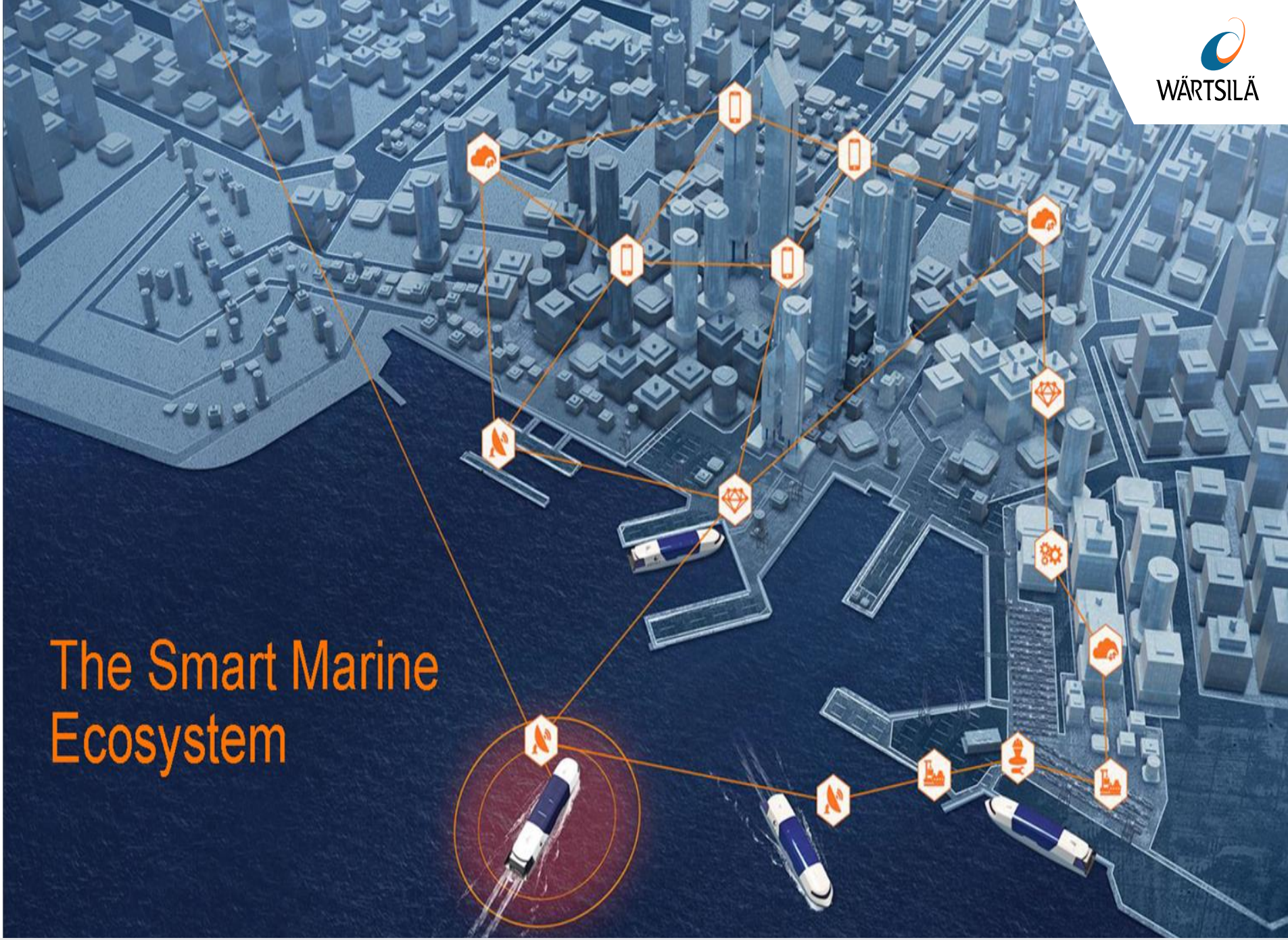
Shipping is today the most efficient means to transport people or goods



If we do nothing: A recent estimate forecasts that CO_2 emissions from ships will increase by up to 250% in the next 35 years, and could represent 14% of total global emissions by 2050




Products
Solutions
Ship
Ecosystem


The Smart Marine
Ecosystem

THE VOYAGE OF THE FUTURE REQUIRES AN INDUSTRY TRANSFORMATION

* Wärtsilä case study from one major port identified the range of 100-200 million euros per year of

Towards zero emission for newbuilds

Legislation - need to reduce/stop emissions

Maximise use of new technology: energy storage, connectivity, modular, clean fuels

Invest in clean solutions Carbon Pricing will make it pay off.

Hercules II, the future in marine engines

Konrad Räss, Director R&D

WIN GD
Simply a better different

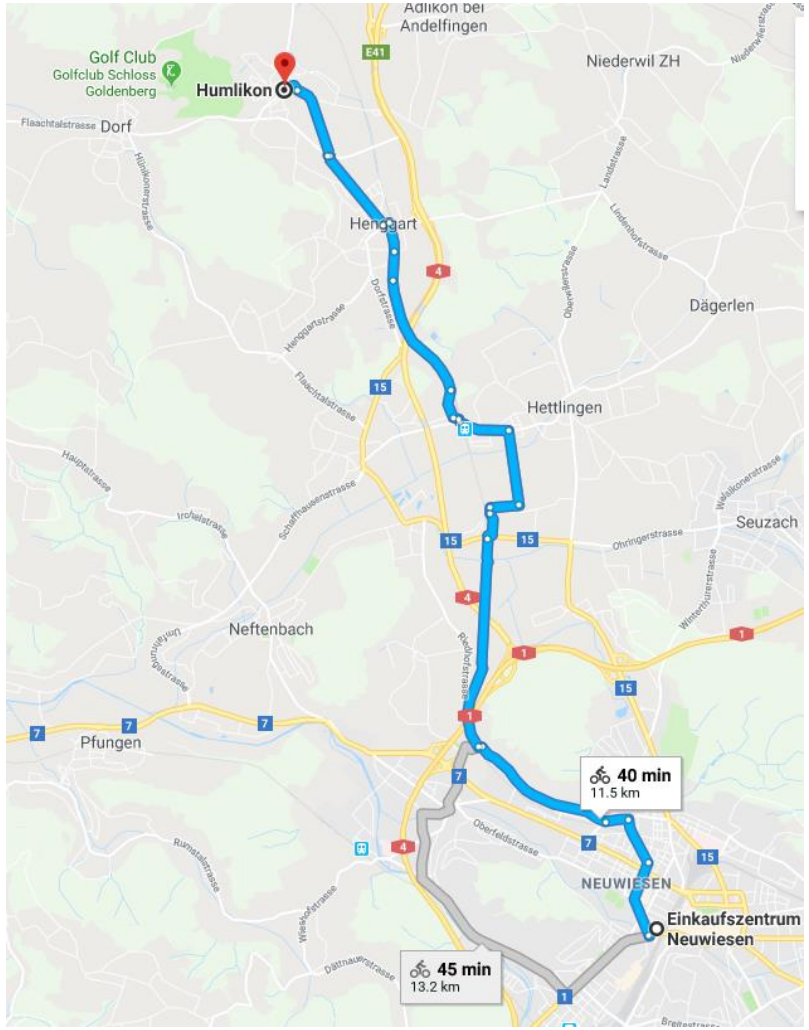
The Future in Marine Engines

Does the large piston engine have a long term future in marine propulsion?

Av. Speed 35km/h =
19 kn
11 Ah/400 Wh Battery

The Future in Marine Engines

Does the large piston engine have a long term future in marine propulsion?



One trip approx. 12km

The Future in Marine Engines

Does the large piston engine have a long term future in marine propulsion?

Approx. 24km / day
Battery charge every 29km, on max. support

Battery full charge approx. 3h

The Future in Marine Engines

Does the large piston engine have a long term future in marine propulsion?

Engine with approx.
75’000kW max. output

The Future in Marine Engines

Does the large piston engine have a long term future in marine propulsion?

Example Hamburg Shanghai
Realistic alternatives to IC engines for a vessel as shown before?

How much battery capacity needed?

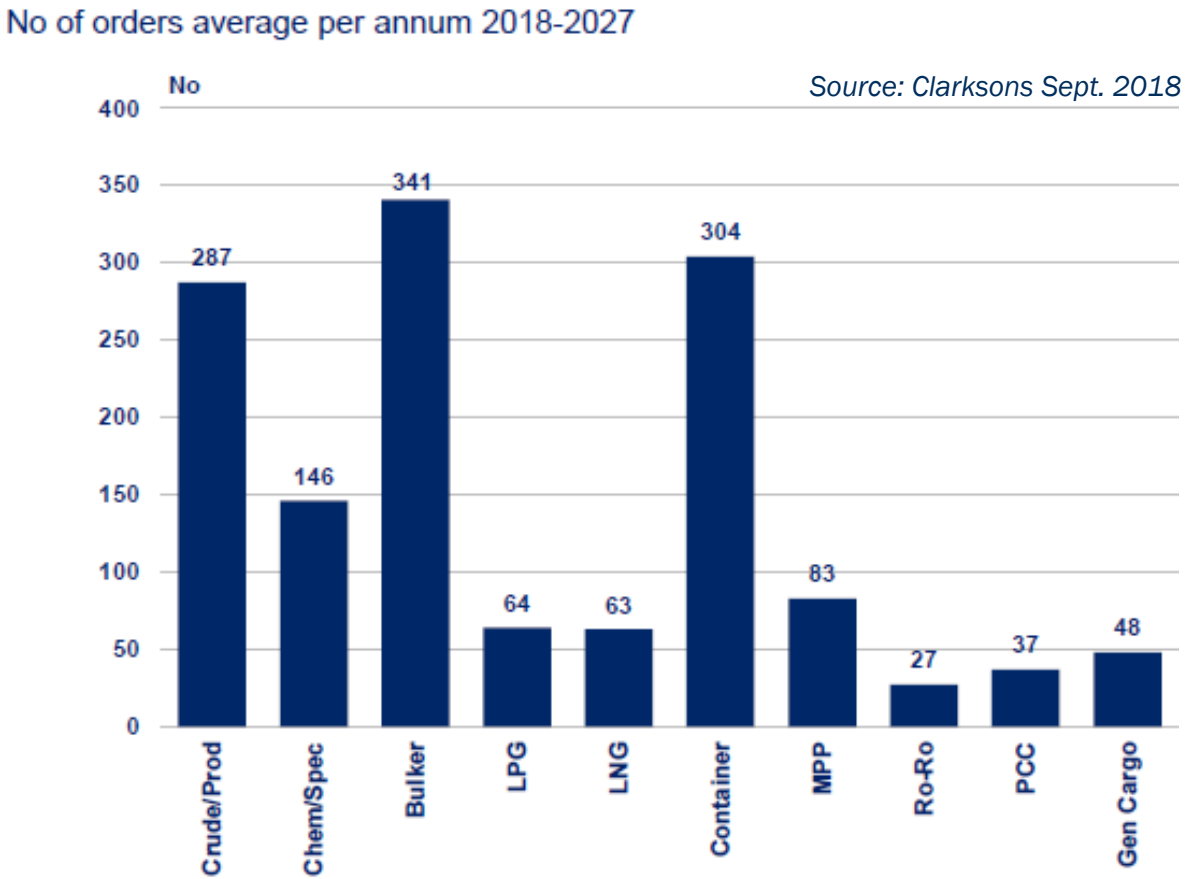
Other sources of electricity?

Oher propulsion methods?

Predicted average annual orders next 10 years

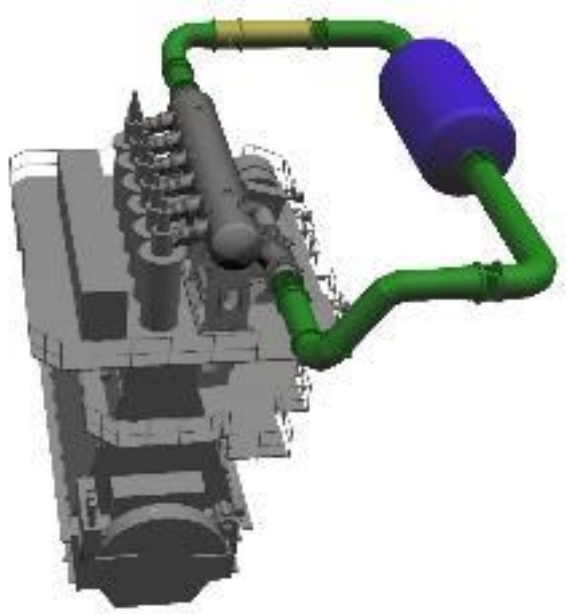
Overall only average numbers

- Tankers incl. Chem/Spec remains the biggest segment by numbers
- Bulk Carrier ordering will not explode like in 2007/8
- LNG is becoming a major segment
- Container stronger on smaller size end then bigger size
- Gen Cargo remains weak even though it is the oldest fleet overall



The Future in Marine Engines

Does the large piston engine have a long term future in marine propulsion?



Yes, but….or DF

The Future in Marine Engines

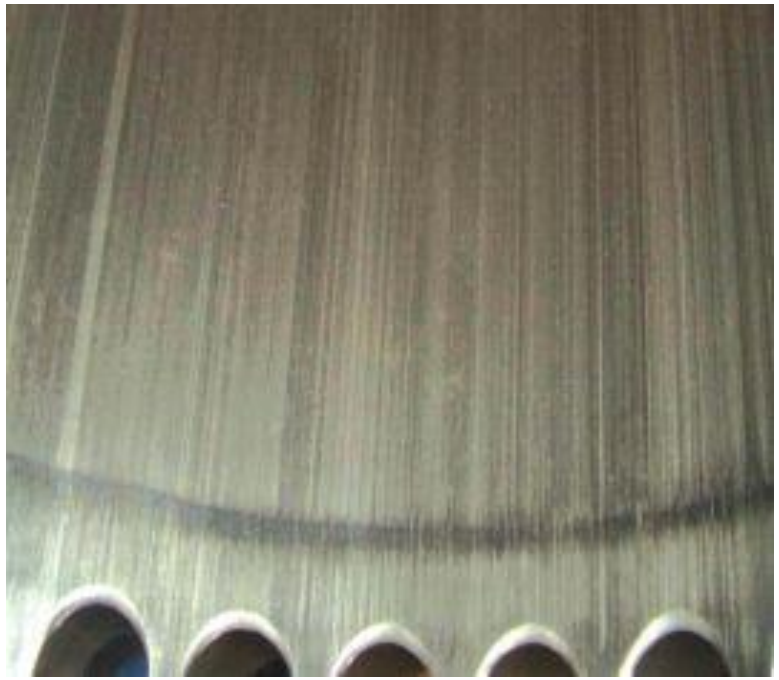
Some statements to the Panel II questions

- Electric drive alone can make sense for short distances, for example electro Tug boats
- PTI/PTO seen as pragmatic hybrid solution for 2-stroke application
- Energy from peripheral power
- The 2-stroke engine is an omnivore that can “digest“ many kinds of fuels, possibly also the ones in the future
- Fuels that can use the todays logistic chain will have a good chance to be used in future
- Future legislation will have a strong impact on the “future” fuel
- Our customers will use the cheapest fuels that fulfil legislation standards
- Crew education must follow the fast increasing technology
- Intelligent components and other measures for improved condition based maintenance are needed, for cost optimization and to maintain emission standards

The Future in Marine Engines

Some statements to the Panel II questions

- Self-Healing Engines…



Picture, damaged cylinder liner, source Google

- Probably still a dream…

The Future in Marine Engines

WinGD thanks

- EU, Horizon 2020
- Prof. Kyrtatos & Team
- BFE Switzerland, Mr. Renz
- Our host MAN
- Partners & Sponsors
- All involved participants