GreenPilot

Engine Conversion

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Co-financed by

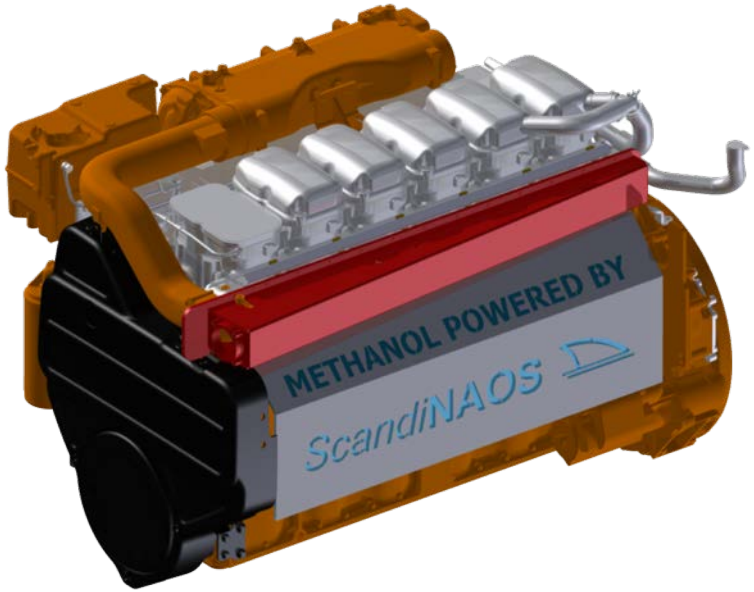
SWEDISH MARITIME ADMINISTRATION

TRAFIKVERKET
SWEDISH TRANSPORT ADMINISTRATION

METHANOL INSTITUTE

AGENDA

- Challenges
- What impacts the emissions?
- Methanol as a fuel
- Project engines
- Engine performance
- Methanol vs diesel engines



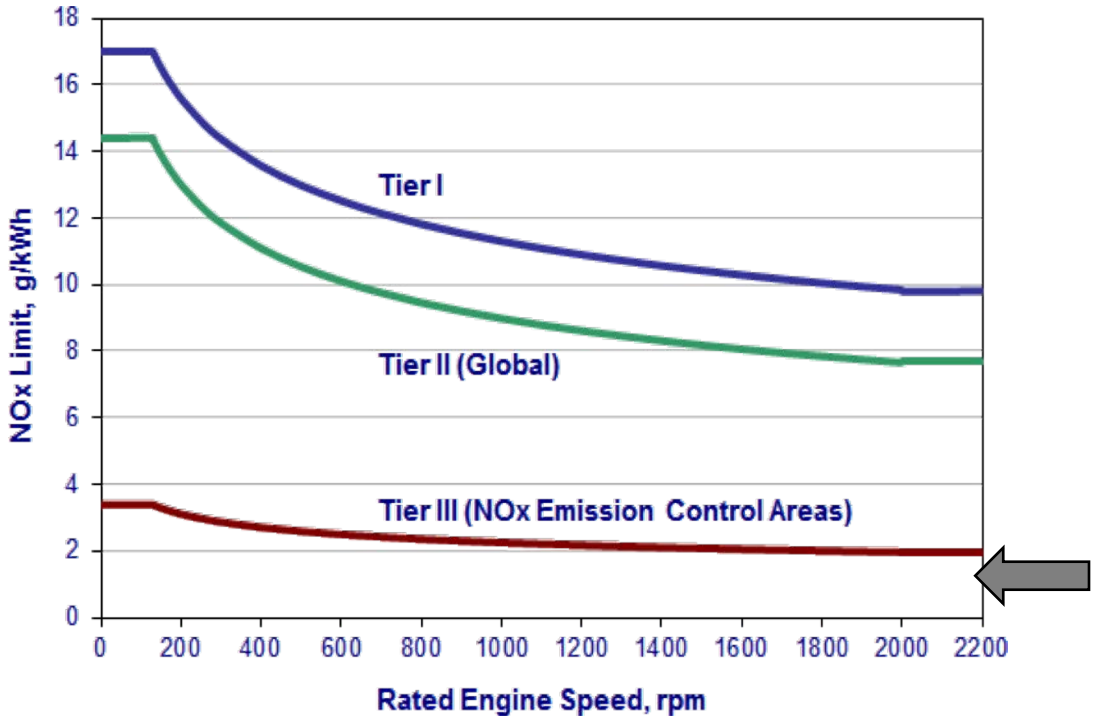
CHALLENGES

EU Inland waterways

EU 2020	g/kWh
NOx	1,8
PM	0,015
HC	0,19
CO	3,5

CO_2 Reduction

IMO Tier (NOx)



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WHAT IMPACTS THE EMISSIONS?

Combustion of fuel

- SOx – dependant on sulphur content in fuel
- NOx – dependant on combustion process (combustion temperature and time)
- CO2 emissions during combustion, dependant on the chemical composition of fuel
- Methane slip during combustion

Production and distribution of fuel

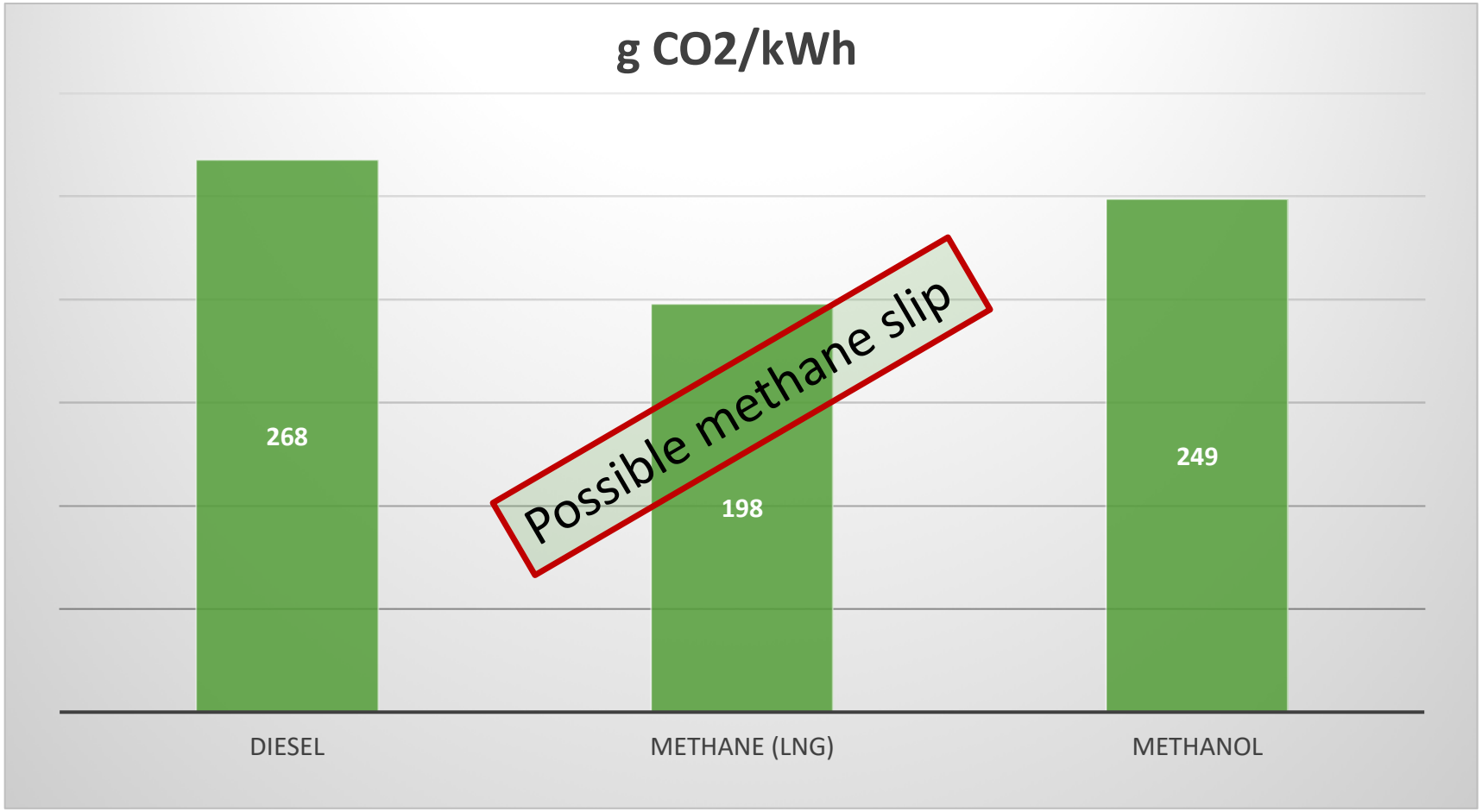
- CO2 footprint due to feed stock
- Energy used for growing, harvesting, production and distribution

SULPHUR CONTENT IN FUEL

Regulation	Sulphur content %	Sulphur content ppm
International shipping	max3,5% sulphur	35000 ppm
From 2020 (2025) International shipping	max0,5% sulphur	5000 ppm
SECA area	max0,1% sulphur	1000 ppm
Heavy duty truck (Euro V and Euro VI)		10ppm

Fuel		Sulphur content ppm
Methanol		max 0.5 ppm

GHG EMISSIONS



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METHANOL AS A FUEL

Emissions

- No sulphur content → will not form any SOx
- No methane slip
- No PM
- Reduced NOx formation

→ Engine can be optimised for a high efficient combustion

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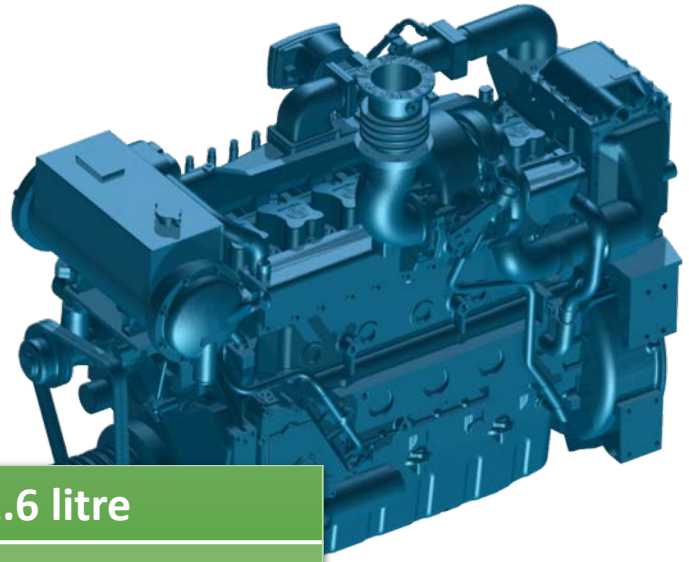
PROJECT ENGINES

Scania DI13
Converted by ScandiNAOS

Weichai
Converted by ScandiNAOS (FiTech ECU)



12.7 litre	11.6 litre
400 kW	313 kW
2000 Nm	1530 Nm
ε=12.3	ε=11.6
100% methanol	100% methanol

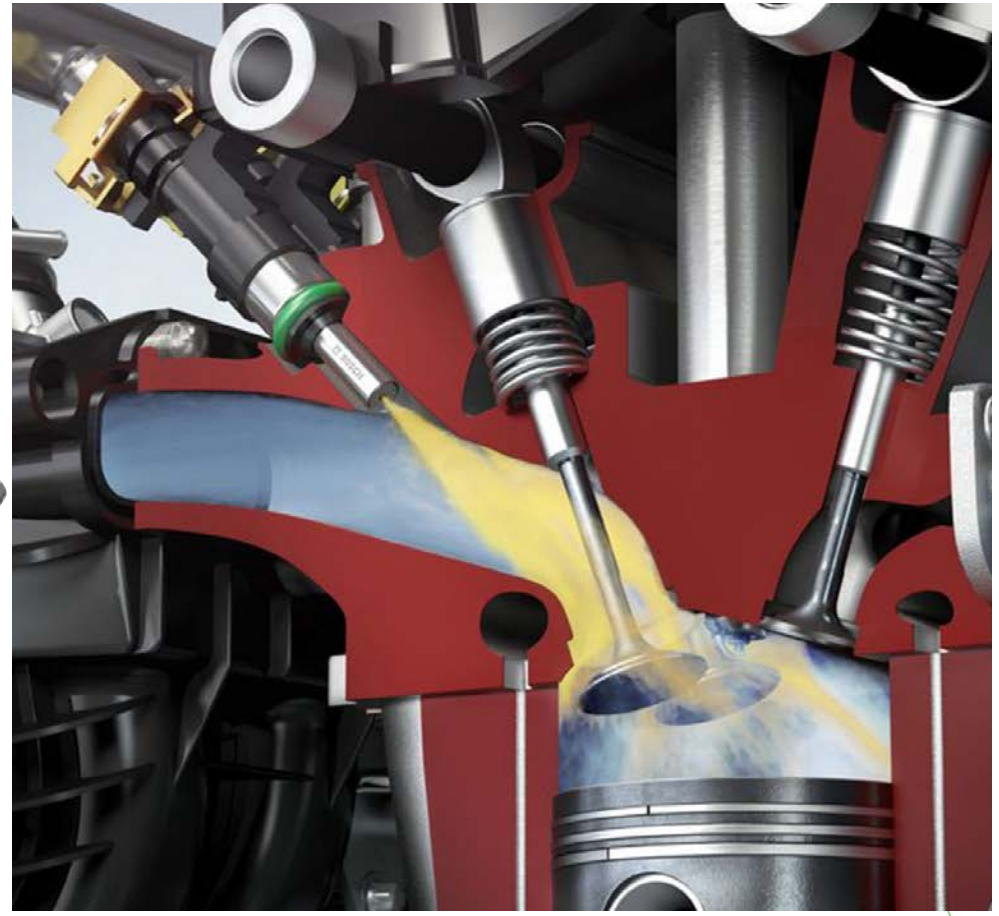
ENGINES

Otto cycle

- Spark ignited
- Port fuel injected (low pressure)

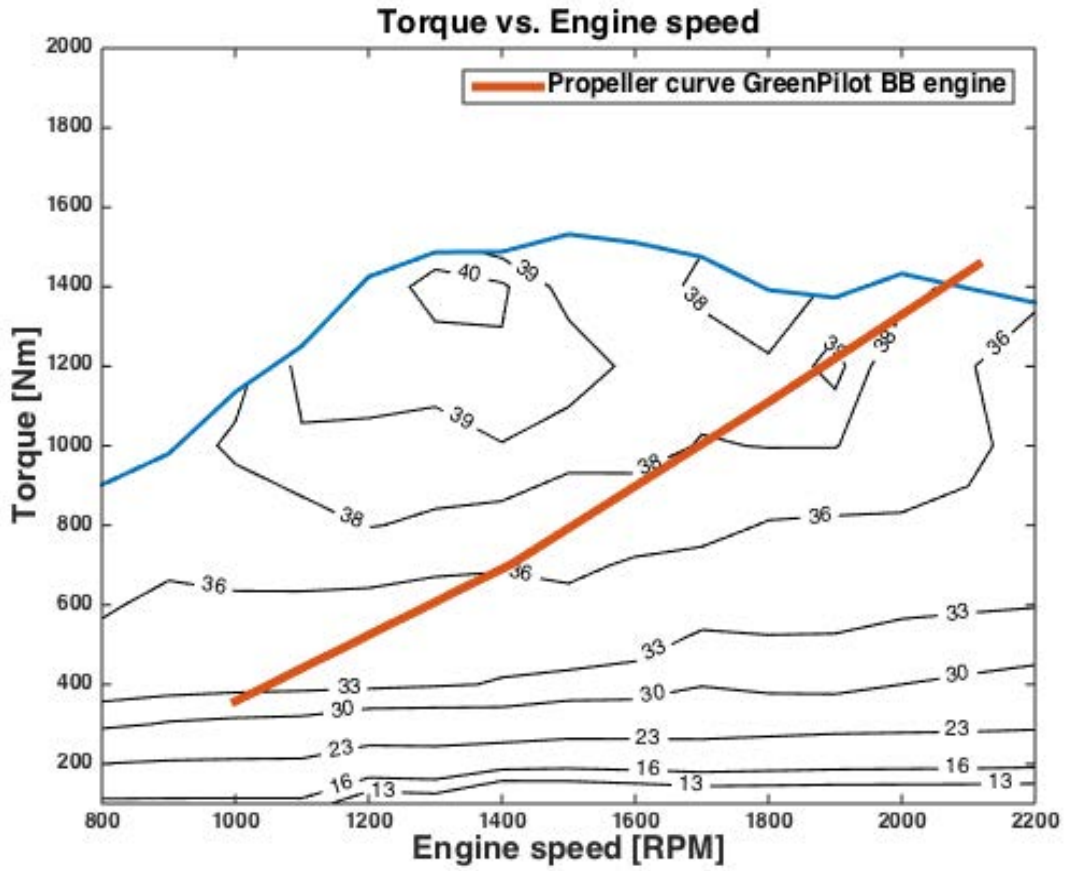
Conversion

- Fuel system
- Spark plugs
- Inlet manifold with fuel injectors
- Smaller turbo charger
- Pistons
- ECU (Engine control unit)



WEICHAI ENGINE MAP

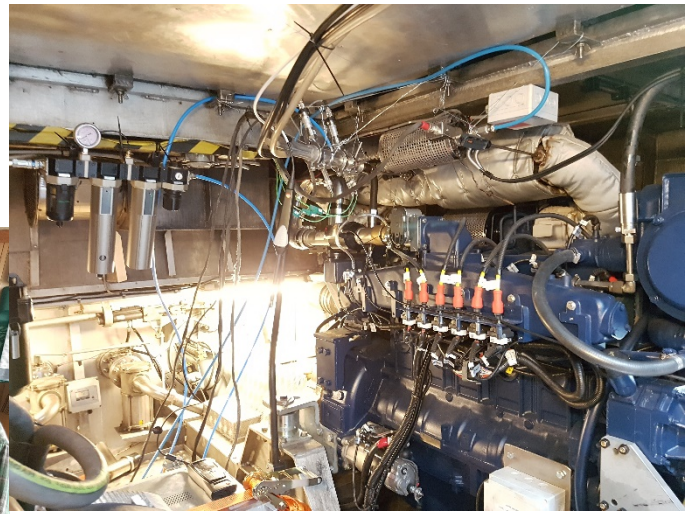
Maximum power @ 2200 rpm	313 kW
Torque @1500 rpm	1532 Nm
Best efficiency	40%
Efficiency along prop curve	36-39%



EMISSION TESTS, ONBOARD

Chalmers Technical University

- SMPS – Scanning Mobility Particle Spectrometer
- FPS – Fine particle sampler
- NDIR – Non-Disruptive Infrared Sensor



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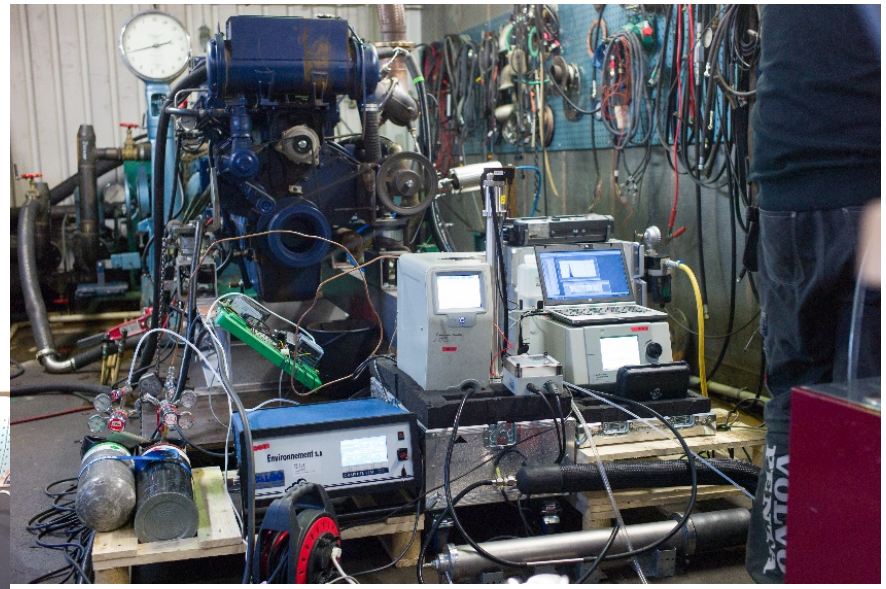
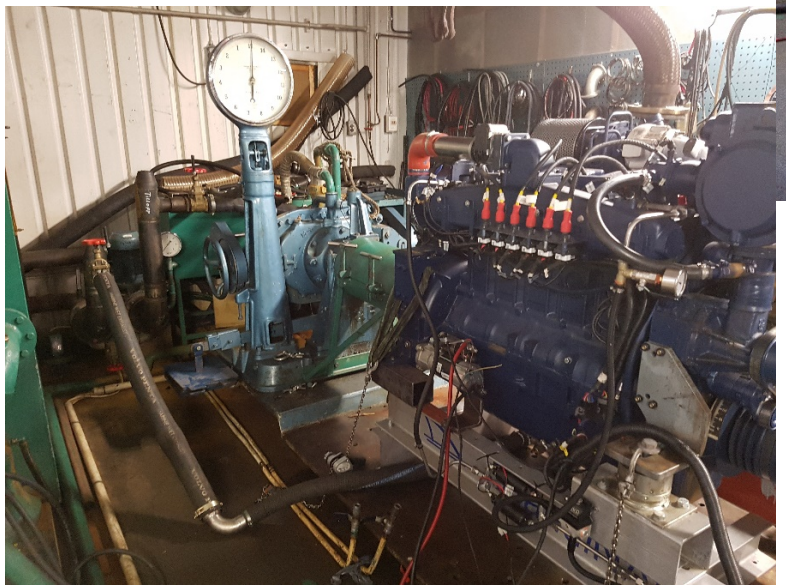
EMISSION TESTS, IN DYNO

Chalmers Technical University and VTT

- FID – Flame ionization detector
- FTIR – Fourier Transform Infrared Spectroscopy





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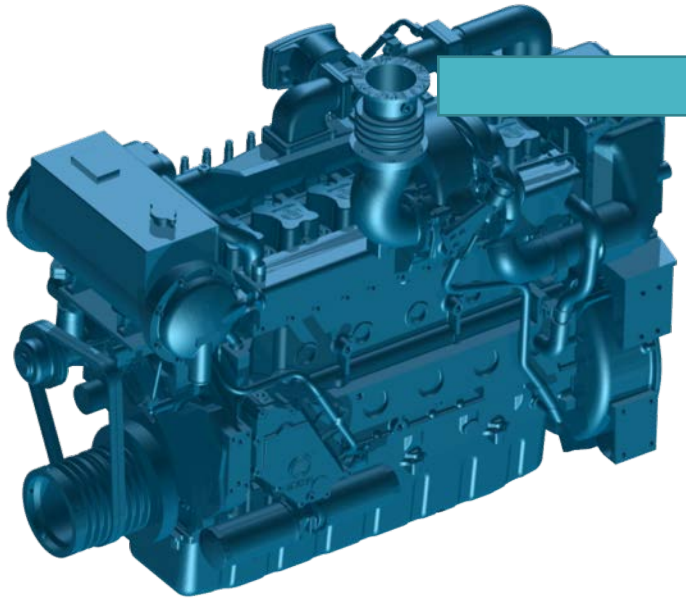
EMISSION RESULTS @100% MCR*



	g/kWh
NOx	1,6
PM	0,000
HC	3,9
CO	2,6

	g/kWh
NOx	1,6
PM	0,000
HC	0,18
CO	0,4

* Maximum continuous rating

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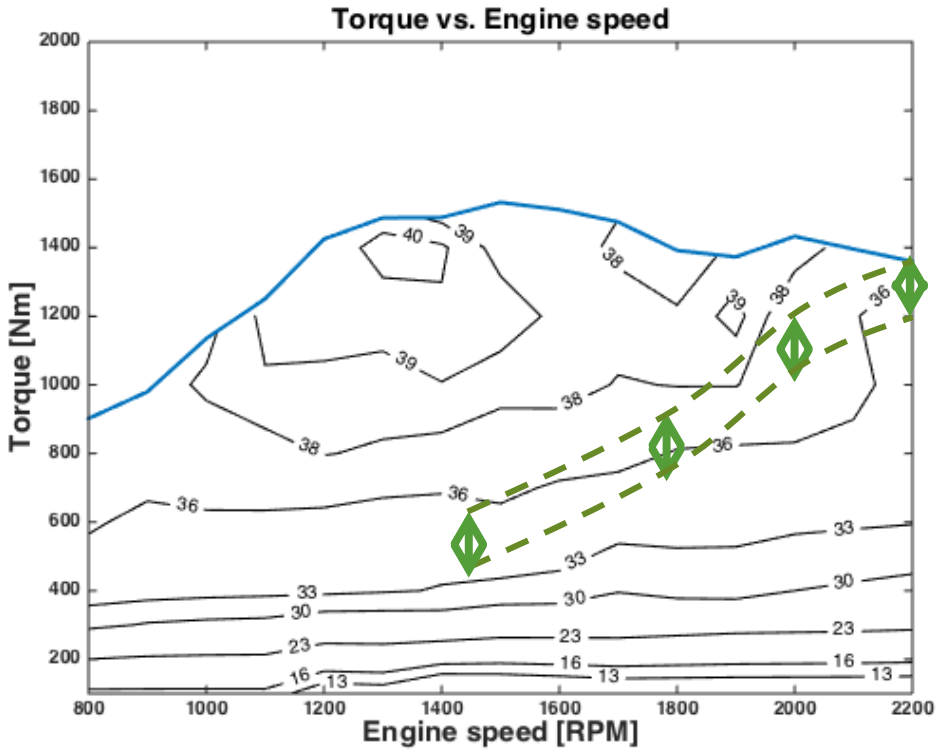
WEICHAI EMISSION RESULTS

	Actual EU E3 [g/kWh]	Actual IMO Tier E3 [g/kWh]	EU 2020 Regulations	
NOx	1,8	1,3	1,8	OK
PM	0,000	-	0,015	OK
HC	0,16	-	0,19	OK
CO	0,4	-	3,5	OK



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… HOW DOES IT COMPARE?

Engine	PM [g/kWh]	NOx [g/kWh]	Aftertreatment	Compliance	Reference
Methanol	0,000	<1,8	Oxidation catalyst	Tier III, 2020 inland waterways	
Methanol	0,000	0,4	3-way catalyst	Euro 6, Tier III, 2020 inland waterways	Johnson Matthey
Cummins QSM 11 (2006)	0,16	6,48	No	Tier II	Cummins marine
Diesel	0,01	0,4	High pressure common rail injection, (2) oxidation catalysts, SCR with UREA, particulate filter	Euro 6, Tier III and inland waterways	Dieselnet

INSTALLATION

AdBlue/Urea

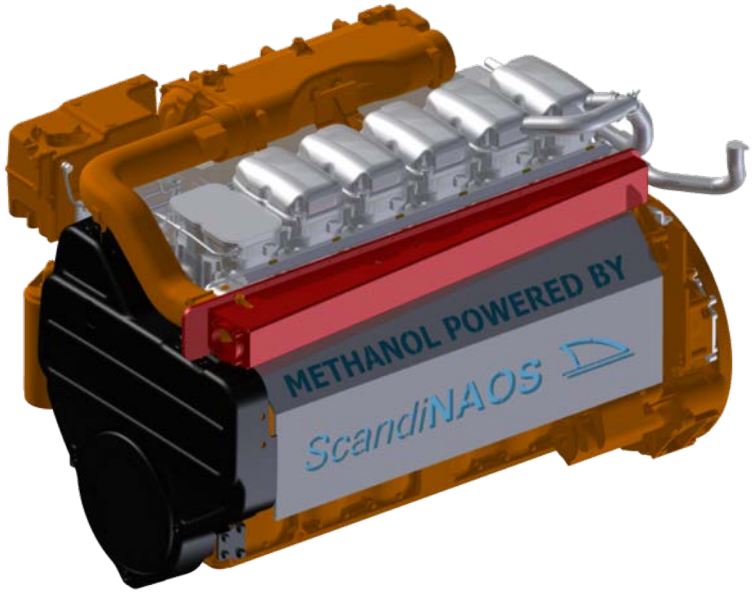
Oxidation catalyst
Particulate filter
2x SCR
2x Ammonia slip catalyst

	Aftertreatment cost	Add on cost
Diesel aftertreatment system	350.000 SEK (40.000 USD)	100%
Methanol Aftertreatment system	15.000 SEK (1700 USD)	5%

catalyst

CONCLUSIONS

- Diesel-like performance
- Recognized and well known technical system
- High efficiency (37-40%)
- Reduction of CO2
- Reduced NOx formation
- No PM
- No SOx
- Methanol engine will comply with present and upcoming EU and IMO regulations without advanced aftertreatment
- Cost efficient



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Thank you
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