

THE ROAD AHEAD

SHIP POWER TECHNOLOGY



Teknologikonferanse 2011

Gass som energibærer i fiskeflåten

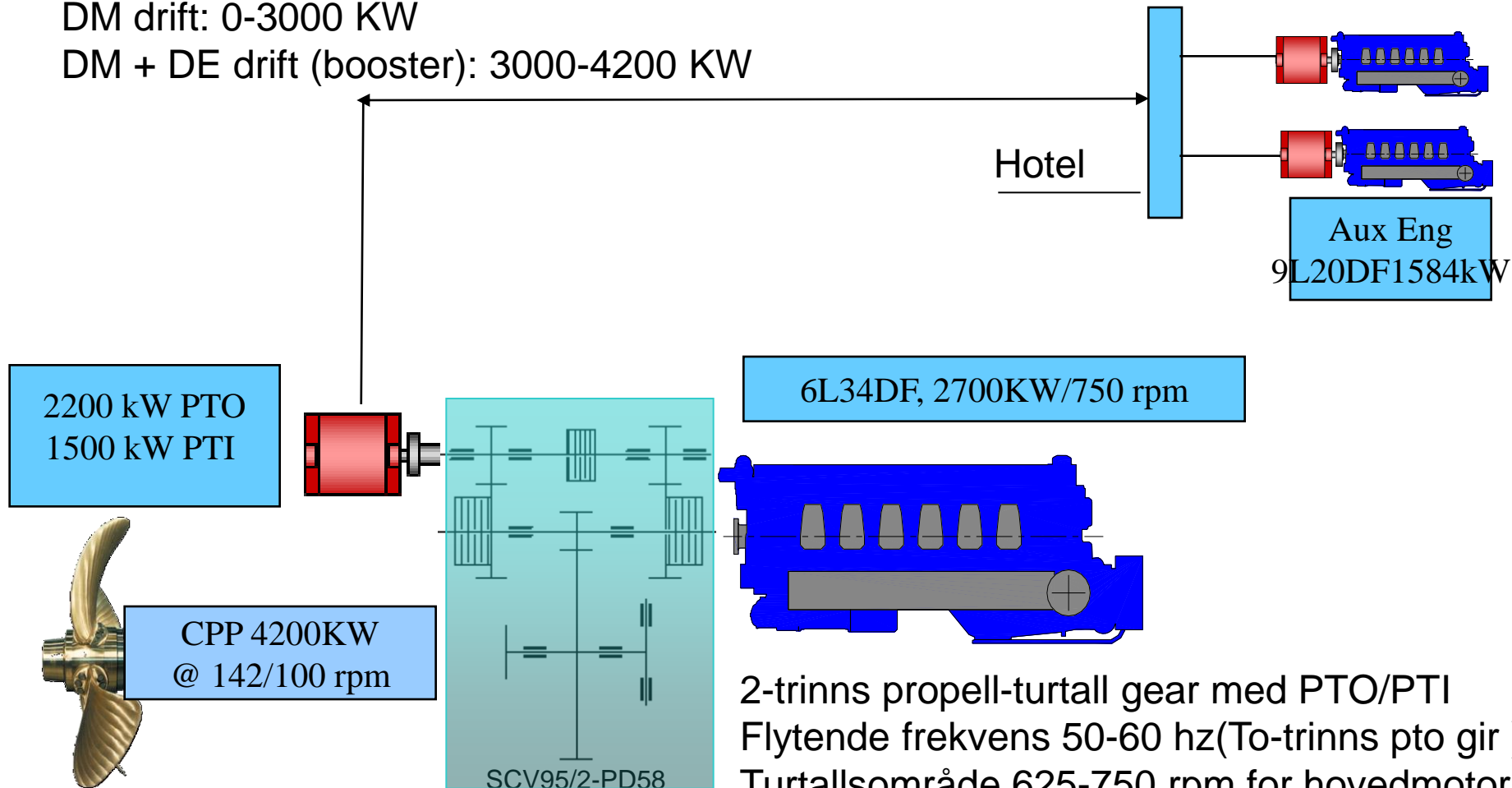
13. oktober 2011 Ålesund



V&S , Alternativ 2, 2-trinns gear m/“booster”

DM drift: 0-3000 KW

DM + DE drift (booster): 3000-4200 KW



2-trinns propell-turtall gear med PTO/PTI
Flytende frekvens 50-60 hz (To-trinns pto gir)
Turtallsområde 625-750 rpm for hovedmotor,
tilsvarende propell turtall: 83-142 rpm
Det kan velges "lavere" turtall ved trinn II en
angitt. Dette er avhengig av driftkondisjoner.

- 1. Introduction to Wärtsilä DF portfolio**
- 2. What's new?**
- 3. Development DF Engines**

Wärtsilä Dual-Fuel Engine Portfolio

ONE WAY
THE ROAD AHEAD

WÄRTSILÄ 20DF



6L20DF 1.0 MW

8L20DF 1.4 MW

9L20DF 1.6 MW

WÄRTSILÄ 34DF



6L34DF 2.7 MW

9L34DF 4.0 MW

12V34DF 5.4 MW

16V34DF 7.2 MW

20V34DF 9.0 MW

WÄRTSILÄ 50DF



6L50DF 5.85 MW

8L50DF 7.8 MW

9L50DF 8.8 MW

12V50DF 11.7 MW

16V50DF 15.6 MW

18V50DF 17.55 MW

0

5

10

15

Higher output for 60Hz / Main engines

WÄRTSILÄ 20DF



WÄRTSILÄ 34DF



WÄRTSILÄ 50DF



- High efficiency
- Low gas pressure
- Low emissions, due to:
 - High efficiency
 - Clean fuel
 - Lean burn combustion
- Fuel flexibility
 - Gas
 - LFO (DF)
 - Bio Fuel
 - HFO (TF)

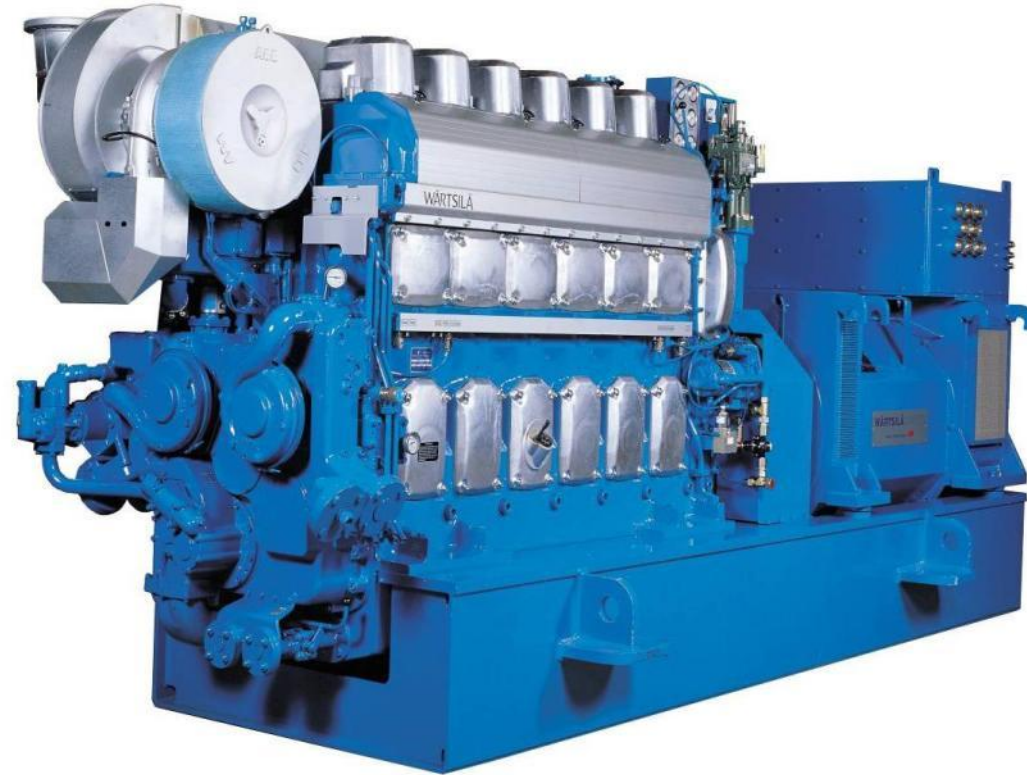
Double wall gas piping

- Three engine models
 - Wärtsilä 20DF
 - Wärtsilä 32DF
 - Wärtsilä 50DF

Wärtsilä 20DF features



- Dual-fuel engine - gas and liquid fuel
- Otto principle at gas operation
- Pilot fuel for ignition of gas
- High efficiency
- Low emissions, thanks to:
 - Clean fuel
 - Lean burn combustion
- Low gas pressure
- Double wall gas piping
- Embedded automation system



Wärtsilä 20DF main technical data



	Marine generating sets	Marine main engines
Cylinder bore [mm]	200	200
Piston stroke [mm]	280	280
Engine speed [rpm]	1000 / 1200	1200
Piston speed [m/s]	9.3 / 11.2	11.2
Mean effective pressure [bar]	20	20
Output per cylinder [kW]	146/176	176
Cylinder configurations	6L, 8L, 9L	6L, 8L, 9L

Engine control and cylinder load balancing based on cylinder pressure sensors

First achievements:

- More reliable knock detection
- Real-time misfire detection
- Maximum cylinder pressure control
- Gas operation on all EIAPP load points (including 10%)

Wärtsilä recommend liquid fuel on lower loads as it is a better fuel for low load operation

Development:

- Automatic engine de-rating control
- Improved fault detection/ diagnostics for preventive maintenance
- Increase of load and efficiency due to better engine control and possibility to run closer to maximum cylinder pressure and knock limits



DF Engine Technology is Inherent Redundant



The Dual Fuel technology give the following advantages:

- A disturbance in gas mode leads to an automatic and instant switch-over to diesel mode and continued operation at desired load/speed
- In case of malfunction of external gas supply or lack of gas, the vessel has the flexibility to operate on diesel fuel
- Can be operated on liquid fuel outside ECA-area, even on HFO

Operation in ECA area – in case of failure:

- Operation on pure liquid fuel resulting from restricted gas supply in cases of failures shall be exempted for the voyage to the next appropriate port for the repair of the failure.
(MEPC 58/23/Add.1 ANNEX 14)

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GAS ENGINE EMISSIONS

Wärtsilä DF

- Legislation
- Combustion
- Methane slip
- Methane slip reduction measures



LOCAL

NO_x

Acid rains
Tier II (2011)
Tier III (2016)

LOCAL

SO_x

3.5% (2012)
ECA 0.1% (2015)

GLOBAL

CO₂& HC

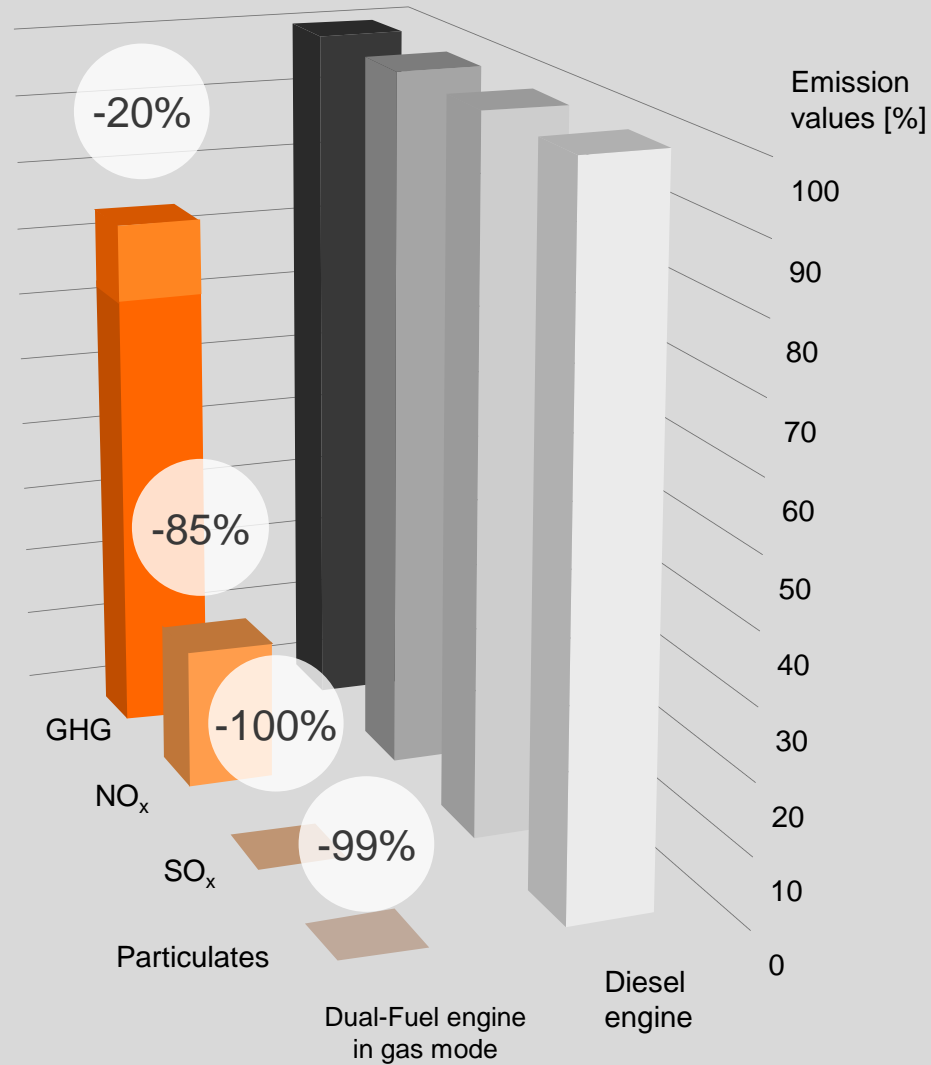
Greenhouse effect
Under evaluation by IMO

LOCAL

Particulate matter

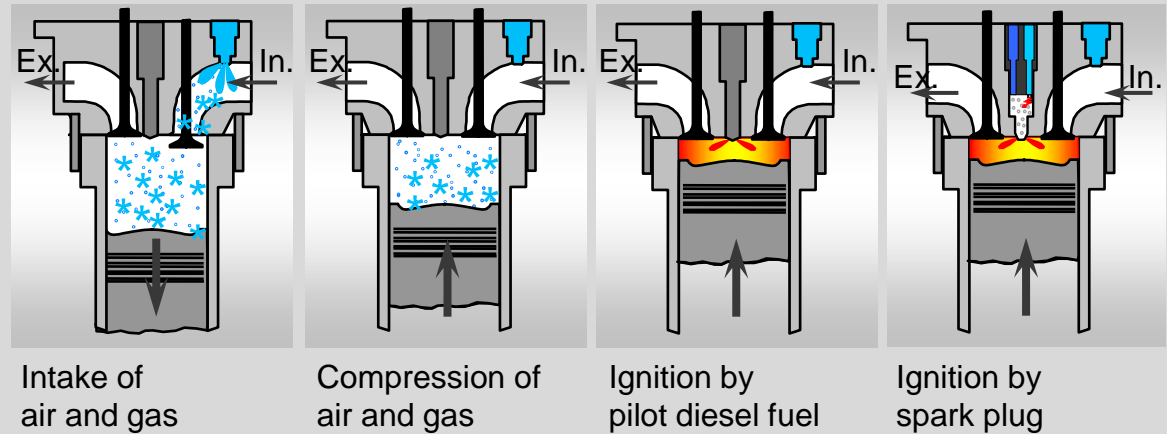
Direct impact on humans
Locally regulated

Natural gas as marine fuel



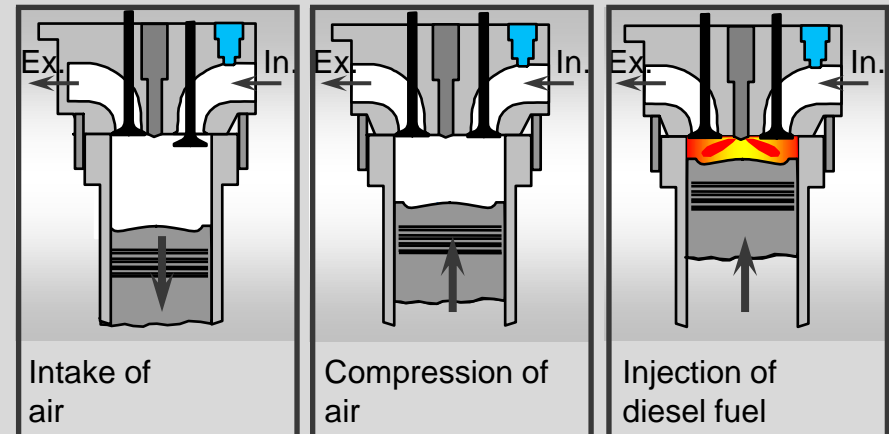
Gas combustion:

- Otto principle
- Low-pressure gas admission
- Pilot diesel injection



Diesel combustion:

- Diesel principle
- Diesel injection

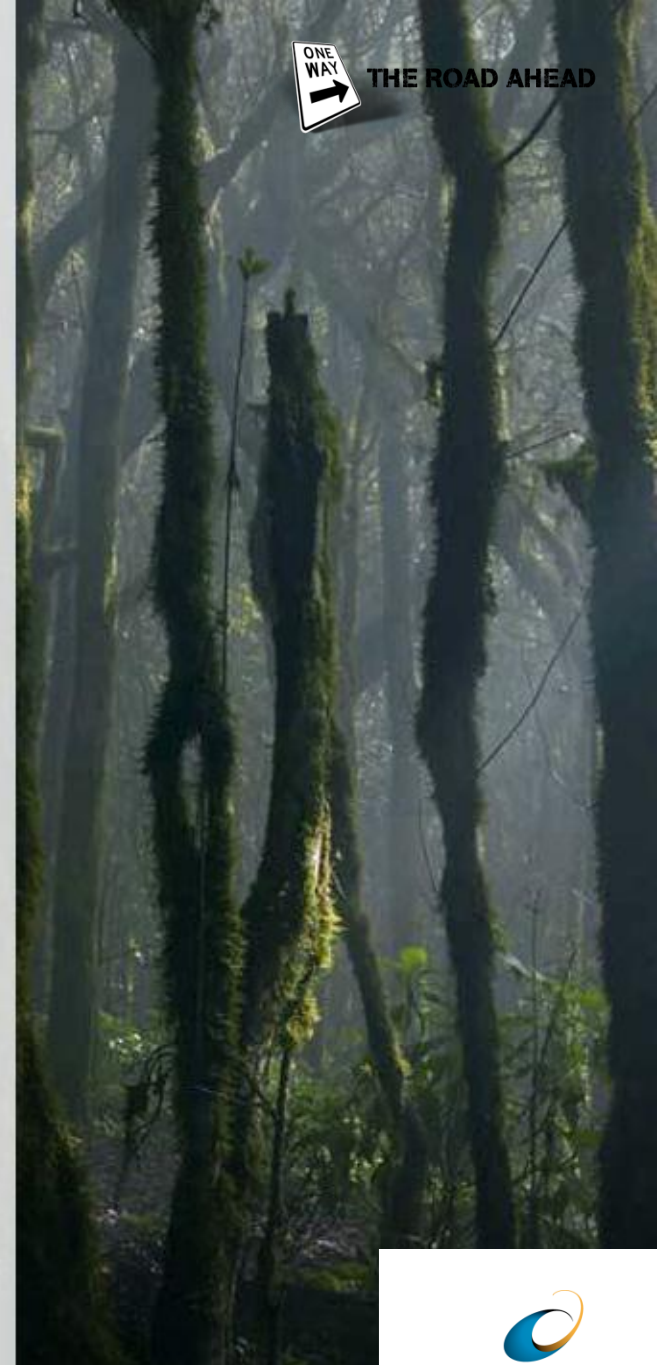


Why methane slip?

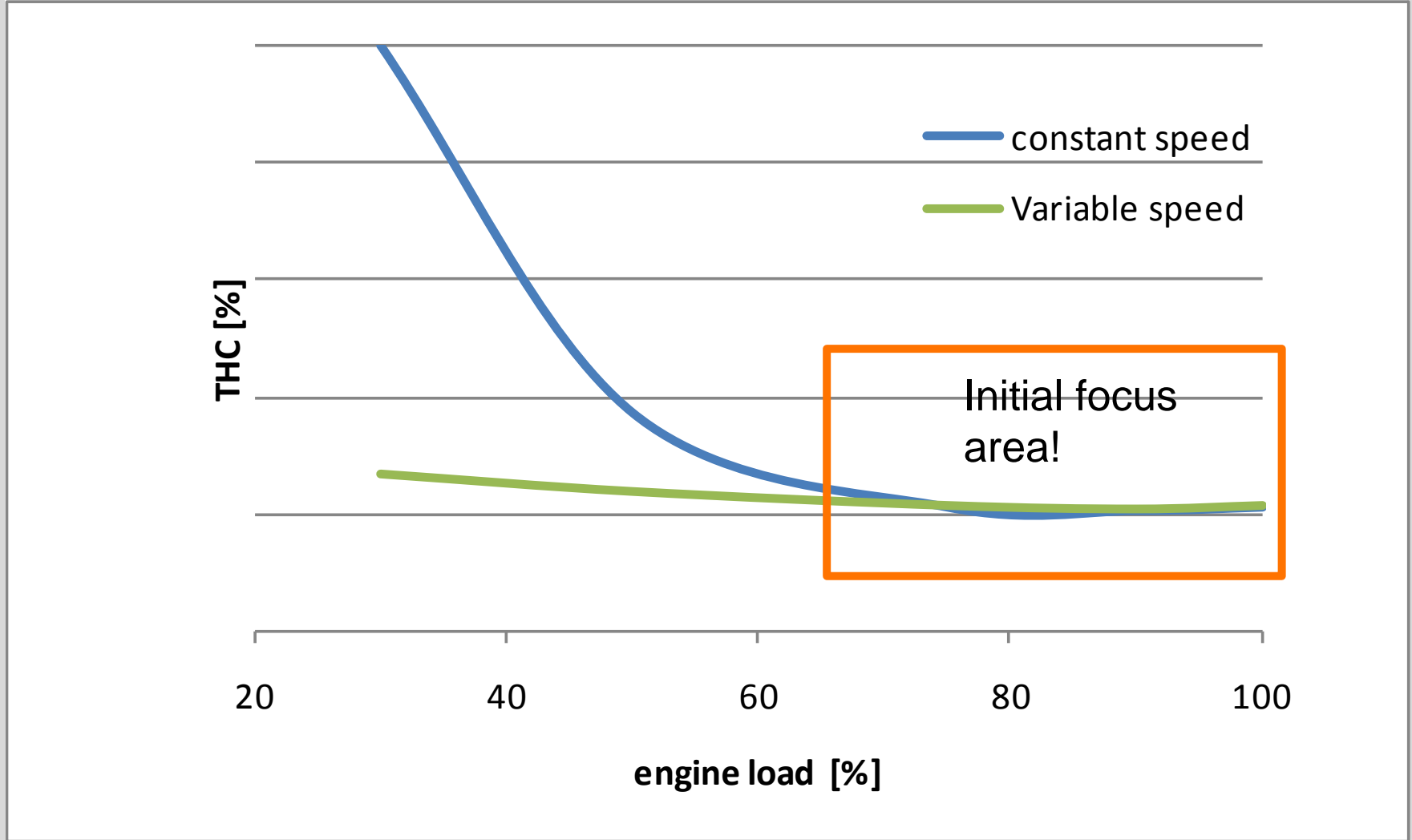
- Oxidation of CH_4 requires $t > 540^\circ\text{C}$
- Heavier C_nH_m do oxidize at lower temperatures
- CH_4 is one of the greenhouse gases listed in the Kyoto protocol
- Methane is 25 times more harmful greenhouse gas than CO_2
 - NG produces about 200 g/kWh less CO_2 than HFO
 - 6 g/kWh CH_4 (methane slip) gives 8-10% lower GHG



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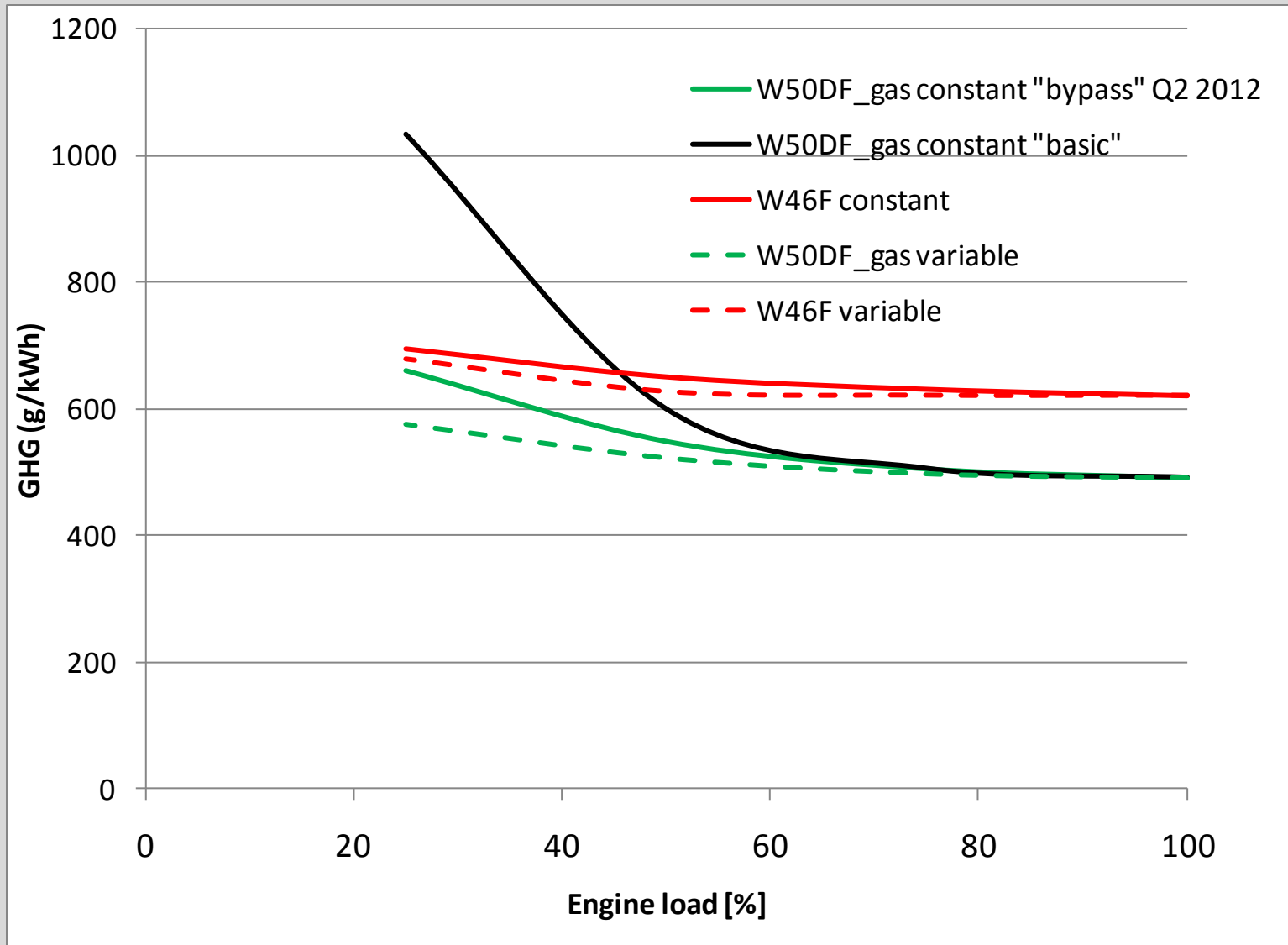


Methane slip – not optimised

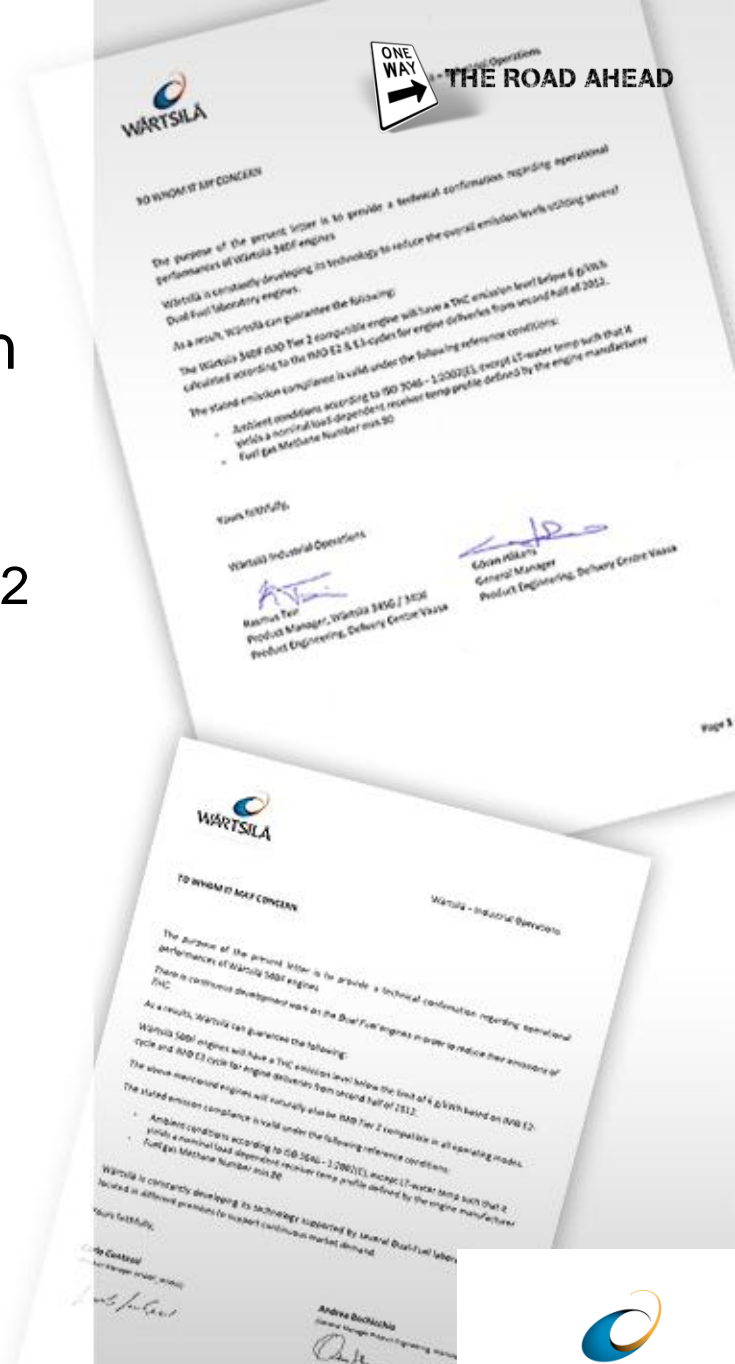


Method	Applicable load (%)	Reduction in THC (%)
Lower boost level (Higher NOx with IMO Tier 3)	60...80	0...40
Higher charge air temperature		
Skip firing	0...30	50...85
MFI timing	~30...100	20...30
Minimizing dead volumes (clearances)	0...100	~20
Optimized combustion chamber (piston bowl shape)	~50...100	~18
Usage of Air by-pass (On constant speed)	20...60	25...60
EGR		
Catalyst (Oxicat)	0...100	50...70
Catalyst (Xcat)	0...100	>90

By combining these measures reduction of 50-80% can be reached at all loads! Some measure can be implemented also on existing engines!



- Implementation plan of CH₄ reduction measures to production **June 2011**
- **W34 DF:** Weighted average acc ISO 8178 E2 and E3 cycle THC < 6 g/kWh for deliveries >Q2 2012
- **W50 DF:** Weighted average acc ISO 8178 E2 and E3 cycle THC < 3.5 g/kWh for deliveries >Q2 2012



Lean burn otto-cycle gas engines have great environmental benefits:

- NO_x limits below IMO Tier III
- SO_x nearly zero
- PM nearly zero
- Less CO_2

Methane emissions at low load and nominal speed for “base-engine”

In spite of CH_4 25* CO_2 effect, total GHG for DF well below same size diesel engine

R&D project finished which explored number of technologies to reduce methane slip. Potential: 50-80% reduction with primary measures

Oxidation catalyst under development

Thank you



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