Benefits by Common Rail injection

- Environmental benefits
- Operational and economical benefits

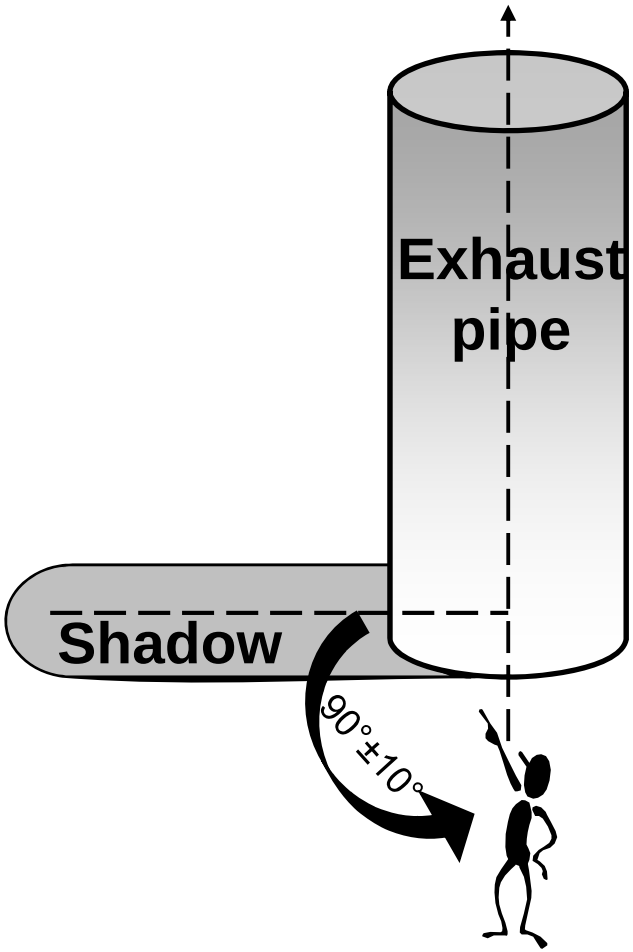
Environmental benefits by Common Rail

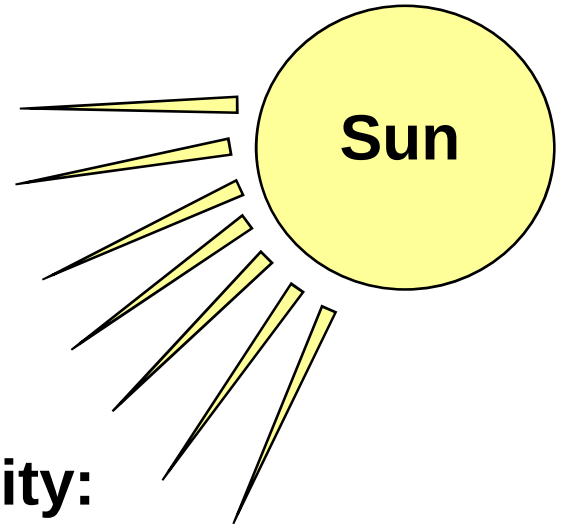
- **Smokeless operation**
- **Nitrogen oxides, compatibility with future rules**
- **Particulates**
- **Sulphur oxides**
- **CO_2 emissions**

Smokeless operation by Common Rail

- **Minimal smoke at start-up**
- **No smoke at steady-state operation**
- **No smoke at manoeuvering**

Wärtsilä standard conditions for determination of smokeless operation



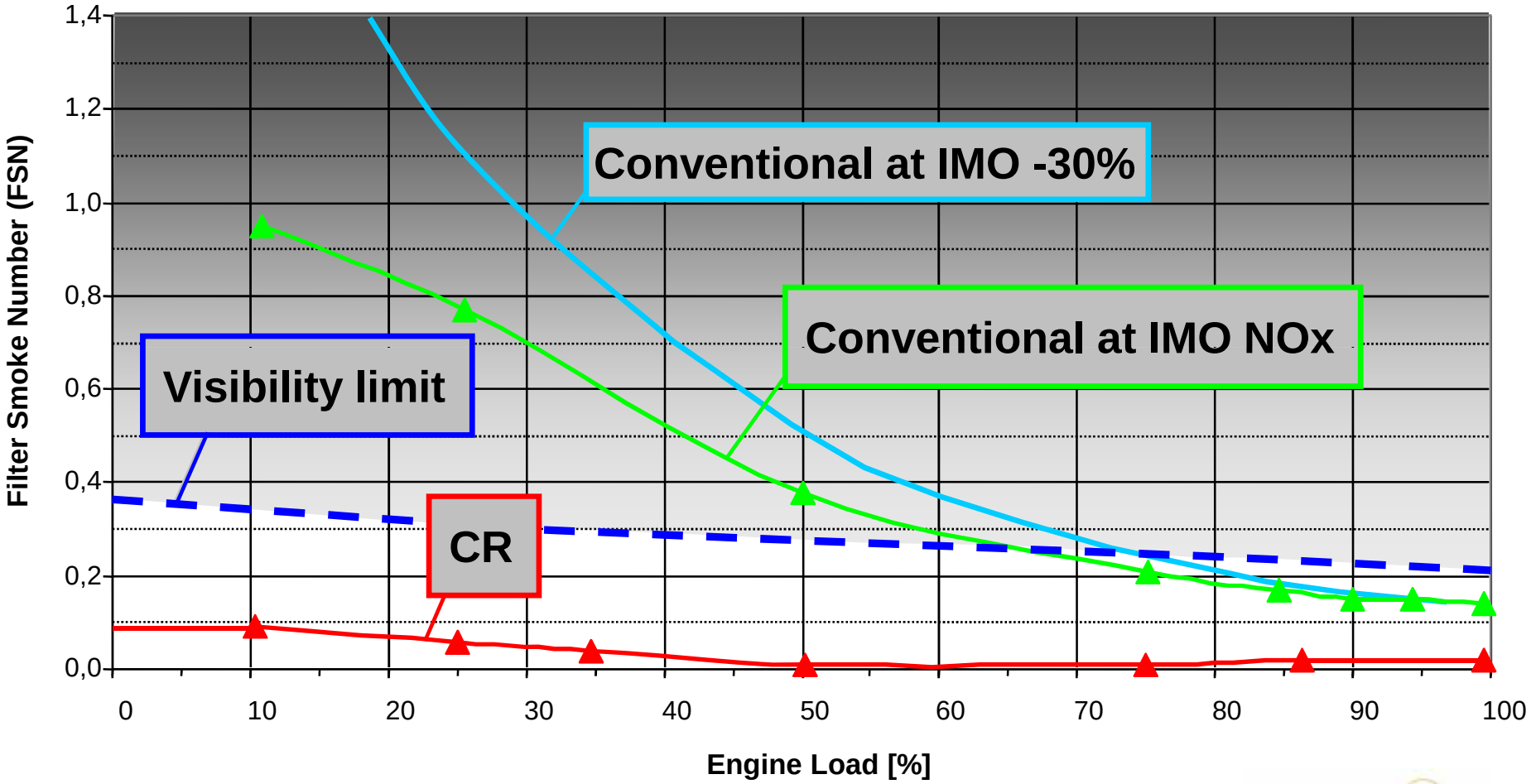


Skylight intensity:

20000 lux

Exhaust pipe dimensions according to Wärtsilä's regulations

W46 smoke CR versus conventional



Maximum smoke at start-up

Common Rail

Conventional

Smoke at 30% load

Common Rail

Conventional

Maximum smoke at manoeuvering acc. fastest load ramp

Common Rail

Conventional

Coral Princess

Nitrogen oxides versus Common Rail

- **Next probable regulatory level is IMO -30%**

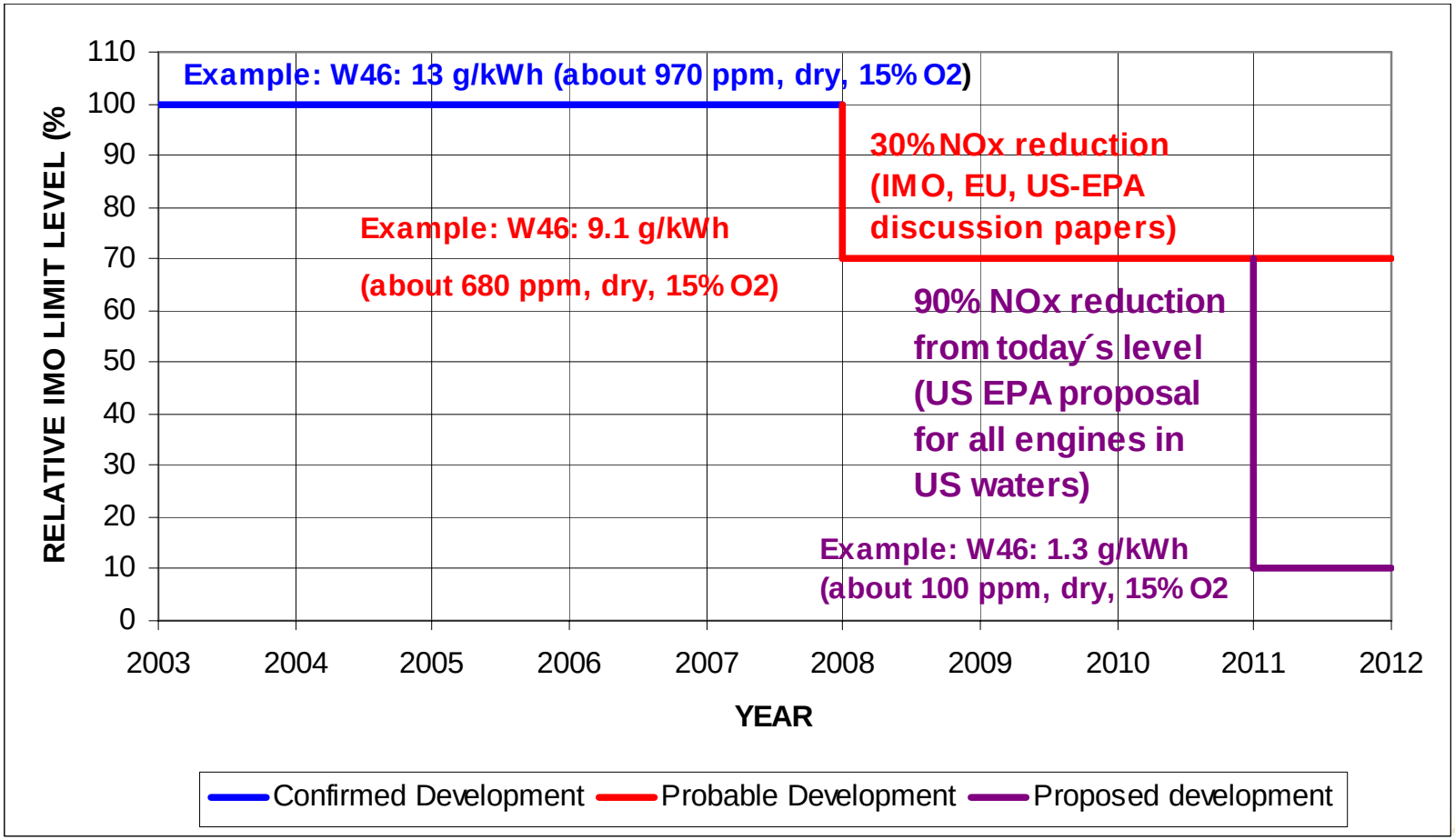
  The ways to reach that are:

  - **Dry low NOx combustion**
    - **Further increased compression ratio and late injection**
  - **Humidification methods, i.e. Combustion Air Saturation**

Both methods would increase smoke but Common Rail solves the problem.

Trends in Marine Emission Legislation

IMO, EU and US-EPA Proposals for Marine NOx Legislation – Reduction from today´s IMO limit:



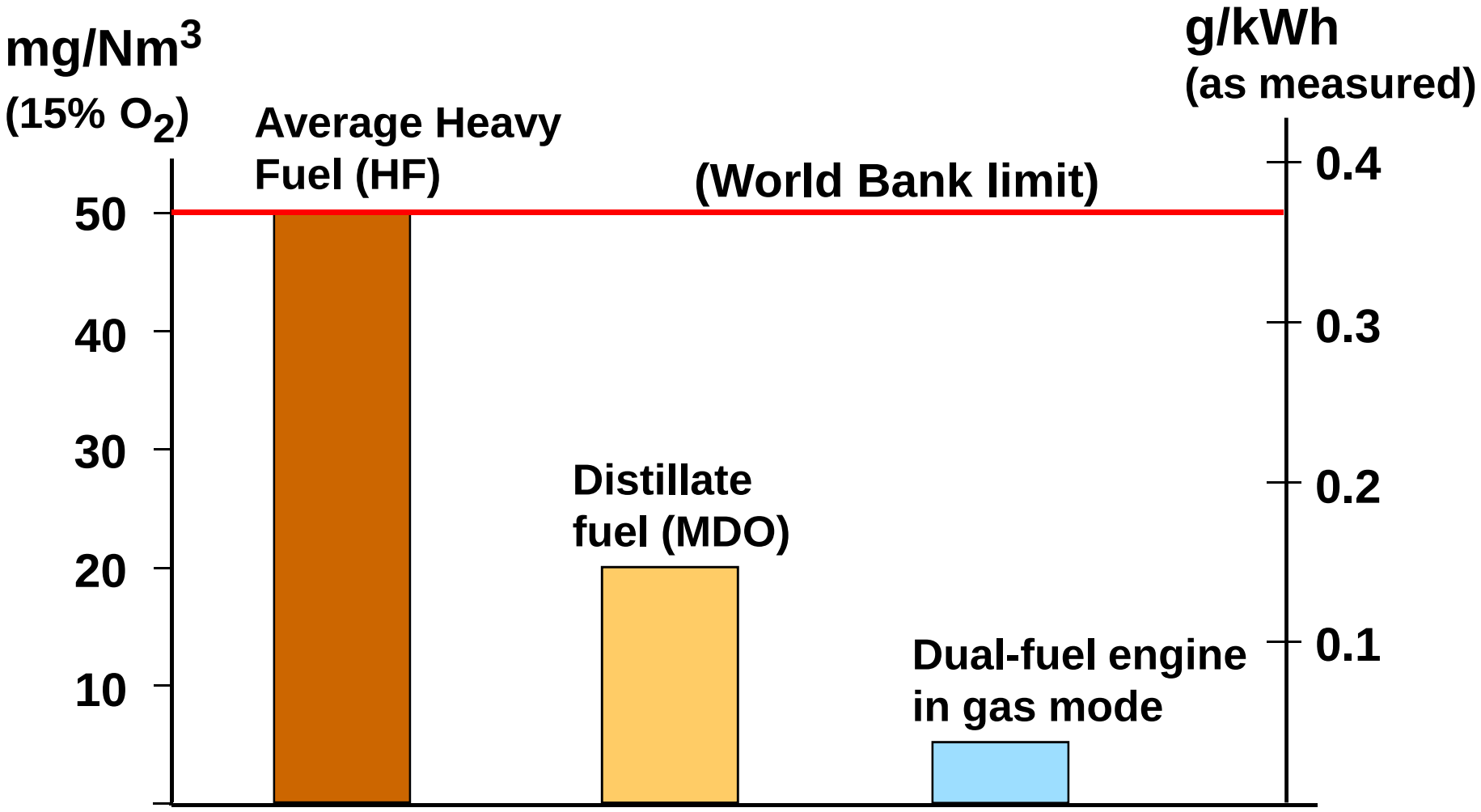
Particulates versus Common Rail

- **US-EPA Tier 2 and EU “Inland waterways” specify particulates less than 0.5 g/kWh from 2007 resp. 2009 for engines up to 30 litres/cyl. The regulation is likely to be extended for larger engines.**
- **Current status is ~0.35 g/kWh when measured in dry hot state and operation on fuels with sulphur content ~2.5.**

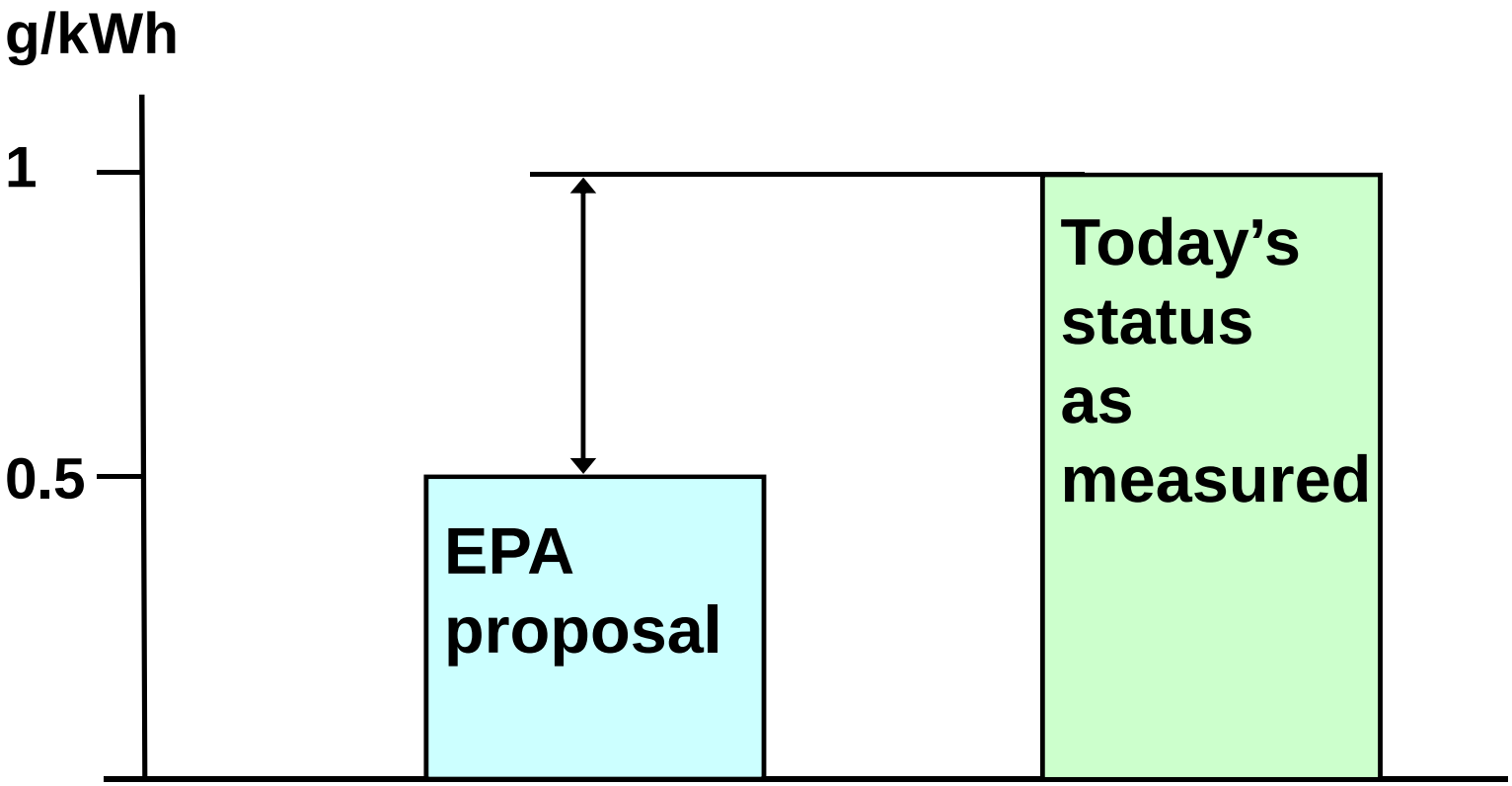
BUT

- **EPA and EU specify “dilution method” measurements which means condensation of liquid components and the results are roughly tripled, i.e. the gap is big.**

Particulates versus fuel choice



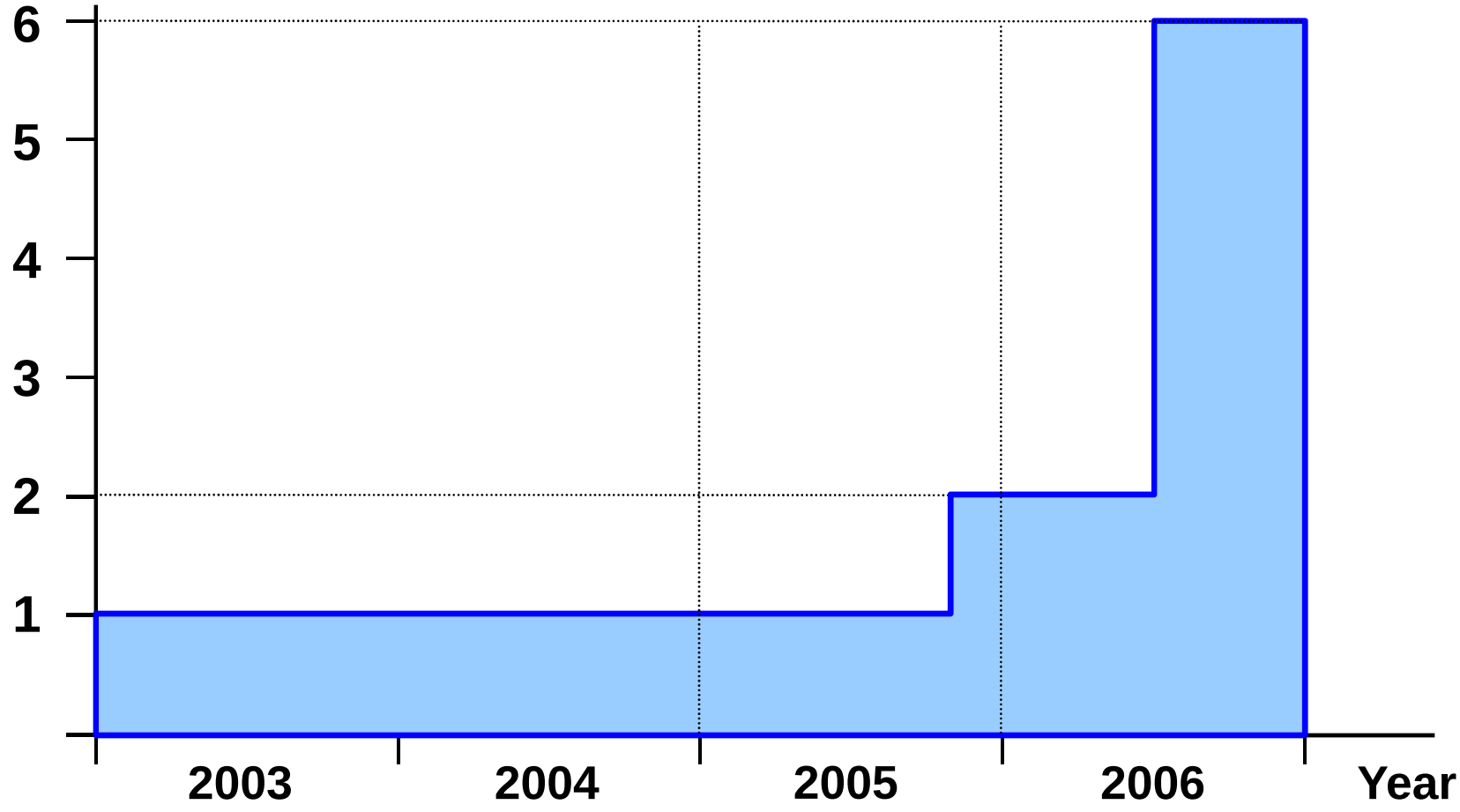
The development gap for particulates, HF operation



Solutions to particulates problems

- **Alternative fuel, i.e. distillate, is the obvious solution.**
- **In order to improve operational economy with alternative fuels the Common Rail injection system is further developed for alternative injection maps.**
- **Common Rail injection results in less particulates at all loads. Optimal injection maps for minimized particulate levels are tested 2005 – 2006 (vast matrix of different fuels, running modes and engine parameters).**

Number of available injection maps in the Wärtsilä Common Rail system



Different ways to utilize alternative injection maps

Two fuels

Low-sulphur fuel	High-sulphur fuel
Smoke optimized	Smoke optimized
NOx optimized	NOx optimized
Economy optimized	Economy optimized

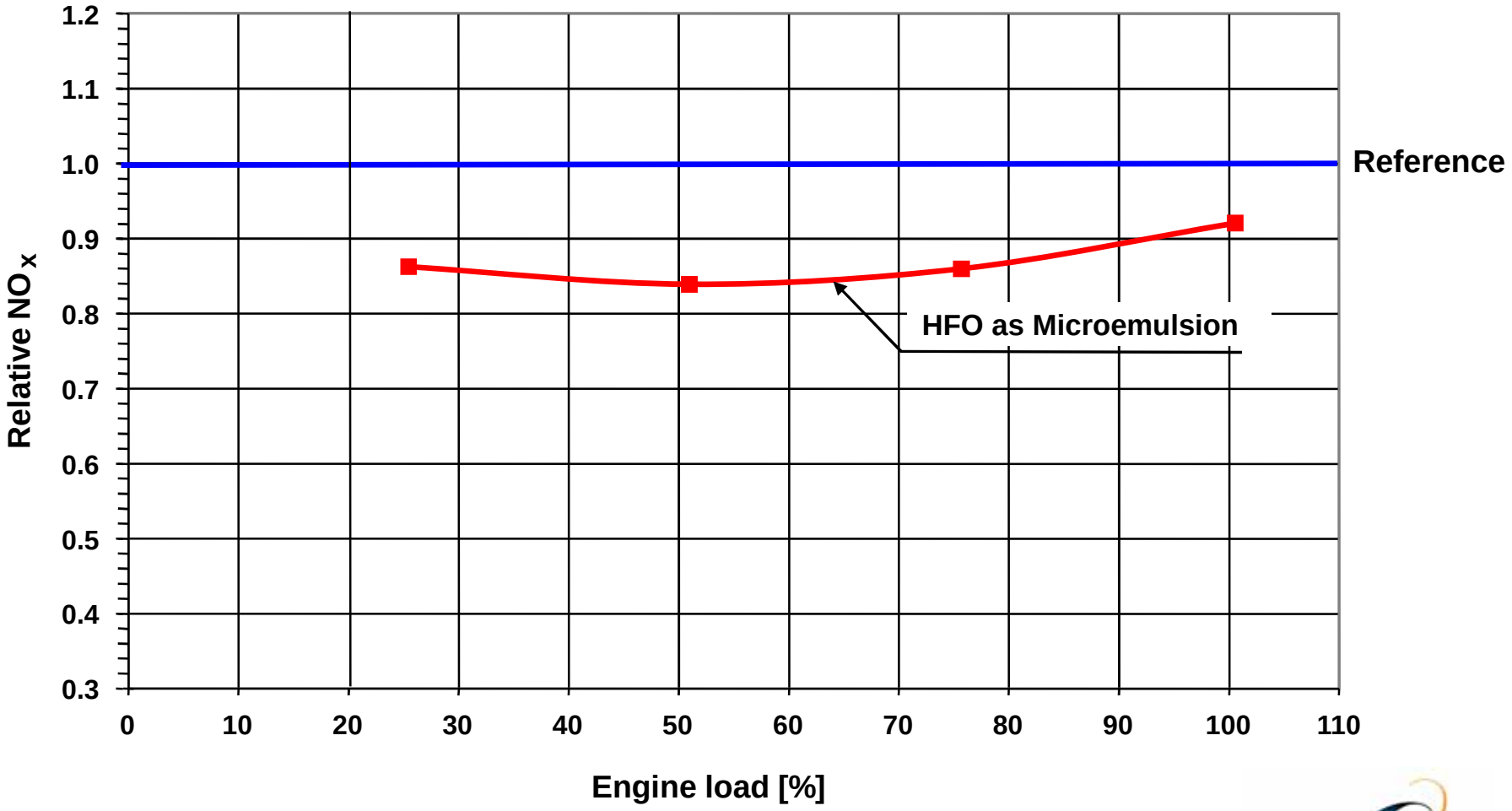
Three fuels

High-sulphur fuel	Low-sulphur fuel	Microemulsion
Smoke optimized	Smoke optimized	Smoke optimized
Economy optimized	Economy optimized	Economy optimized

Different choices can be easily implemented.

WÄRTSILÄ

NOx reduction by Microemulsion



Sulphur oxides versus Common Rail

Sulphur oxides are solely fuel dependent.

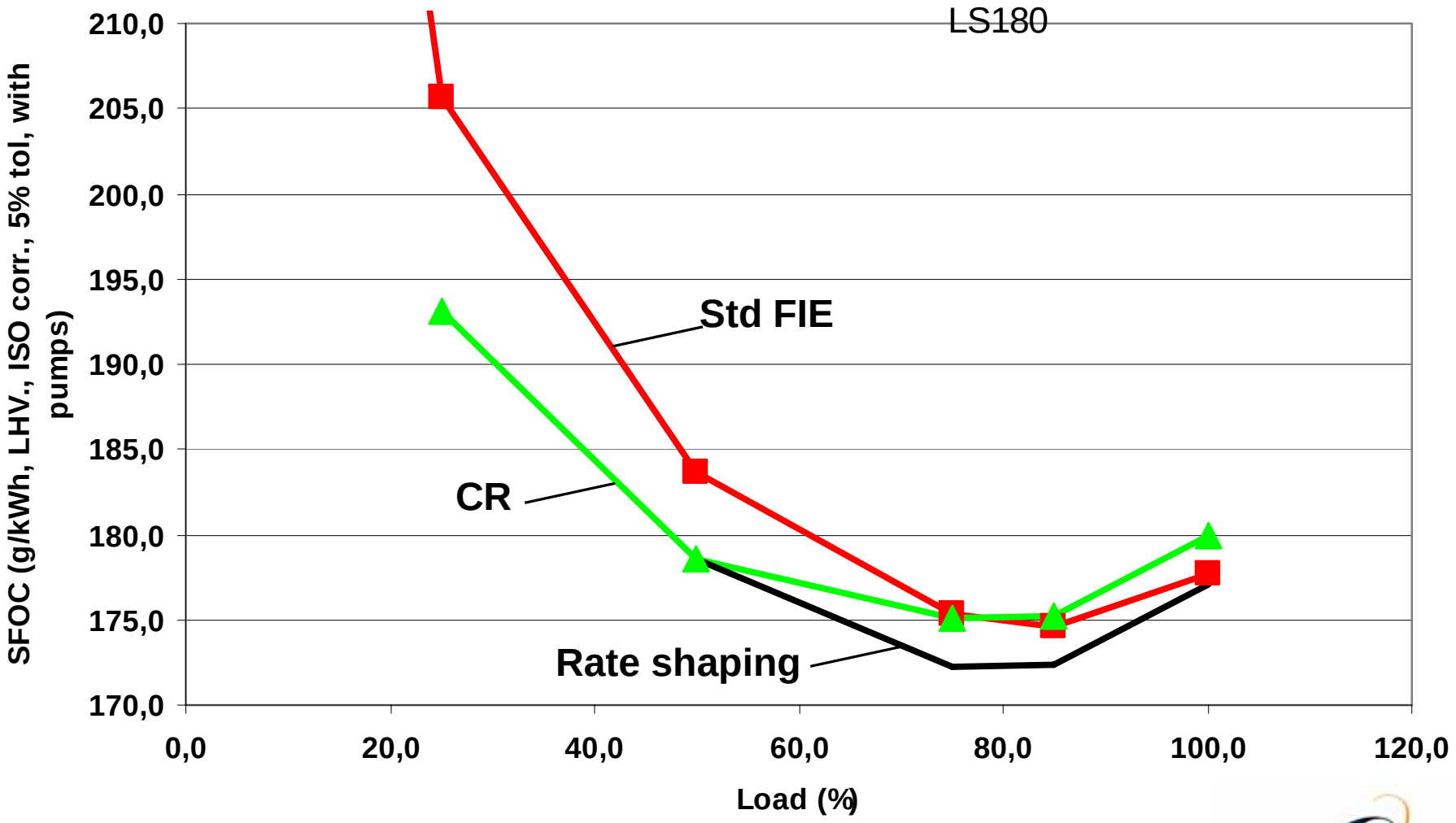
To meet load restrictions operation on low-sulphur fuel is the obvious solution.

Alternative injection maps may improve total fuel consumption by 2-3 g/kWh as an average.

CO_2 emissions

Lower fuel consumption results in lower CO_2 emissions.

W6L46C2, 1050 kW/cyl, Const. speed, Std FIE vs CR, SFOC comparison



Operational benefits by Common Rail

- Lower fuel consumption in total
- No risk of smoke penalties
- Further improved fuel economy by alternative injection maps for different fuels
- Two engines can be maintained in operation without smoke or fuel consumption disadvantages (valid for multiengine ships)
- Longer lifetime of nozzles and high-pressure pumps

Summary of Common Rail benefits

IMAGE **MONEY**

(No problems to meet with regulations)