



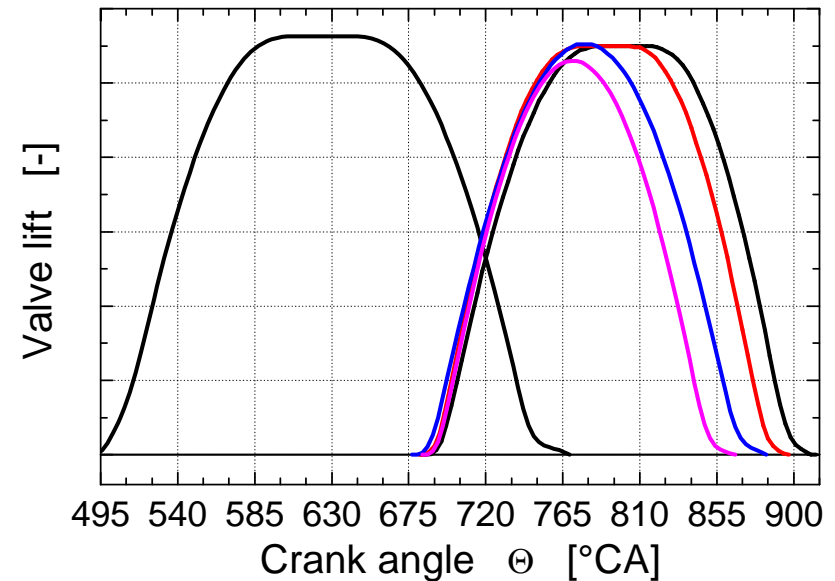
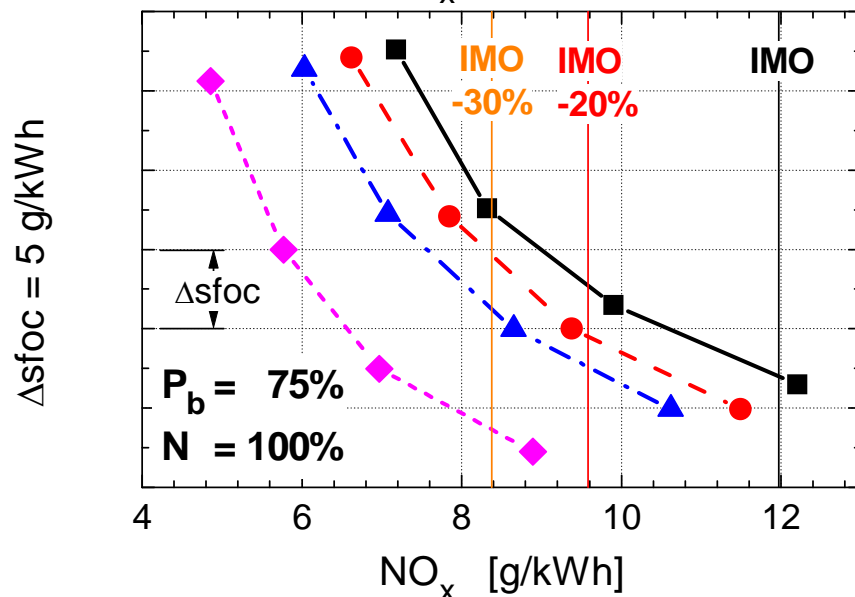
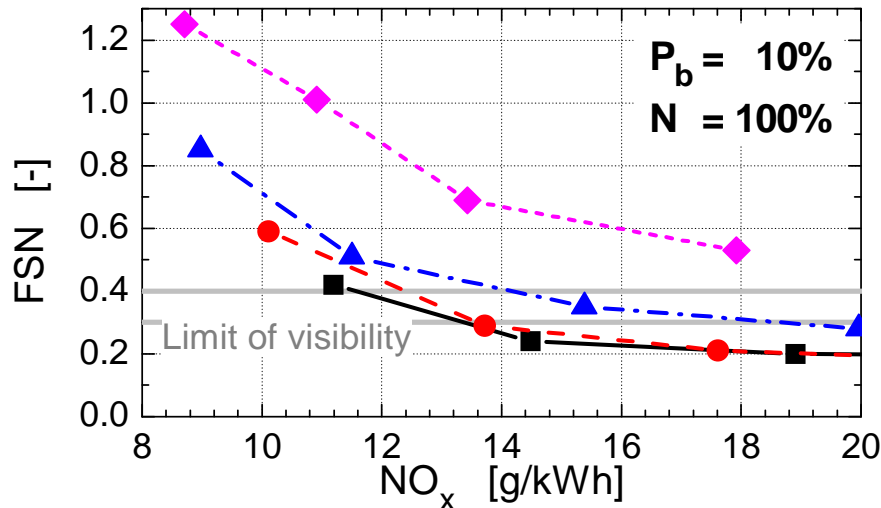
## Medium Speed SFOC-Emission trade off

# Future Emission Reduction



- **NOx reduction in 2-steps**
  - Tier2 internal engine measures
  - Tier3 wet measures / after-treatment
  
- **SOx reduction**
  - limitation of fuel sulphur content / scrubbing
  
- **PM reduction**
  - PM from HFO operated engines consist of mainly sulphates , limitation as for SOx

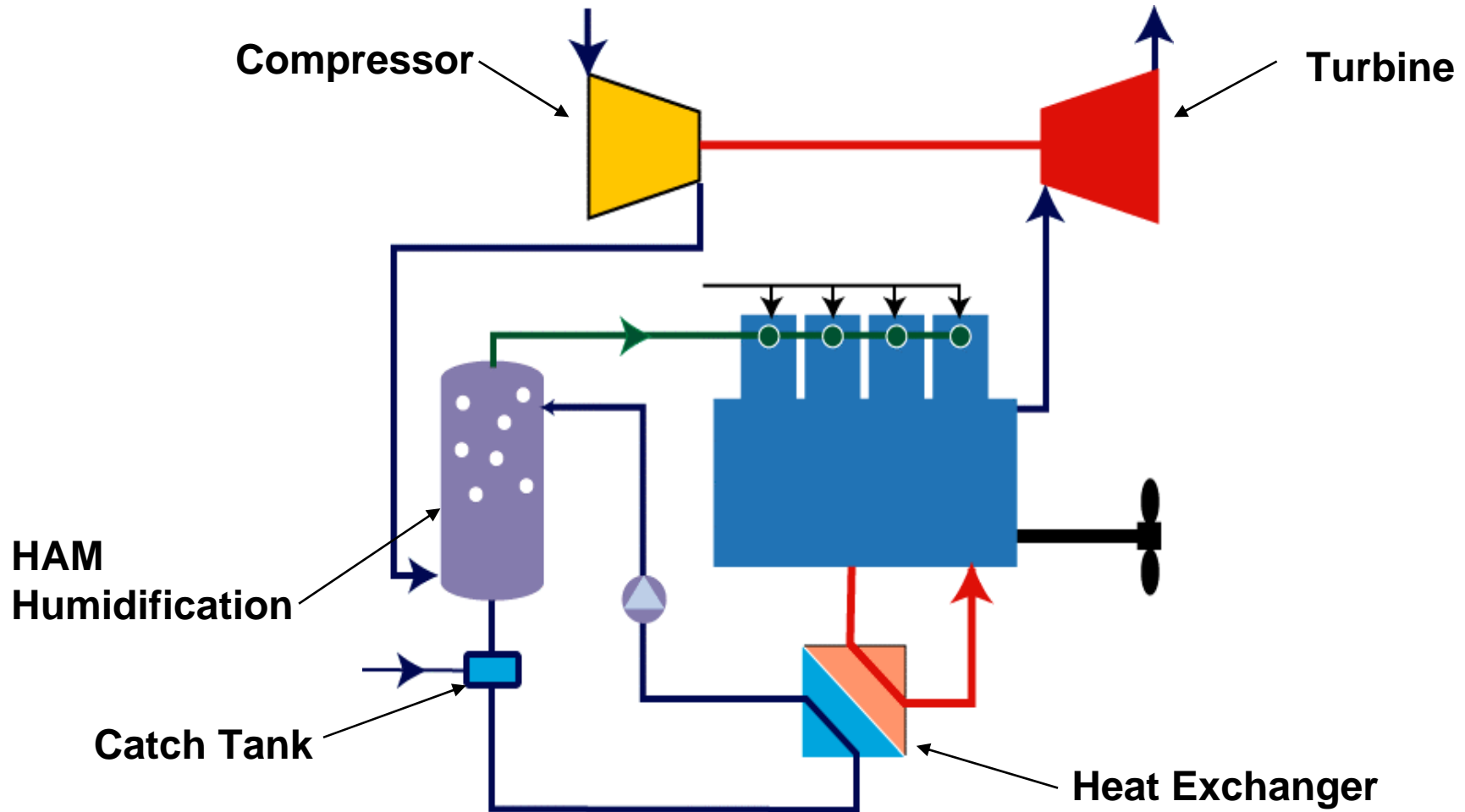
# NOx-SFOC-trade-off-improvement Internal measures – Miller cycle



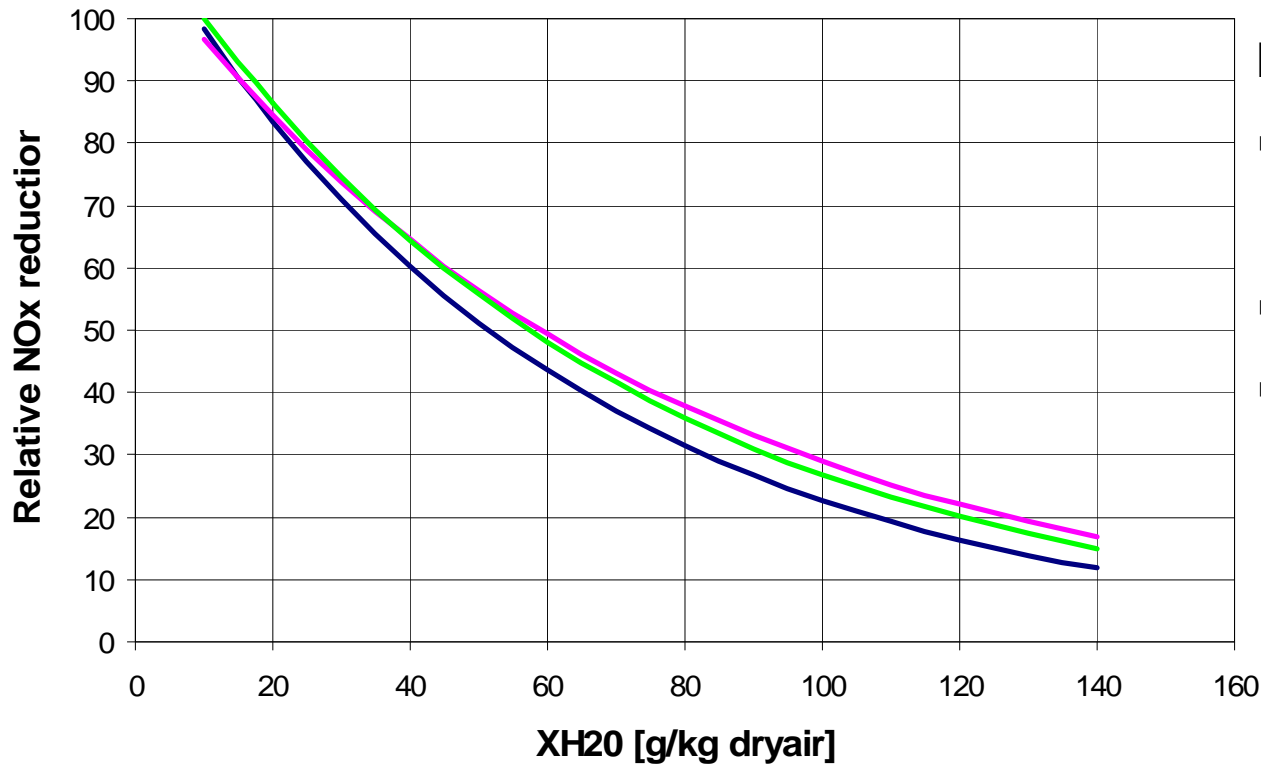
## Requirements for improved NOx-SFOC-trade-off

- High pressure & efficiency turbochargers
- Variable Air management -> **VVT**
- Variable Fuel management -> **CR**

# HAM System (Humid Air Motor)



# NOx-SFOC-trade-off-improvement Wet measures – Humid Air Motor

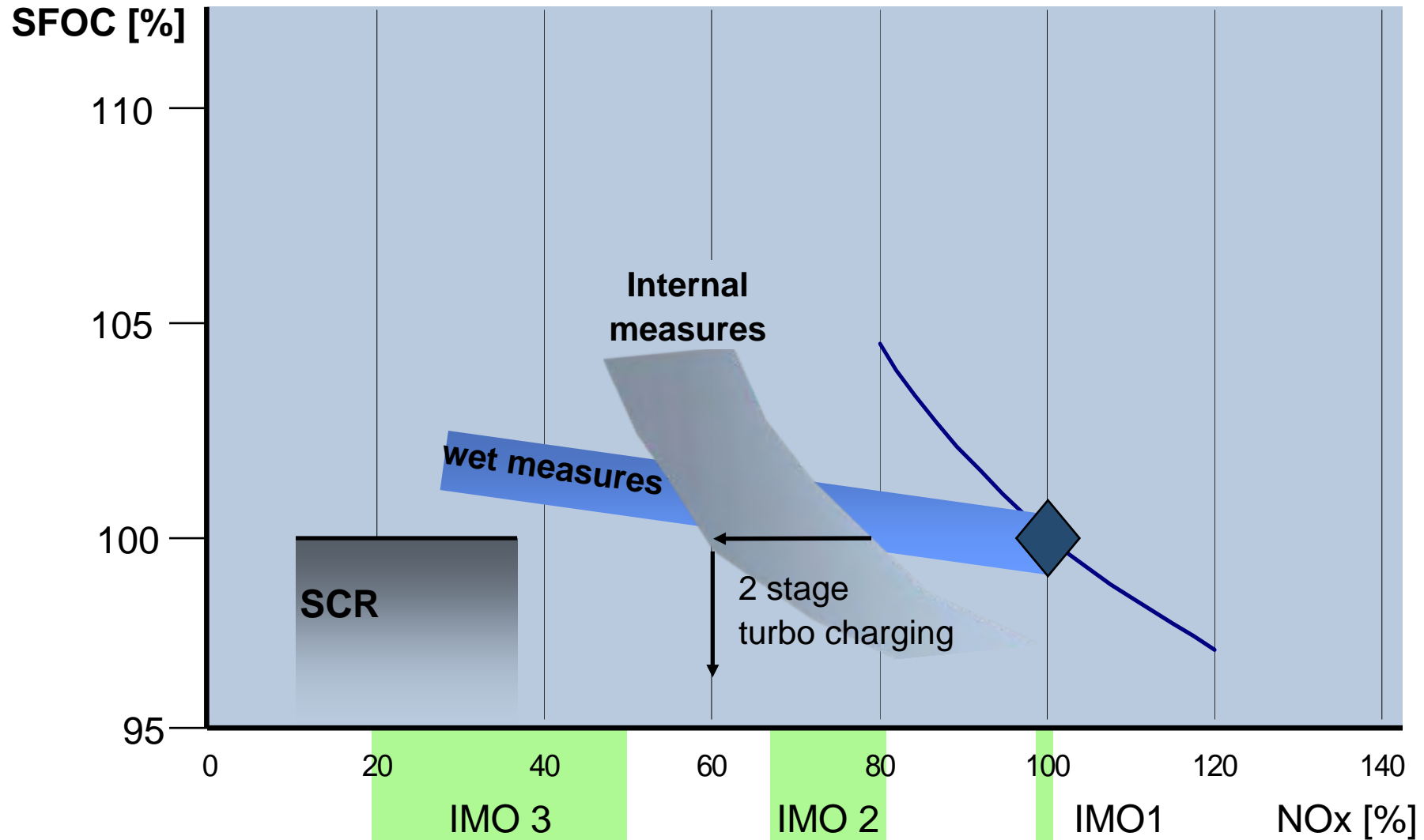


## HAM System

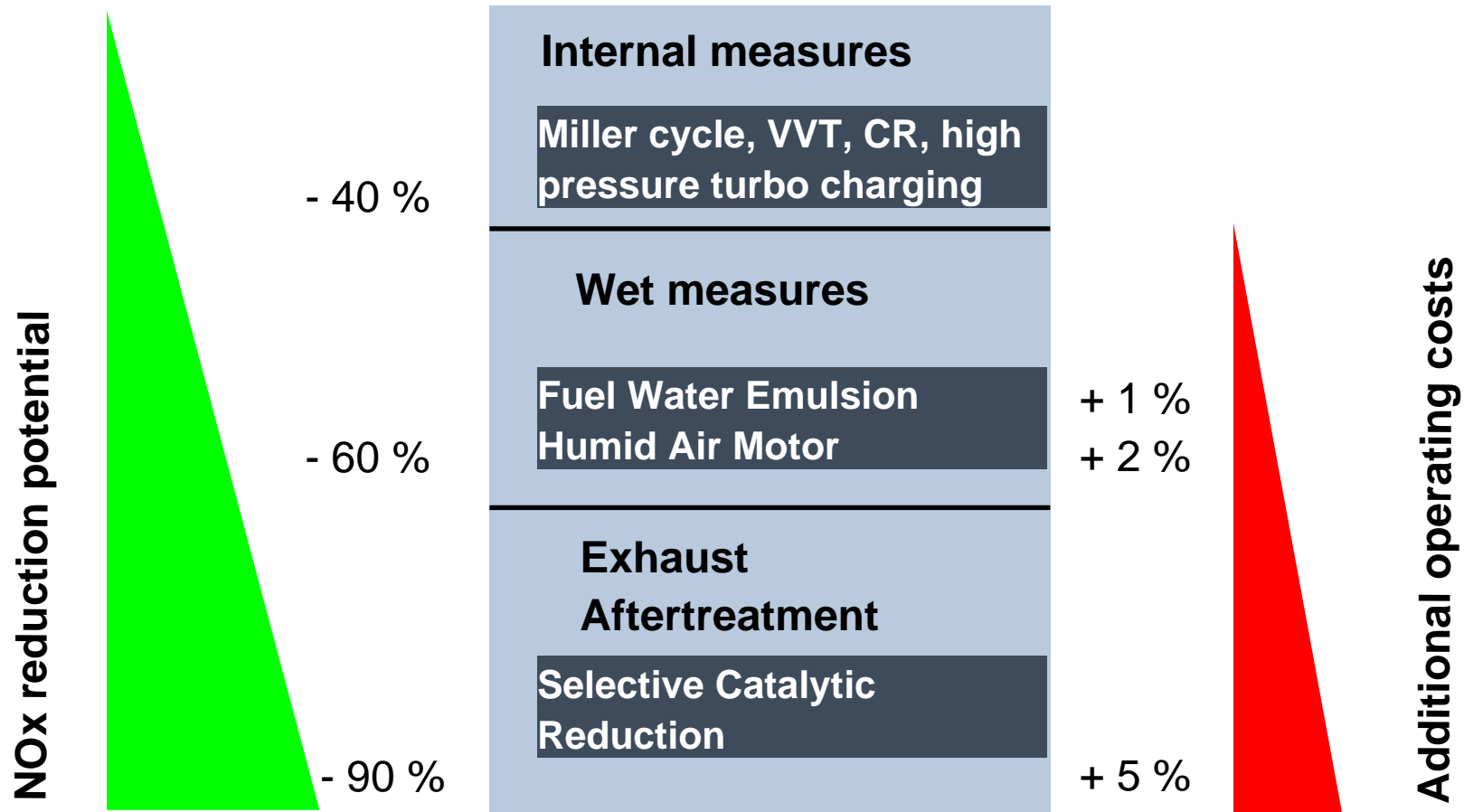
- Reducing agent: seawater
- Less exhaust heat
- Slight SFOC increase

**60% NOx Reduction -> SFOC + 3%**

# Future Emission limits NOx – SFOC trade-off



# Emission - Fuel economy Operating Costs



# Methods for emission reduction

## Summary



- OEM have to offer various technologies to reduce the emissions beyond the required limits
- New engine designs have to be prepared according expected future emission legislation
- Solutions for future fuels must be available
- Additionally most technologies should be available as retrofit-packages for existing engines
- Technology packages have to be designed according environmental and economical aspects of the customers to ensure optimal decisions for investments

# R&D Engineering Medium Speed

