



# WÄRTSILÄ GAS ENGINE DEVELOPMENT & METHANOL ADAPTATION

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# Regulation drivers - Impact on the environment



**NO<sub>x</sub>**

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



**SO<sub>x</sub>**

Acid rains  
Sulphur content in fuel  
SECA (2015) – Global 2020/2025



**Particulate  
matter**

Direct impact on humans  
Locally regulated



**CO<sub>2</sub>**

Greenhouse effect  
Under evaluation by IMO  
EEDI / SEEMP

# Where to go



# Hydrocarbon variations in Wärtsilä ICE

**SG = Spark Ignited**

- Otto process
- Fuel: gas
- low pressure gas

**DF = Dual Fuel**

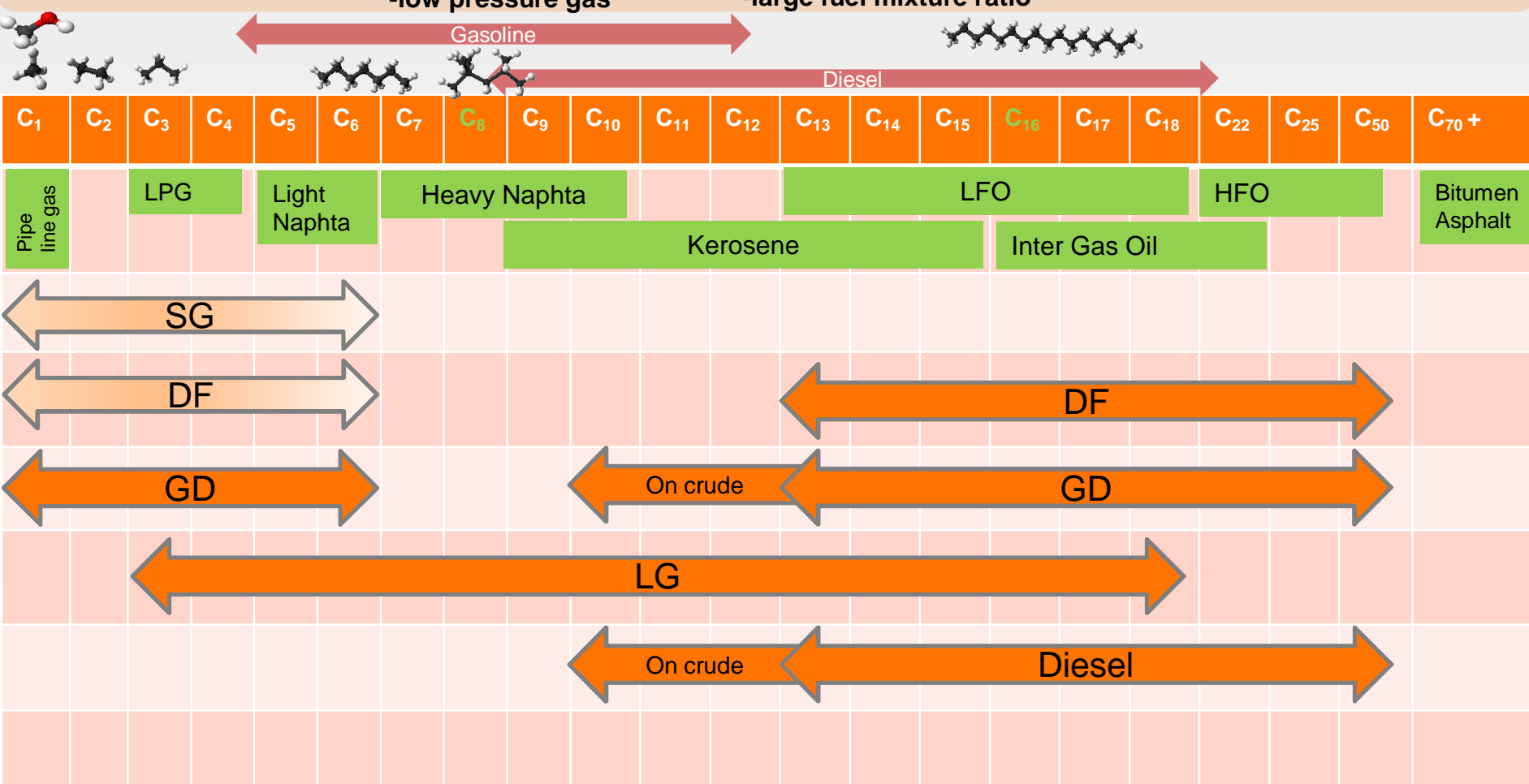
- Otto process + pilot
- Diesel process
- Fuel: gas + liquid fuels
- low pressure gas

**GD = Gas Diesel**

- Diesel process + pilot
- Fuel: gas + liquid fuels
- high pressure gas
- large fuel mixture ratio

**LG = Liquid Gas**

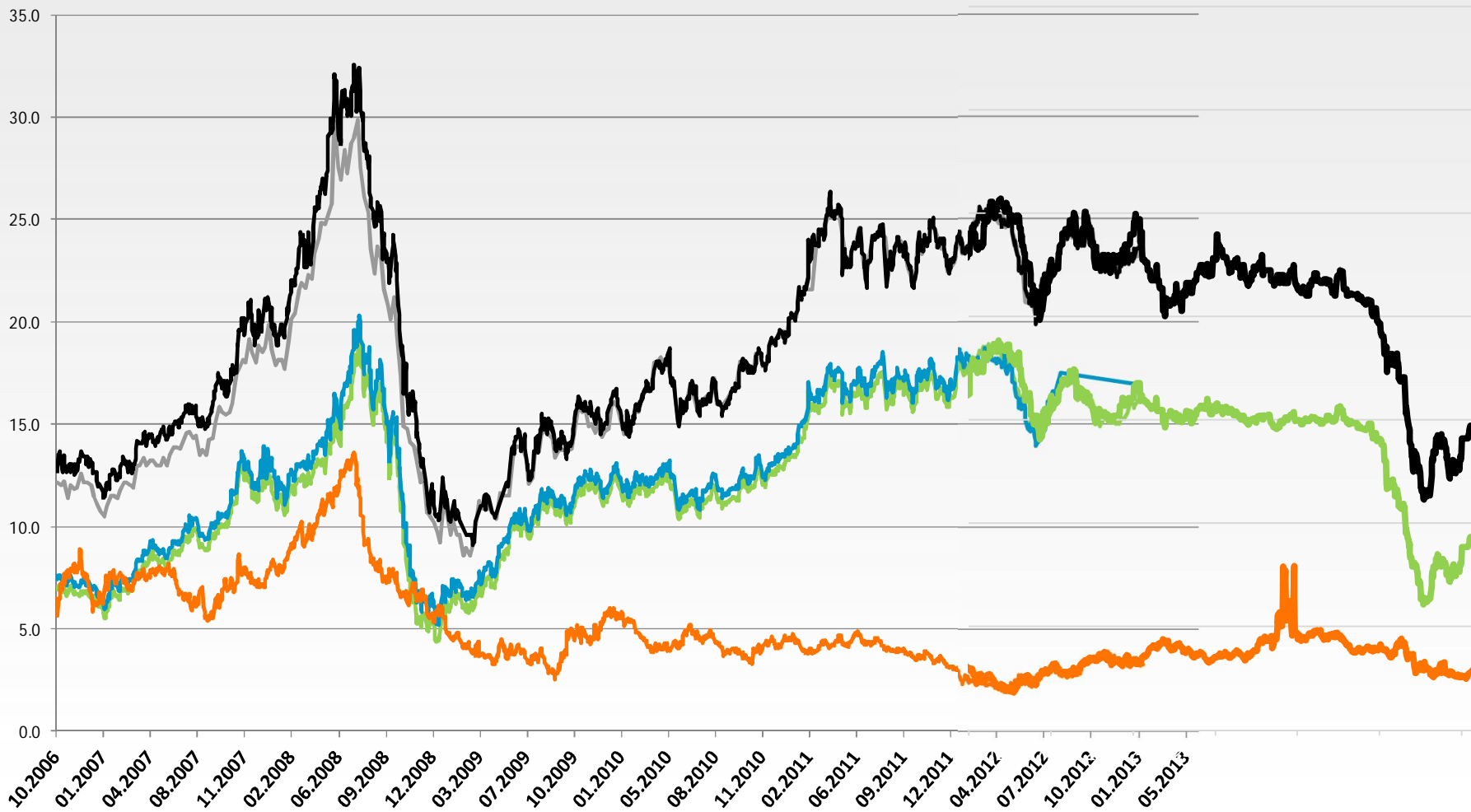
- Diesel process + pilot LFO
- Fuel: HC liquids + LFO
- Common rail main+pilot



# Driving trends: fuel price development

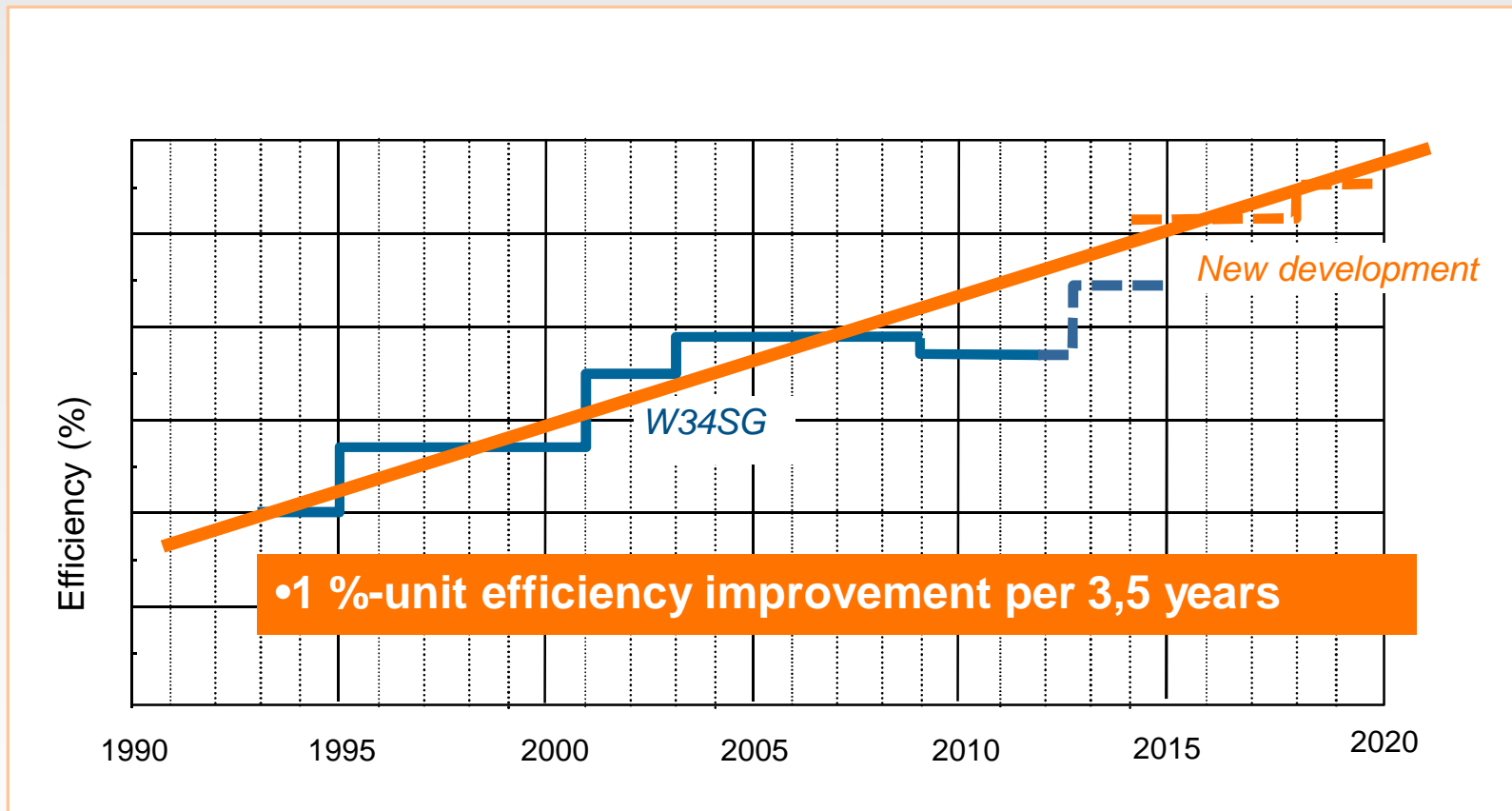
- Marine Gas Oil Rotterdam
- Marine Diesel Oil Rotterdam
- 180 Centistoke Rotterdam
- 380 Centistoke Rotterdam
- Henry Hub (Natural Gas)

Fuel price [USD/MMBTU]



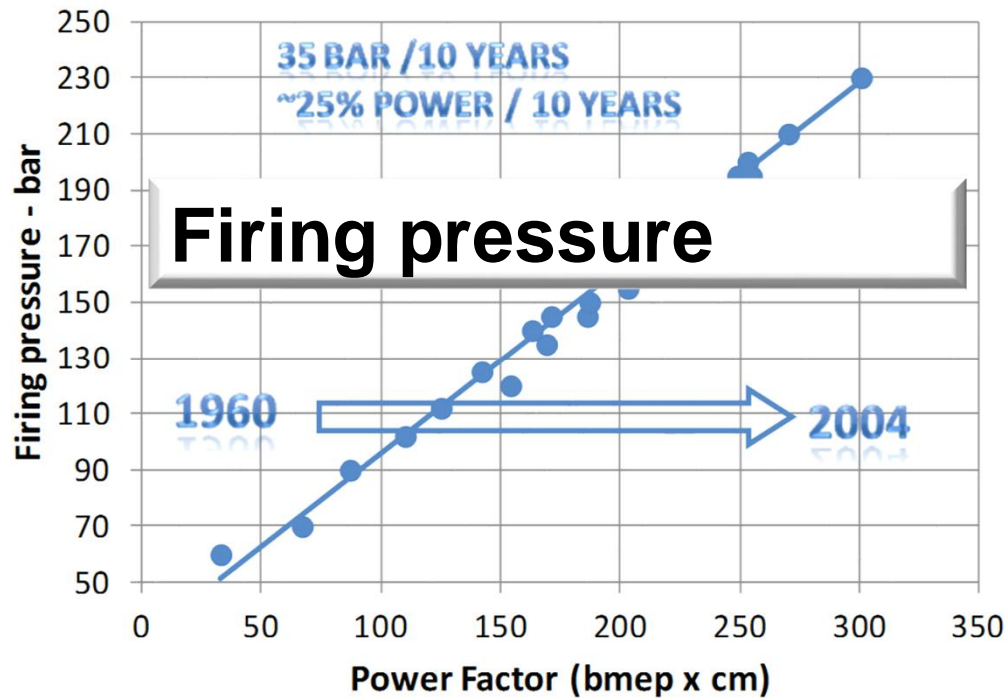
Source: bunkerworld.com; LNG OneWorld.com

# Historical development: W34SG case

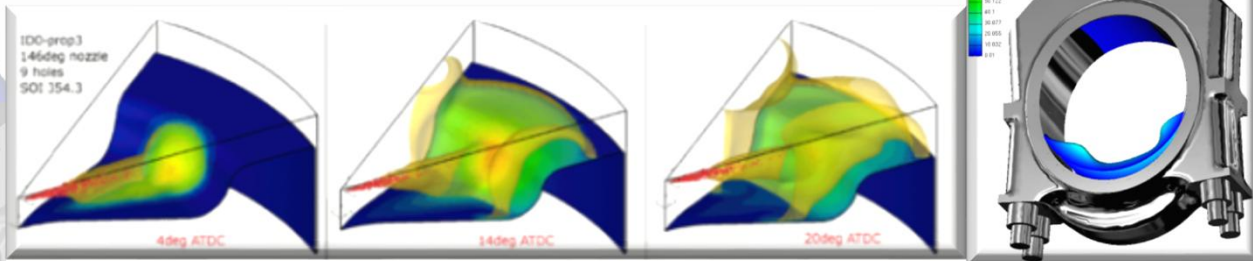
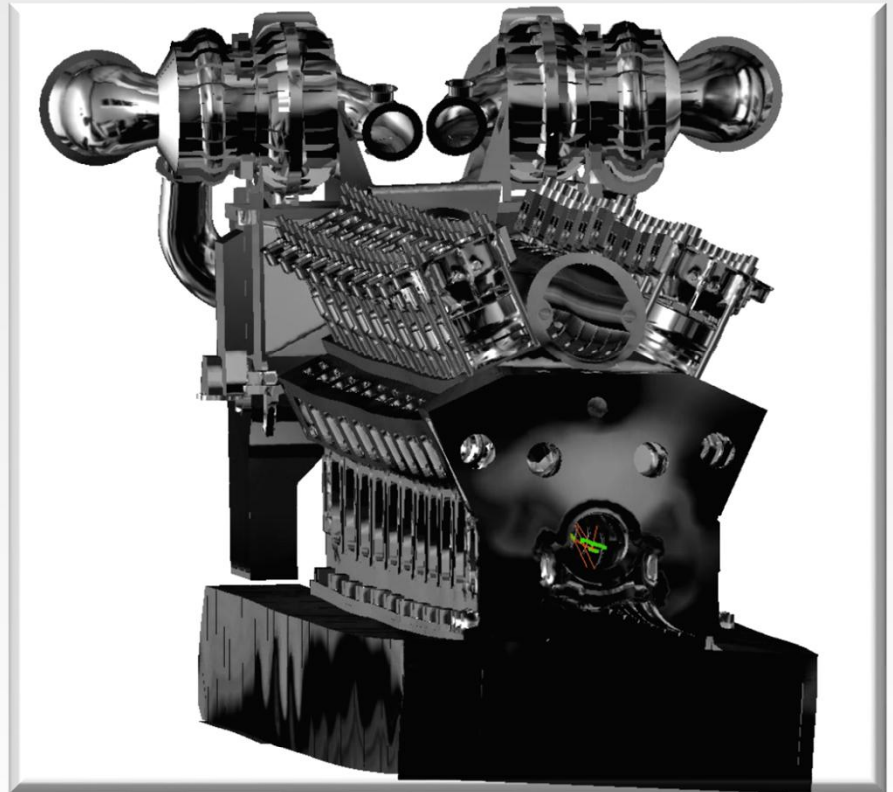
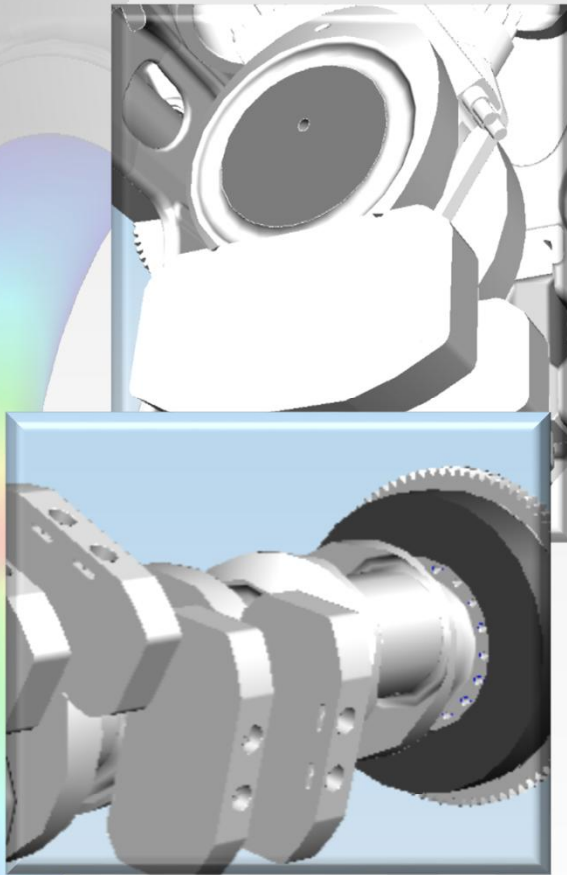


- Evolution is "digital" according to technology implementation (steps)
- Output is as well constantly increased !

# Key Enablers



# Design, calculation and virtual validation





# Engine validation

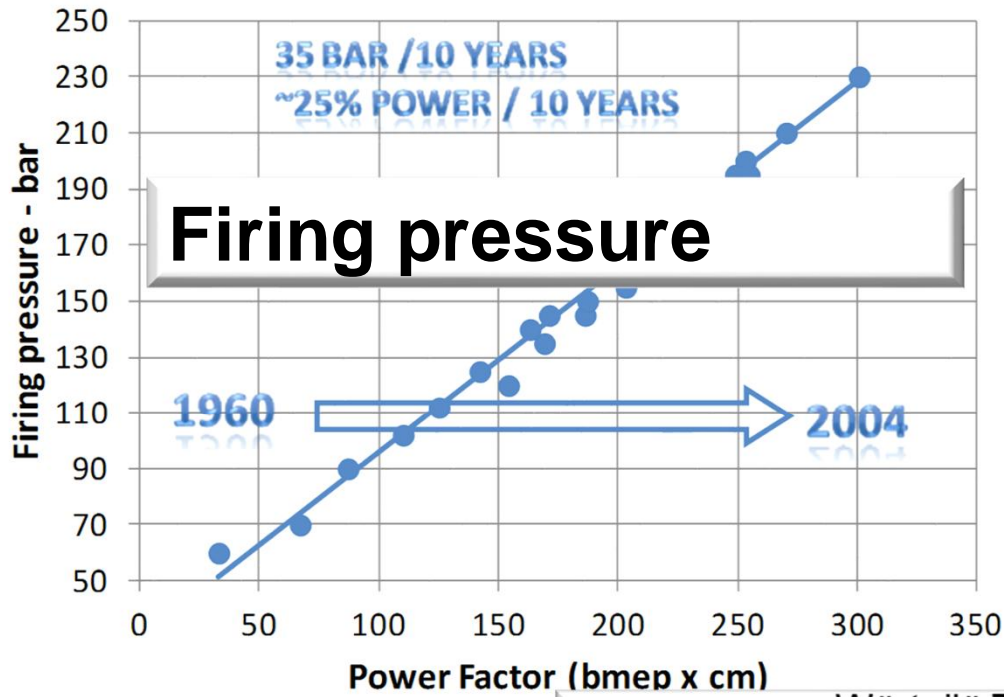
## Single cylinder engine validation



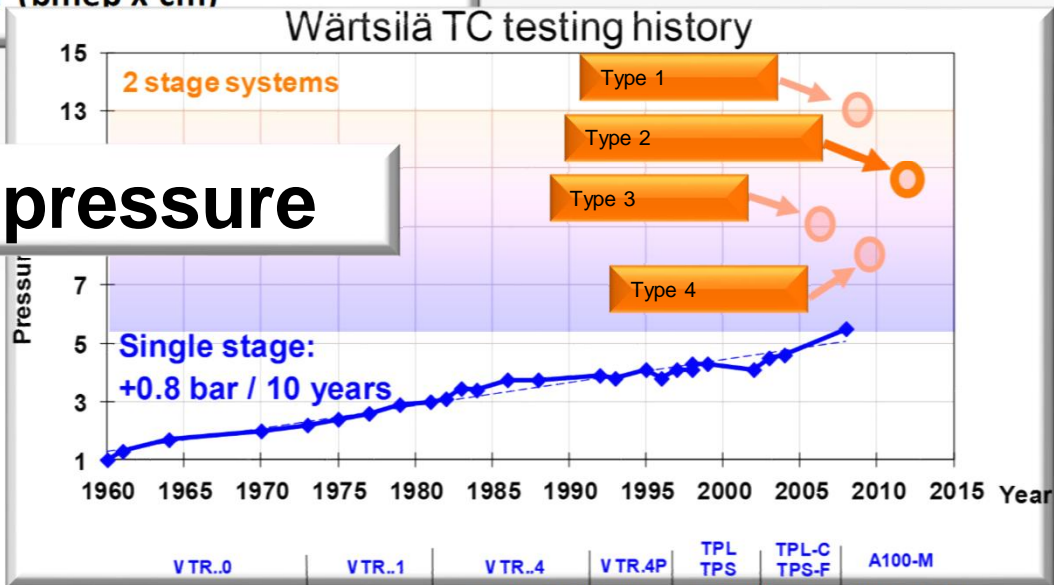
## Engine validation



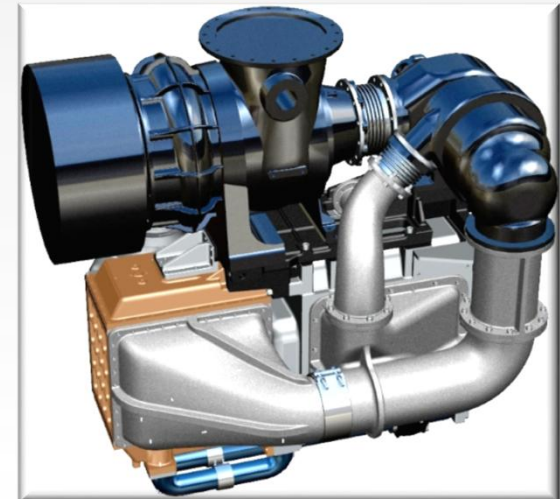
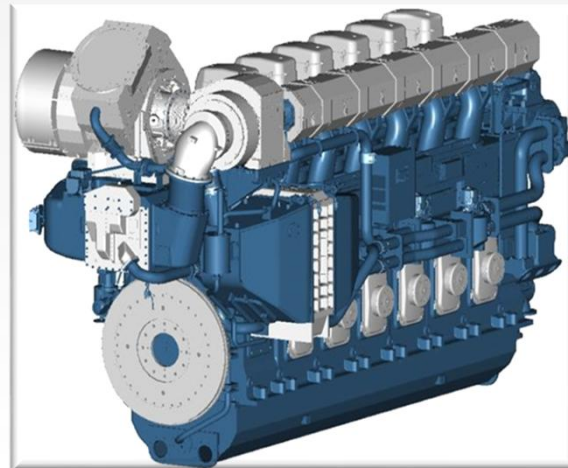
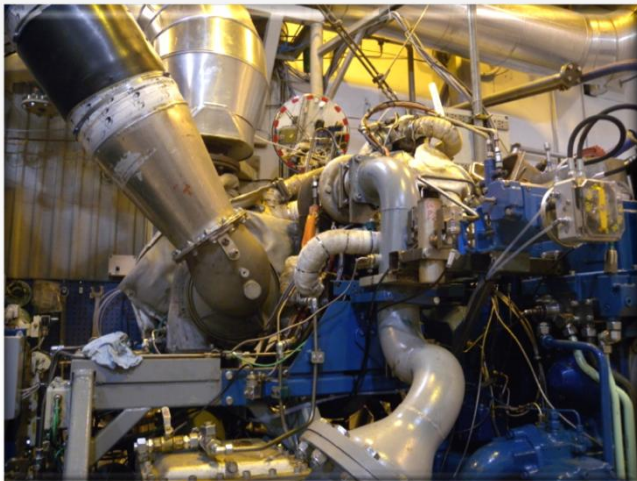
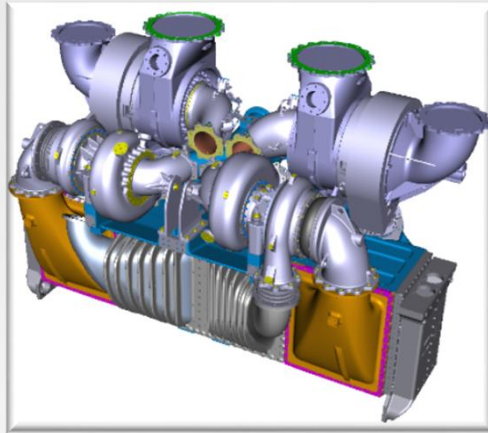
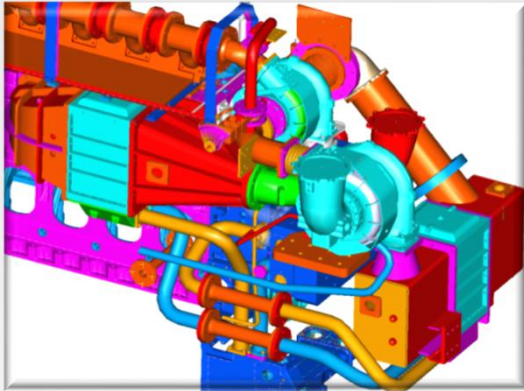
# Key Enablers



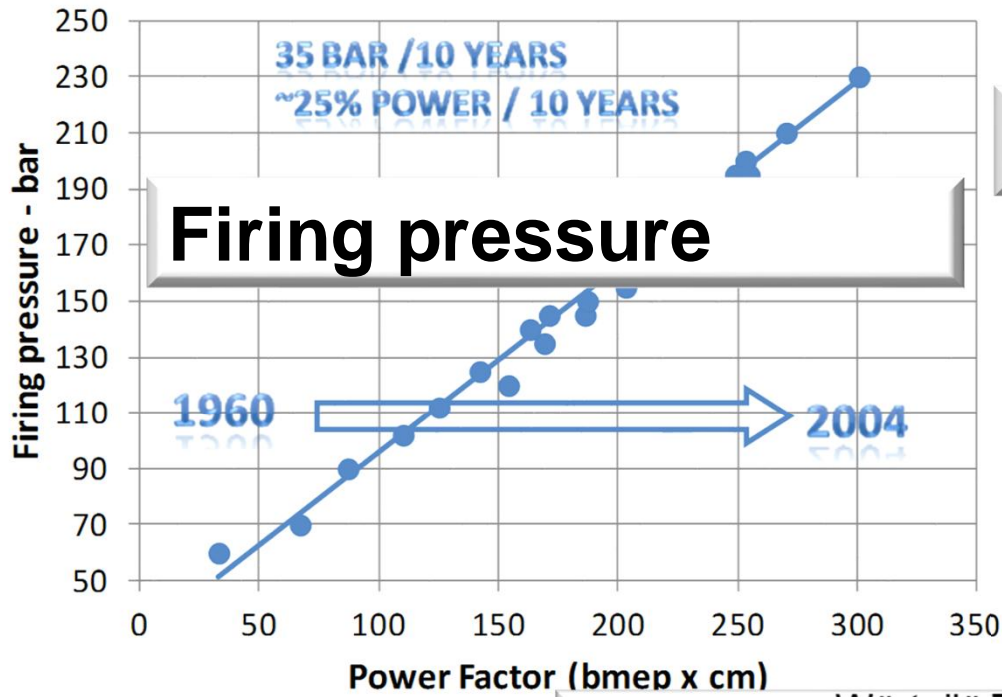
## Boost pressure



# 2-stage turbo charging



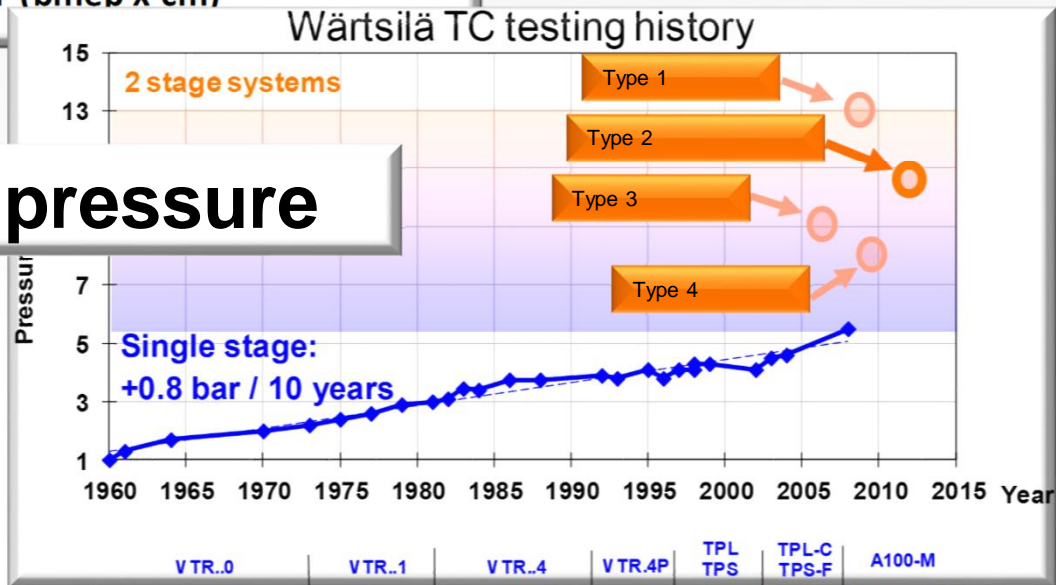
# Key Enablers



## Flexible operation



## Boost pressure



# Automation & Controls



**Control**

**Integrated Solutions**

**Monitoring**

**Safety**

**Operator  
interfaces**

# The future at sea

...fast load variations

...high fuel efficiency on the whole operation area

... optimized performance

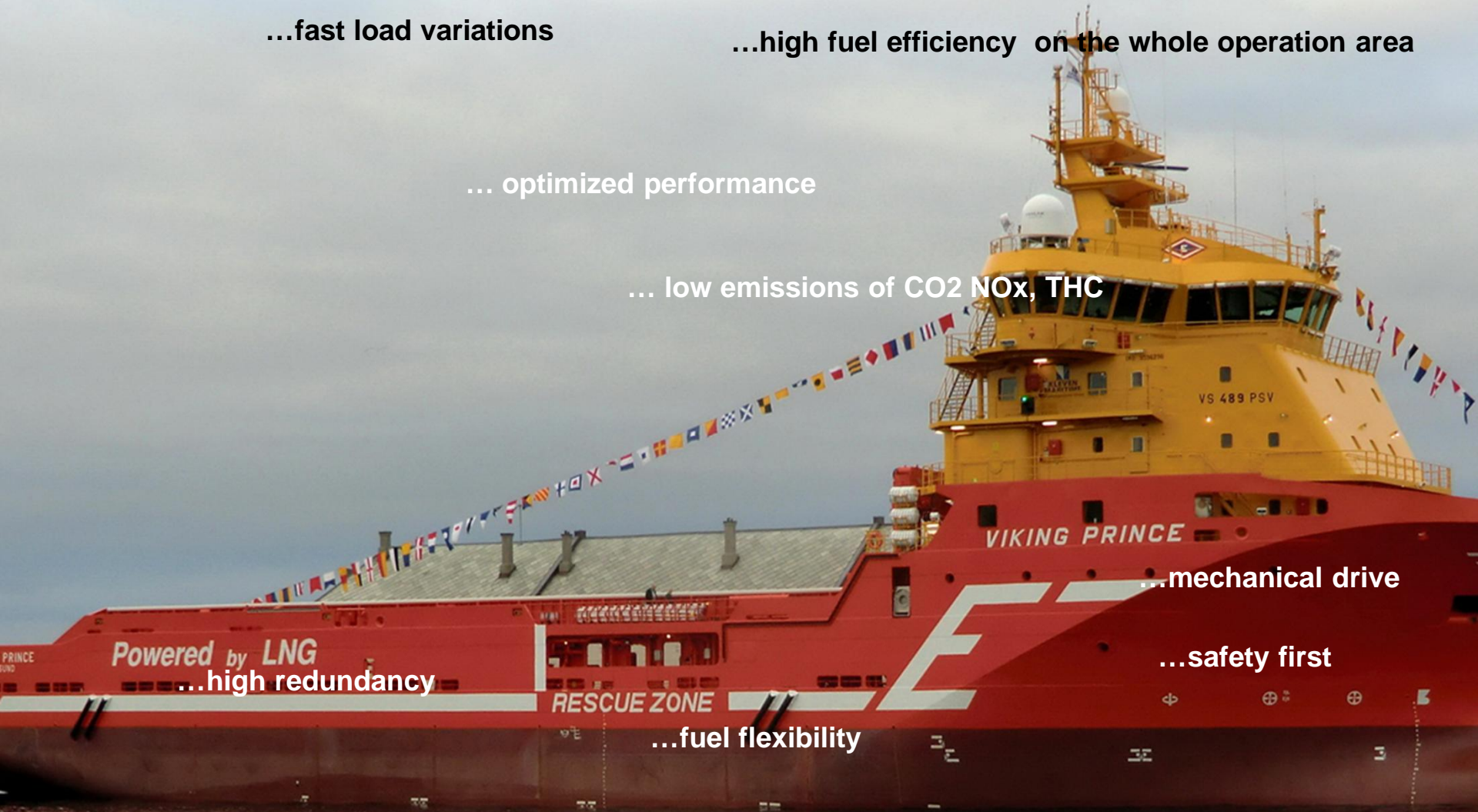
... low emissions of CO2 NOx, THC

...mechanical drive

...safety first

...high redundancy

...fuel flexibility



# The future on land

...short time to electricity production

... increasing grid demands

...full output both on high altitude  
as in dry areas

... small own consumption

...high efficiency also on part load

...high electrical efficiency

...minimized water consumption

...combined heat and  
power production

...high availability and no need  
for additional power

...low demands for gas and fuel quality

...optimized maintenance  
programs for all types of plants

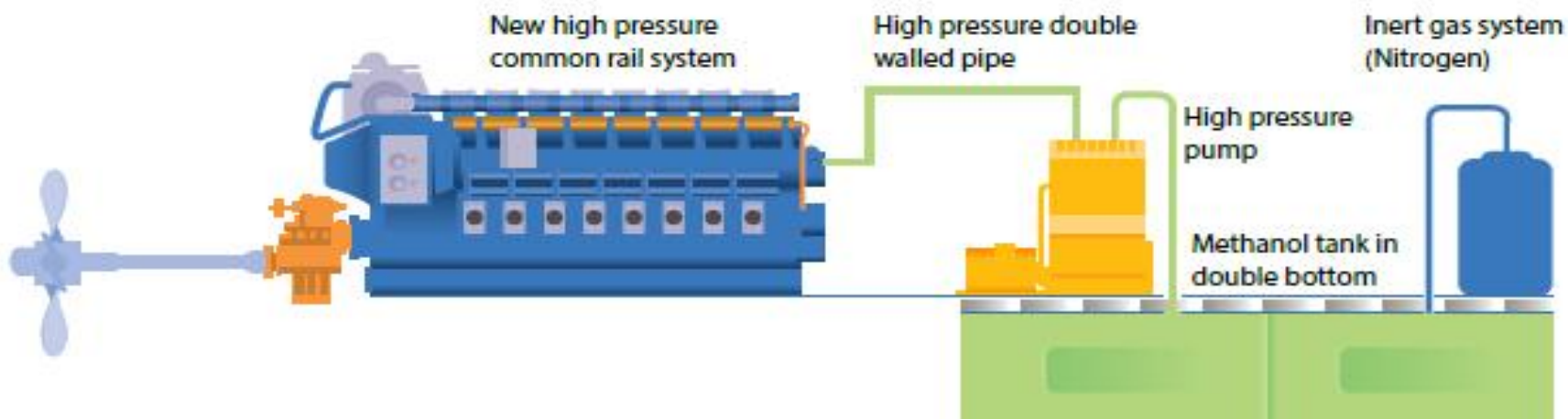
...possibility for gradual increasing  
of the plant size

# Methanol adaptation of Stena Germanica

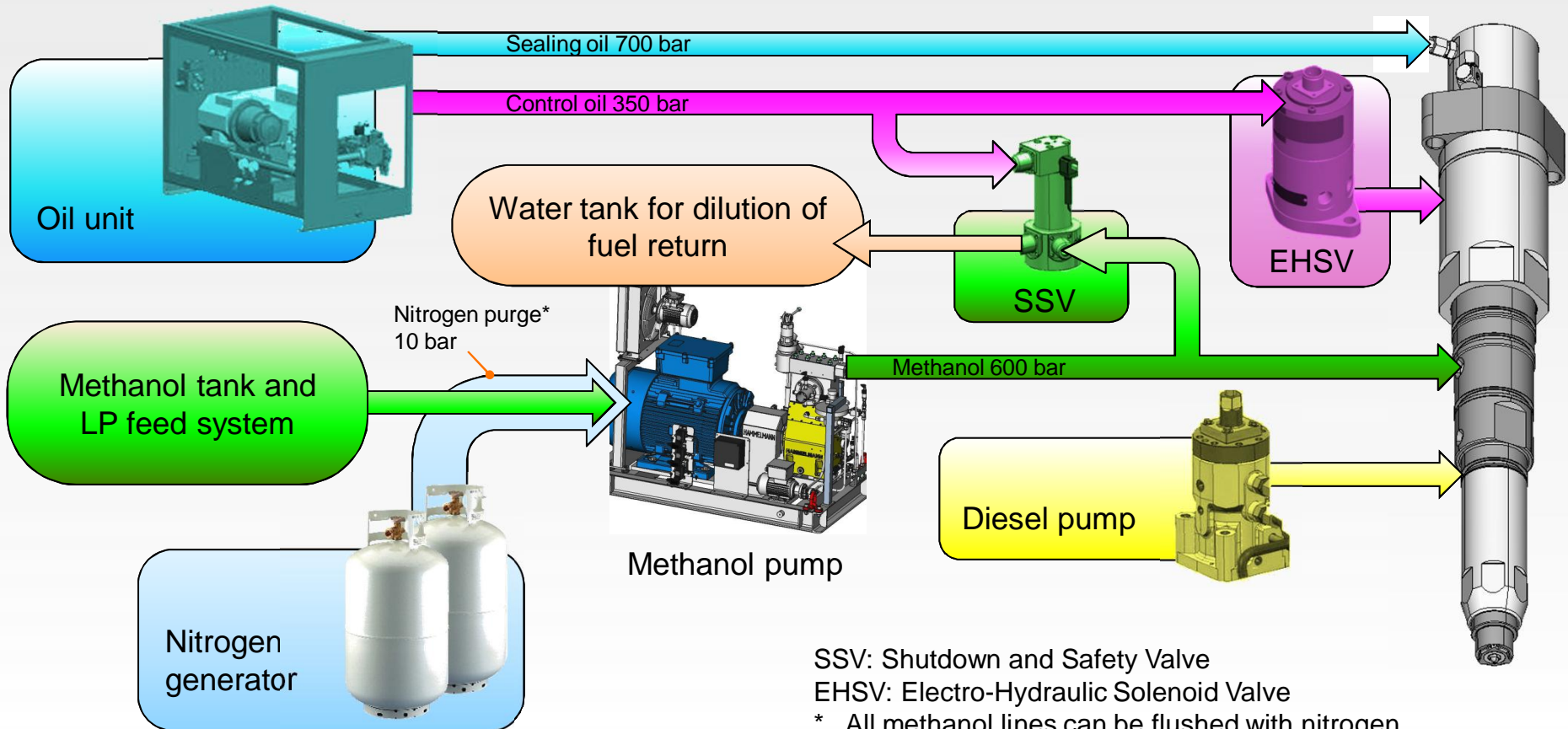




# Stena Germanica – Conversion Scope

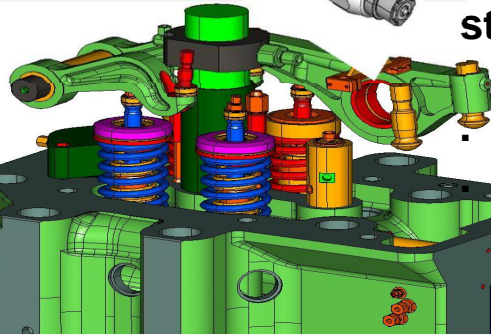
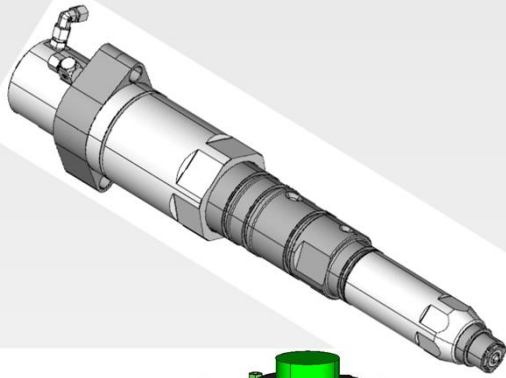


# Technology – GD System layout



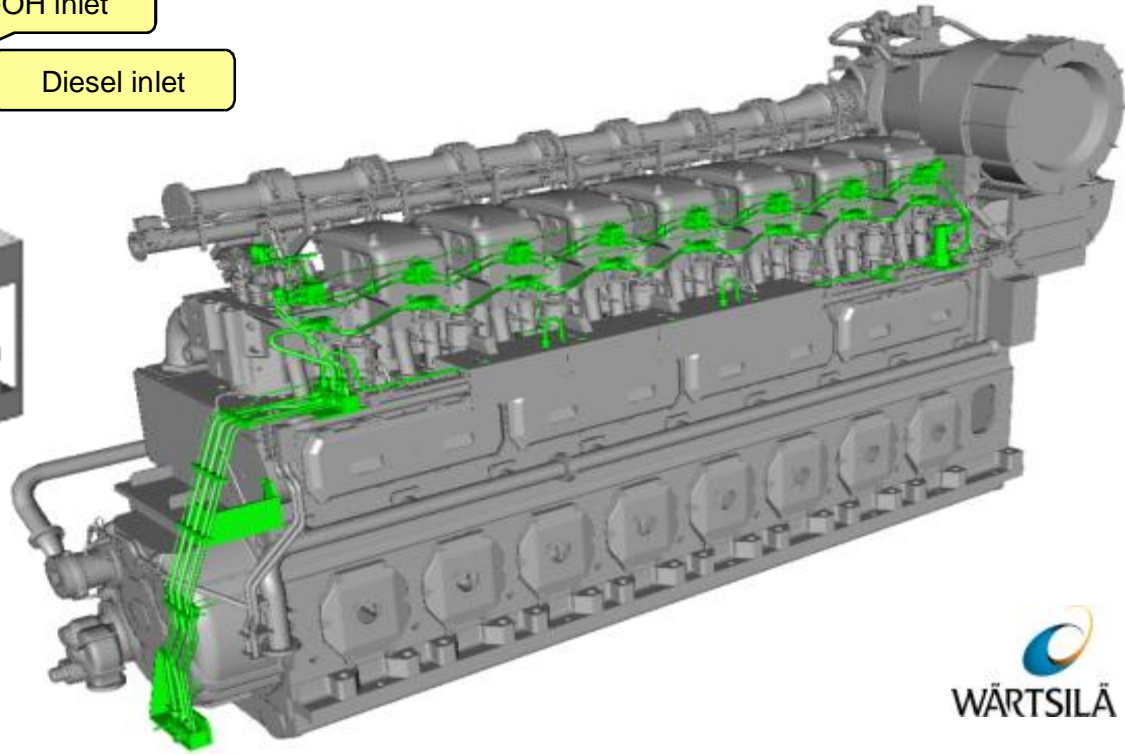
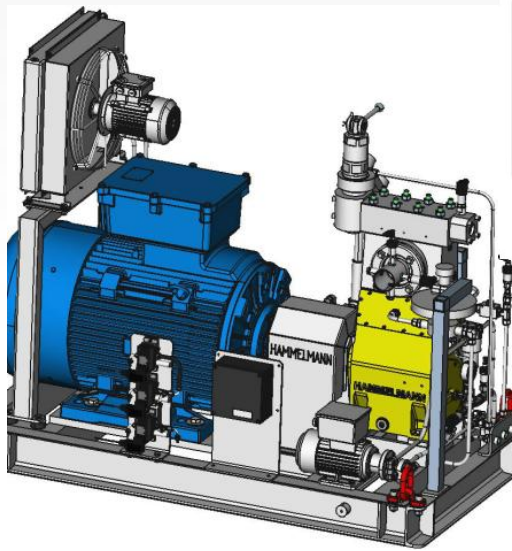
# Technology – Engine Development, retrofit solution

- ❑ On-engine scope is limited to exchange of cylinder heads, fuel injectors and fuel pump plungers
- ❑ A common rail system for methanol injection will be added on the engine
- ❑ In addition to the on-engine conversion parts, the conversion kit includes: standalone high pressure methanol pump, standalone oil unit for supply of sealing and control oil to the fuel injectors, and an update of the automation system.



MeOH inlet

Diesel inlet



# Methanol Injector

**CONTROL OIL 370 bar** ■ →  
FROM SOLENOID VALVE

**METHANOL 600 bar** ■ →  
FROM METHANOL HP PUMP

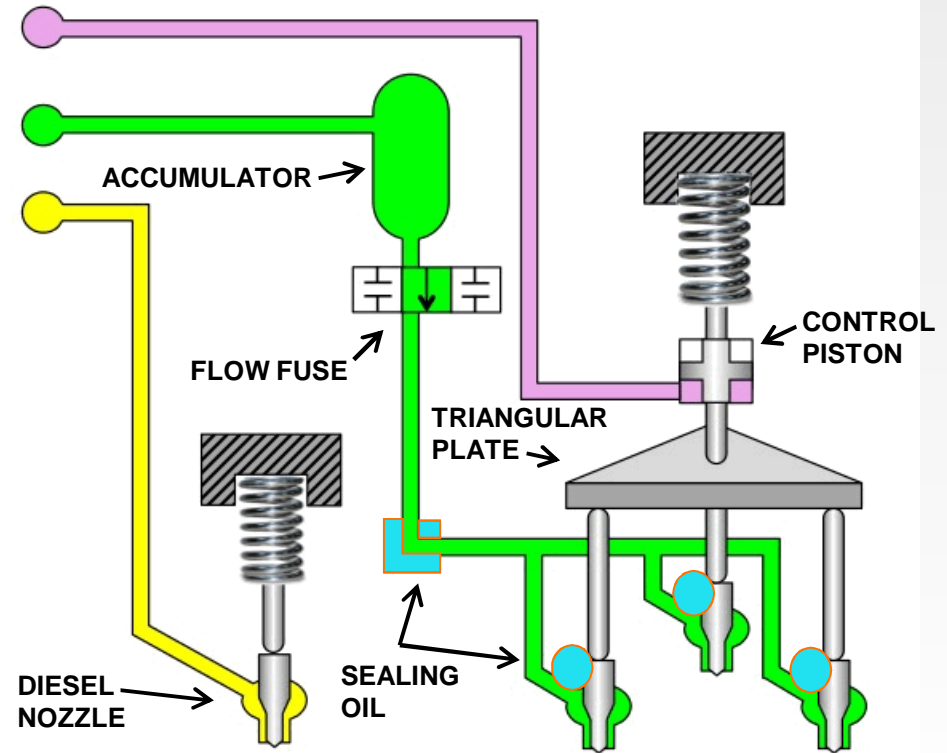
**PILOT DIESEL** ■ →  
FROM DIESEL JERK PUMP

**SEALING OIL 700 bar** ■  
AT METHANOL SEALING SURFACES  
+ AROUND METHANOL NEEDLES

**COOLING OIL 10 bar**   
CIRCULATES IN GALLERIES  
AROUND THE NOZZLE BODY

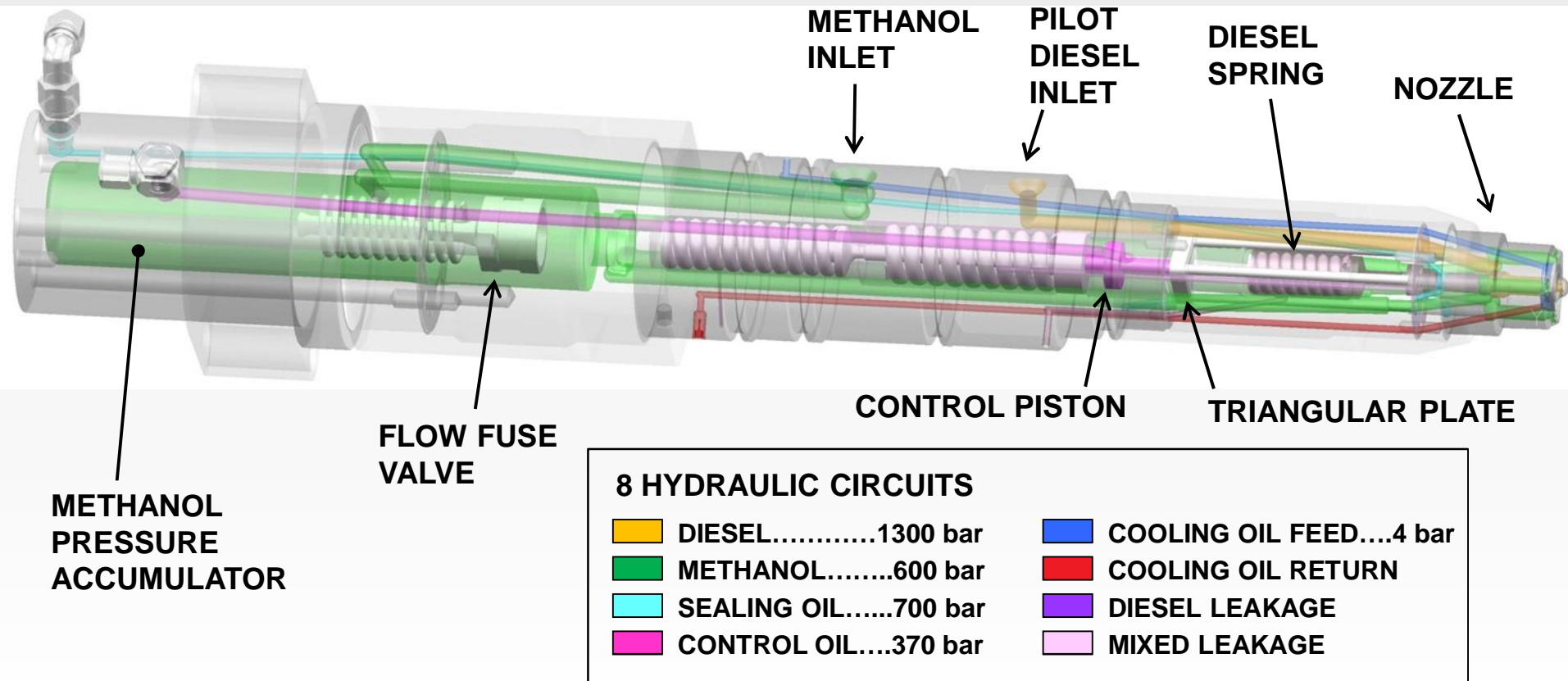
**DIESEL FUNCTIONAL LEAKAGE**   
DEDICATED COLLECTION LINE

**MIXED LEAKAGES**   
CONTROL OIL, SEALING OIL  
FUNCTIONAL + FROM POSSIBLE  
SEALING SURFACE FAILURE



# Methanol Injector

## METHANOL INJECTOR



# Stena Germanica conversion

Stena Germanica conversion of the main propulsion machinery, 4 x Wärtsilä 8ZAL40S

Totally 24.000 kW at Remontowa shipyard, Gdansk, March 2015



# Methanol adaptation



Engine conversion to dual fuel



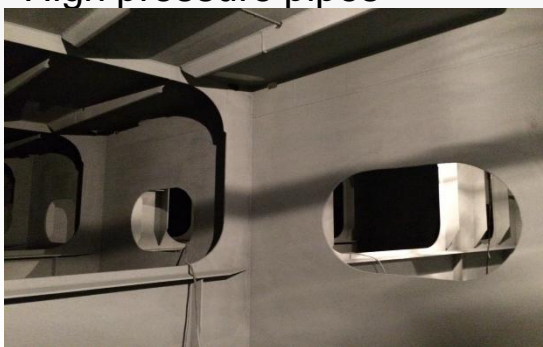
High pressure pipes



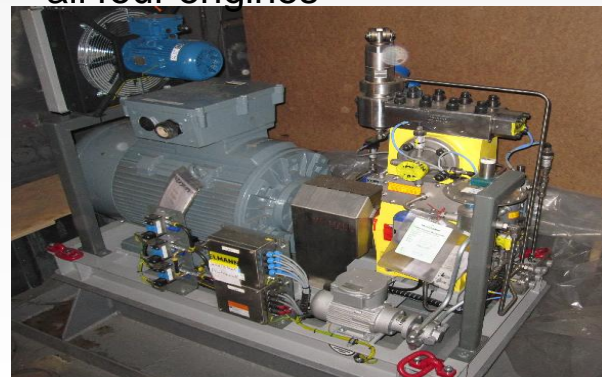
New engine control system for all four engines



13 km new cables



Methanol storage tank painted with zinc silicate



High pressure pumps

# Engine before and after conversion





# Wärtsilä cooperation with schools and universities

1. Advertising for students
2. Wärtsilä info at educational institutes
3. Wärtsilä employer image
4. Recruitment fairs and events
5. Job announcements
6. Summer jobs, final thesis and traineeships
7. Company visits
8. Cooperation with schools, student groups and guilds

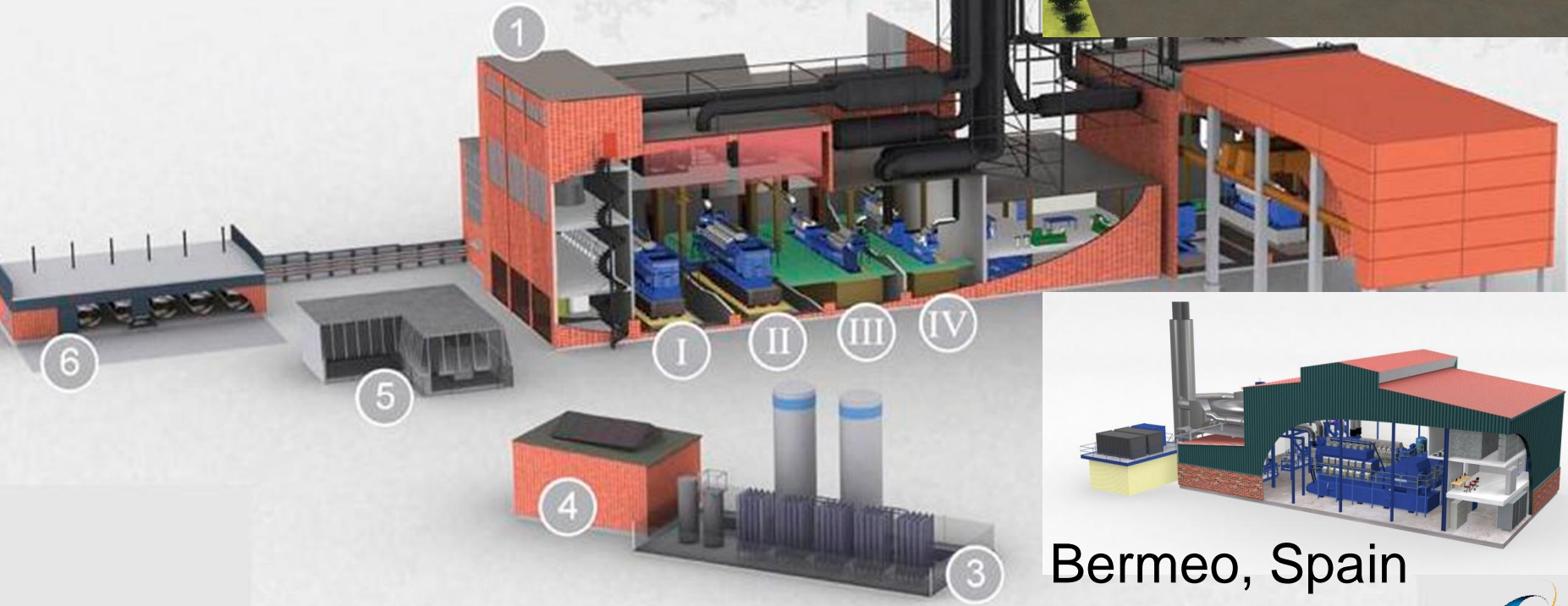
Universities in Finland		Universities in Switzerland		Universities in Germany		Universities in the Netherlands		Other universities		
University	University	University	University	University	University	Majors	Contact	Actions made	BU	Wärtsilä contact
Aalto University	ETH Zurich	University Rostock	TU of Eindhoven	NTUA Athens						
Tampere University of Technology	ZHAW Winterthur (University of Applied Science)	FVTR Rostock	HTWG Konstanz (University of Applied Science)	University del Salento						
Lappeenranta University of Technology	PSI (Paul Scherrer Institute)	TU Munich	TU of Delft	University of Sheffield						
Vaasa University	FHNW Windisch (University of Applied Science)		Twente university	Newcastle University						
Turku University of Ap. Sc.	Possibly to include:		Hogeschool Rotterdam	Kyushu University						
Abo Akademi	EMPA (Research Institute)		Avans Hogeschool, Brabant	London City University						
Novia University of Ap. Sc.	HSLU Luzern (University of Appl. Science)		Avans hogeschool den Bosch							

# Engine testing

Vasa, Finland



Trieste, Italy



Bermeo, Spain





# WÄRTSILÄ