THE MOST EFFICIENT 4-STROKE ENGINE IN THE WORLD WÄRTSILÄ 31

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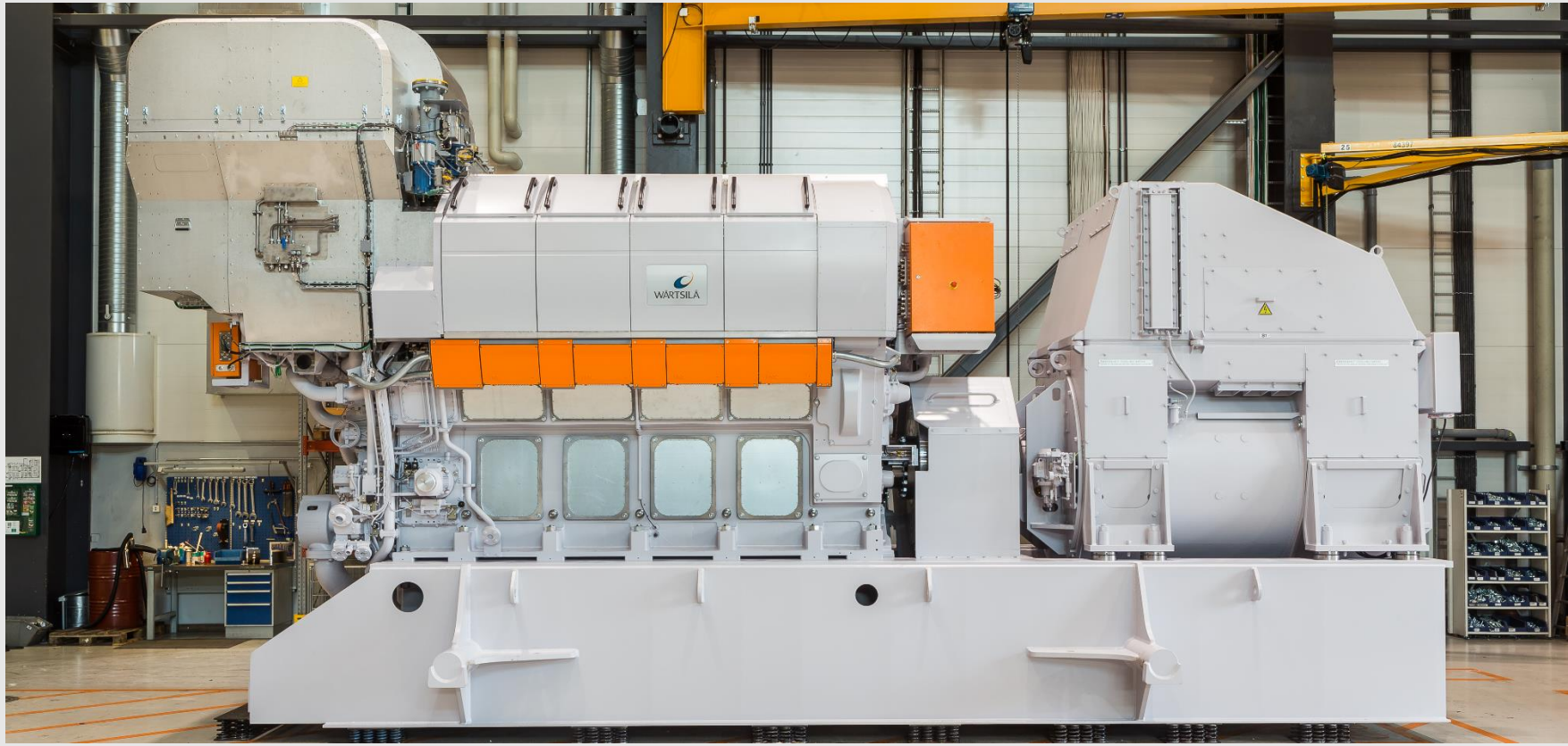
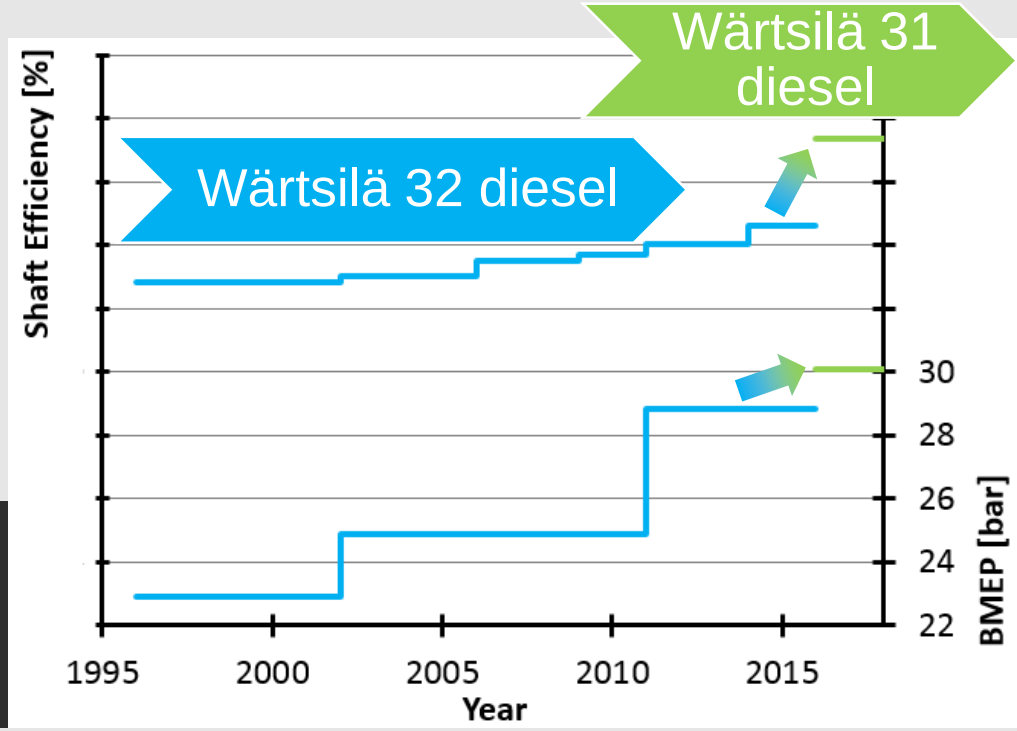


Wärtsilä 31 main technical data

	Diesel	Dual Fuel	Spark Gas
Bore / Stroke (mm)	310 / 430 mm	310 / 430 mm	310 / 430 mm
Nom. Speed (rpm)	750	750	750
Max. Output/Cyl (kw)	610	550	550
BMEP (bar)	30.1	27.1	27.1
Charge air system	2-stage turbocharging + variable valvetrain		



> 3 in 1.

Wärtsilä 31 test engines

- Prototype engines of each type available for testing
  - Full scale engine validation
  - Performance optimizations

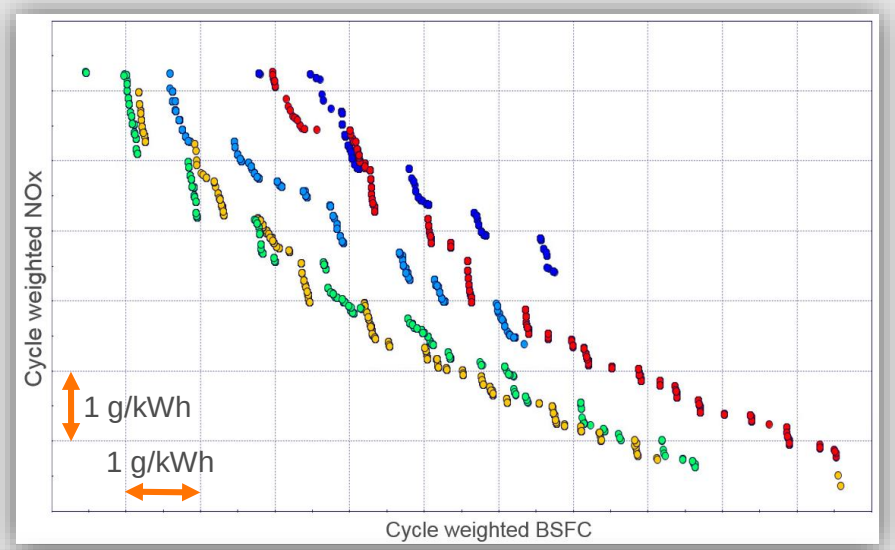
10V31 SG
Started in
2013


8V31
Started in
2014

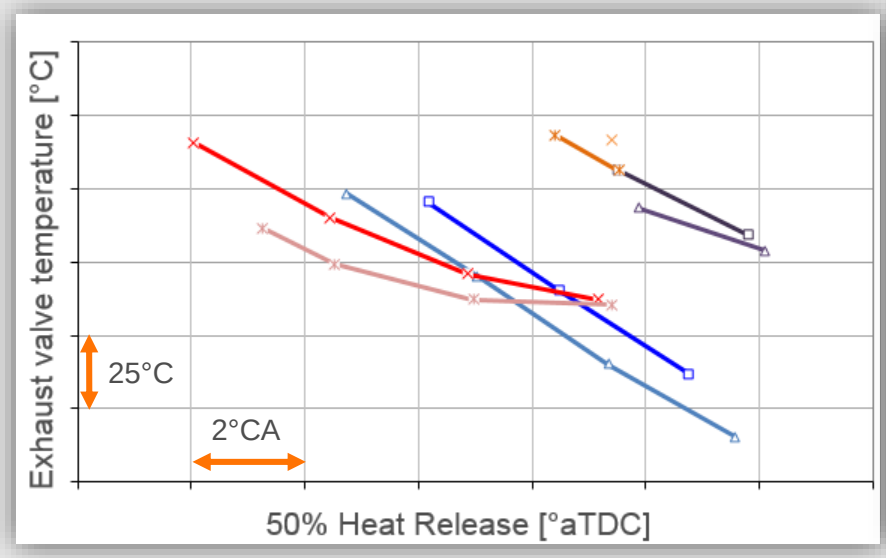

10V31 DF
Started in
2015

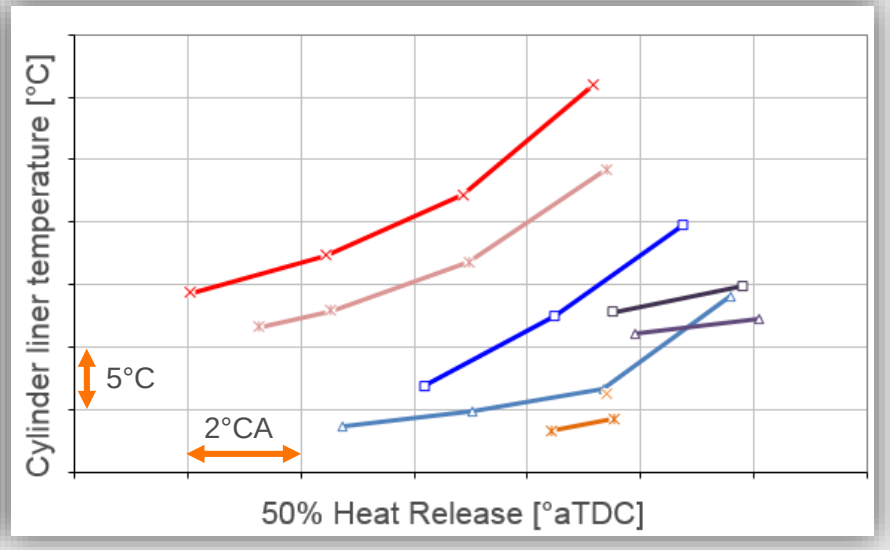
Main Components

- Single cylinder engine used for selecting major components
- Components chosen based on both performance and reliability



Piston top shape



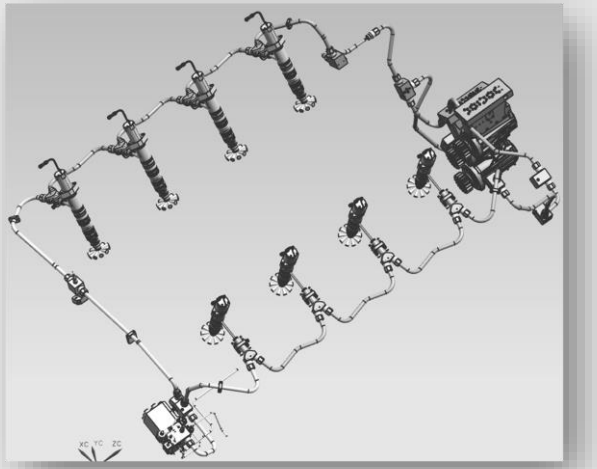


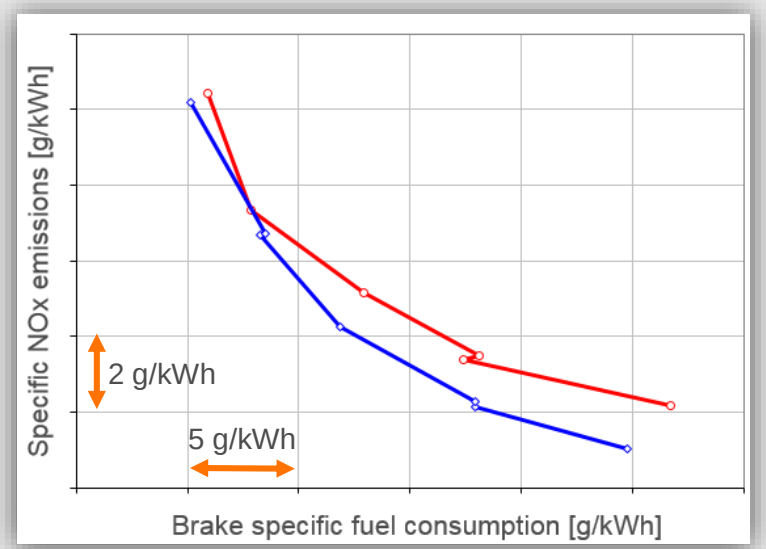
Narrow nozzle spray angle

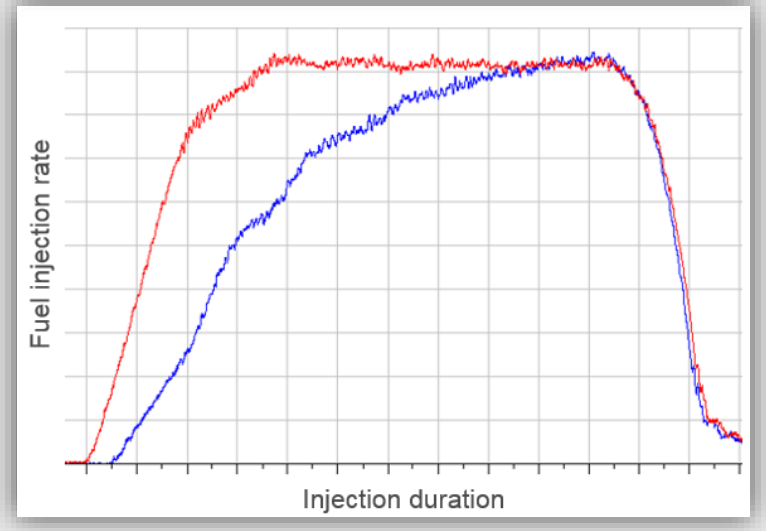
Wide nozzle spray angle

Fuel Injection System

- LFO and HFO capable common rail system, with the ability to run multiple injections per cycle
- Fuel injection rate shaping used to improve the NOx-BSFC trade-off
  - Slow rate shaping requires higher cylinder pressure. Taken into account in the design phase !





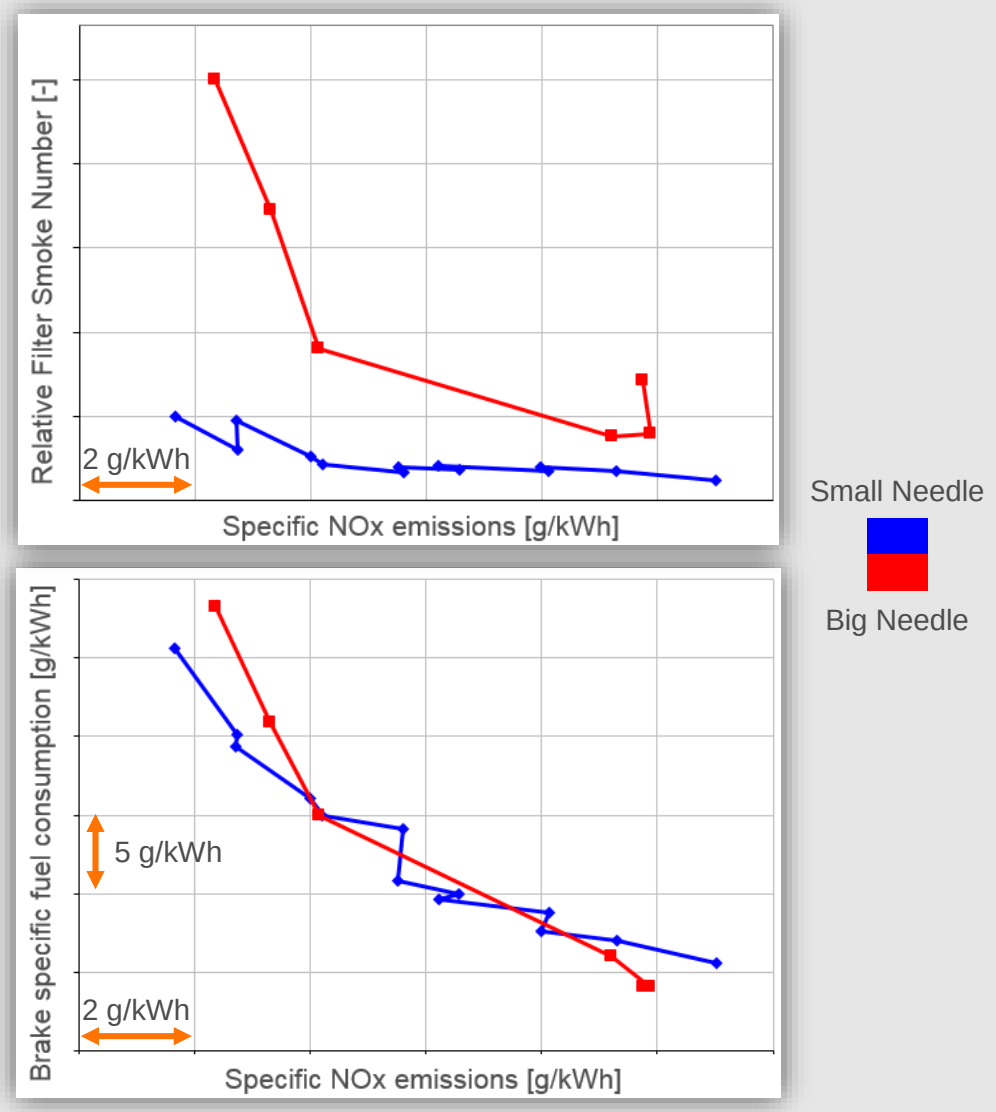


Fast rate shaping

Slow rate shaping

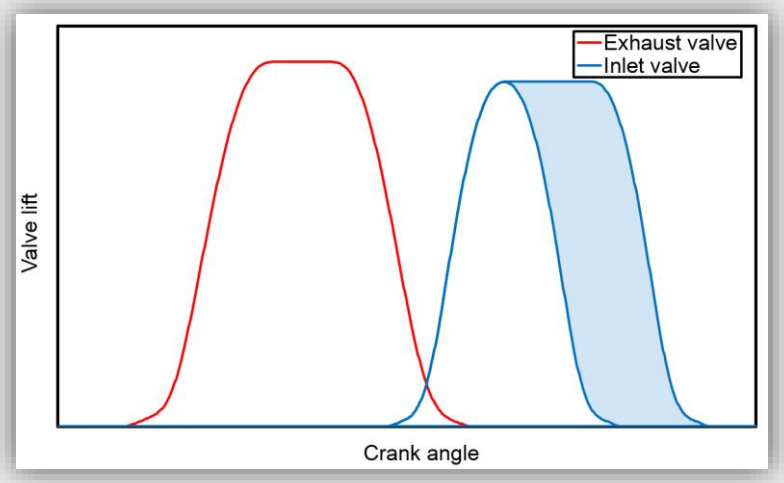
Twin needle injector

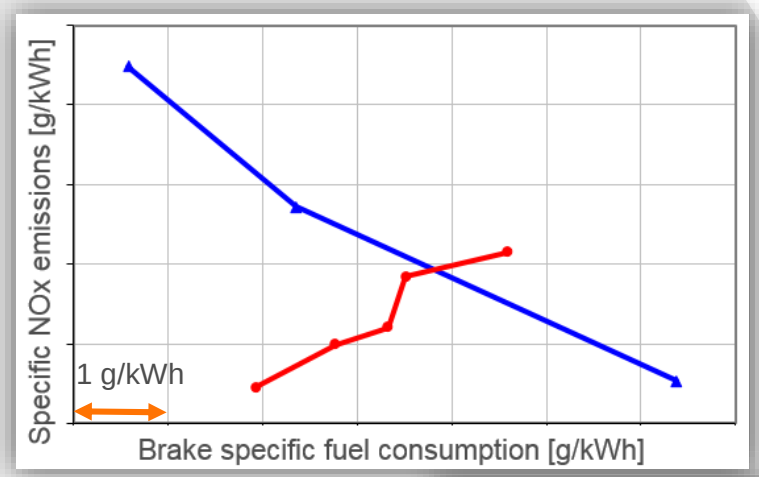
- Small injector nozzle for low smoke operation. Good atomization of fuel also at low rail pressure
- With the small nozzle a better NOx-BSFC trade-off can be achieved due to more tuning freedom thanks to the lower smoke emissions



Stepless VIC (Variable Inlet valve Closing)

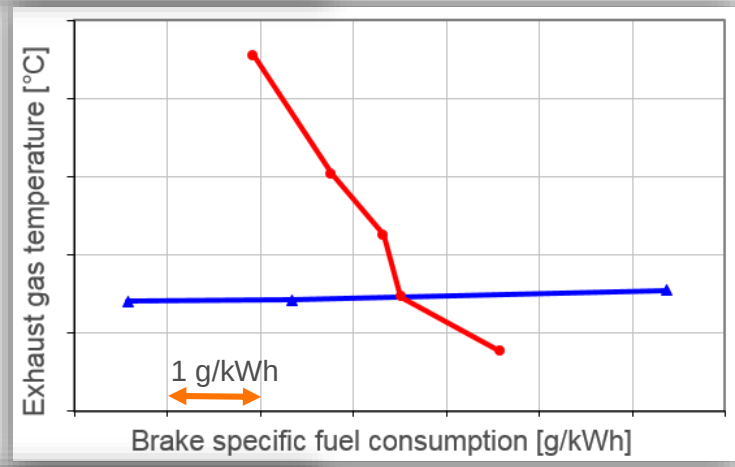
- A key feature for optimizing the engine at all loads.
  - NOx, BSFC, EGT, Pmax, Smoke, ...
- Direct enabler for better part load performance

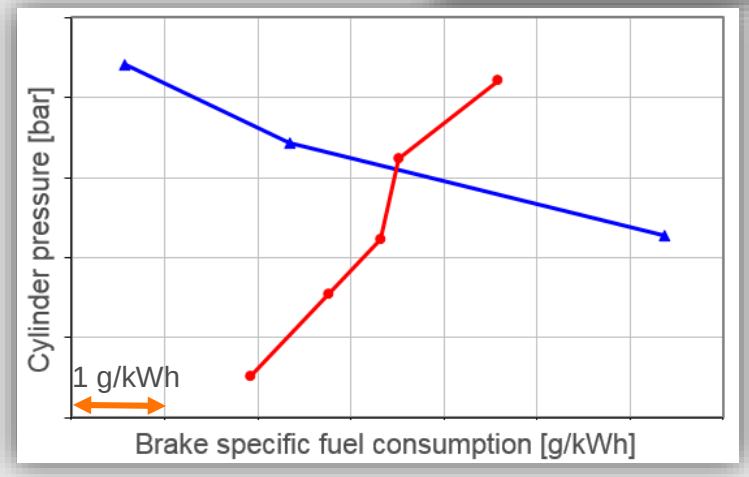




Miller + SOI sweep

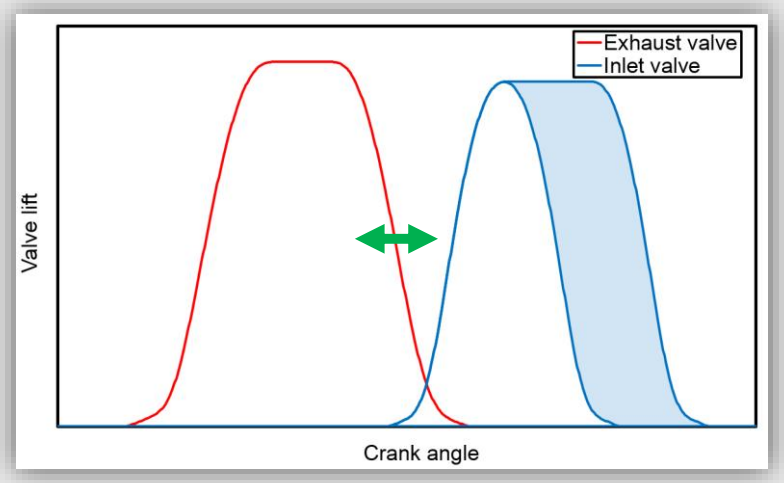
SOI sweep

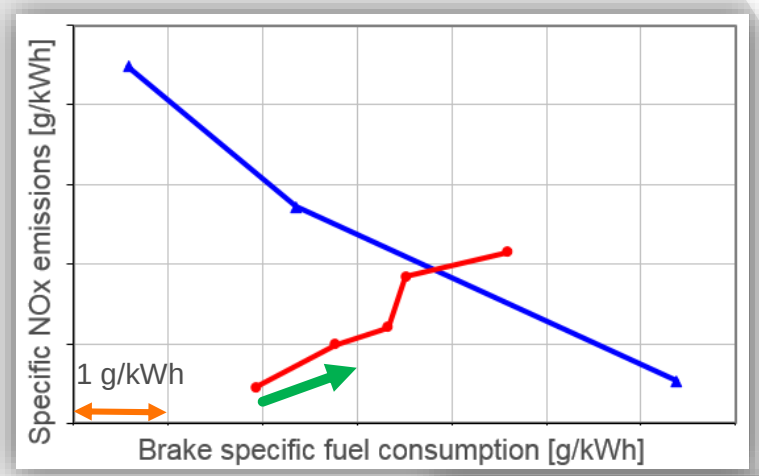




VEC (Variable Exhaust valve Closing)

- VEC is used to adjust the amount of scavenging
  - Another factor bringing more options for optimization
  - Low load running without reverse flow

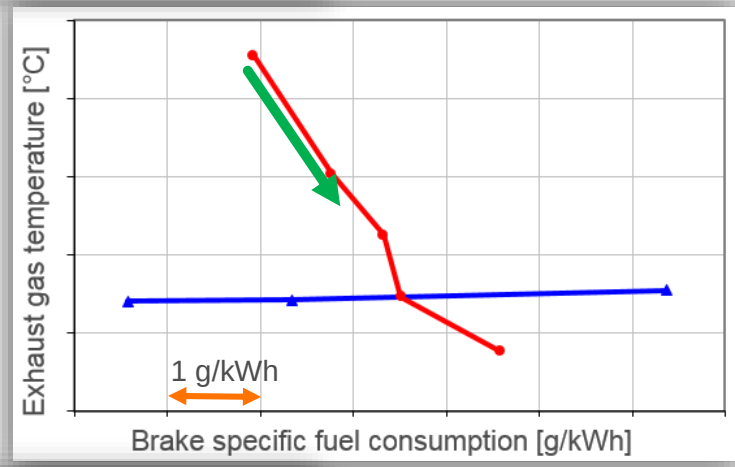


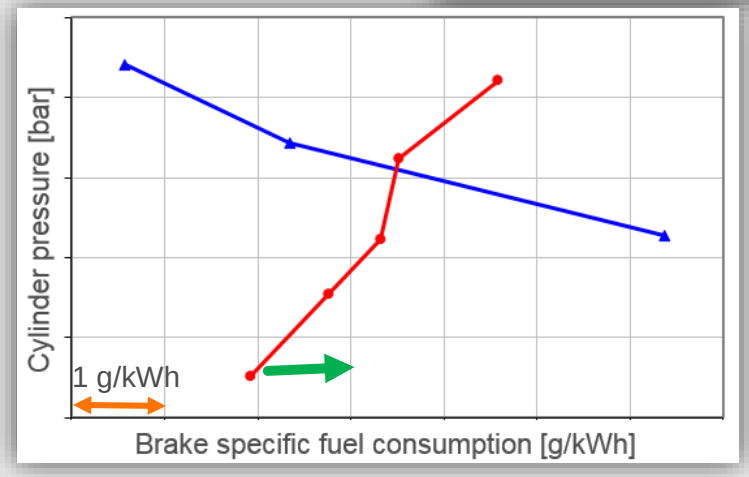


Miller + SOI sweep

Direction of VEC impact

SOI sweep



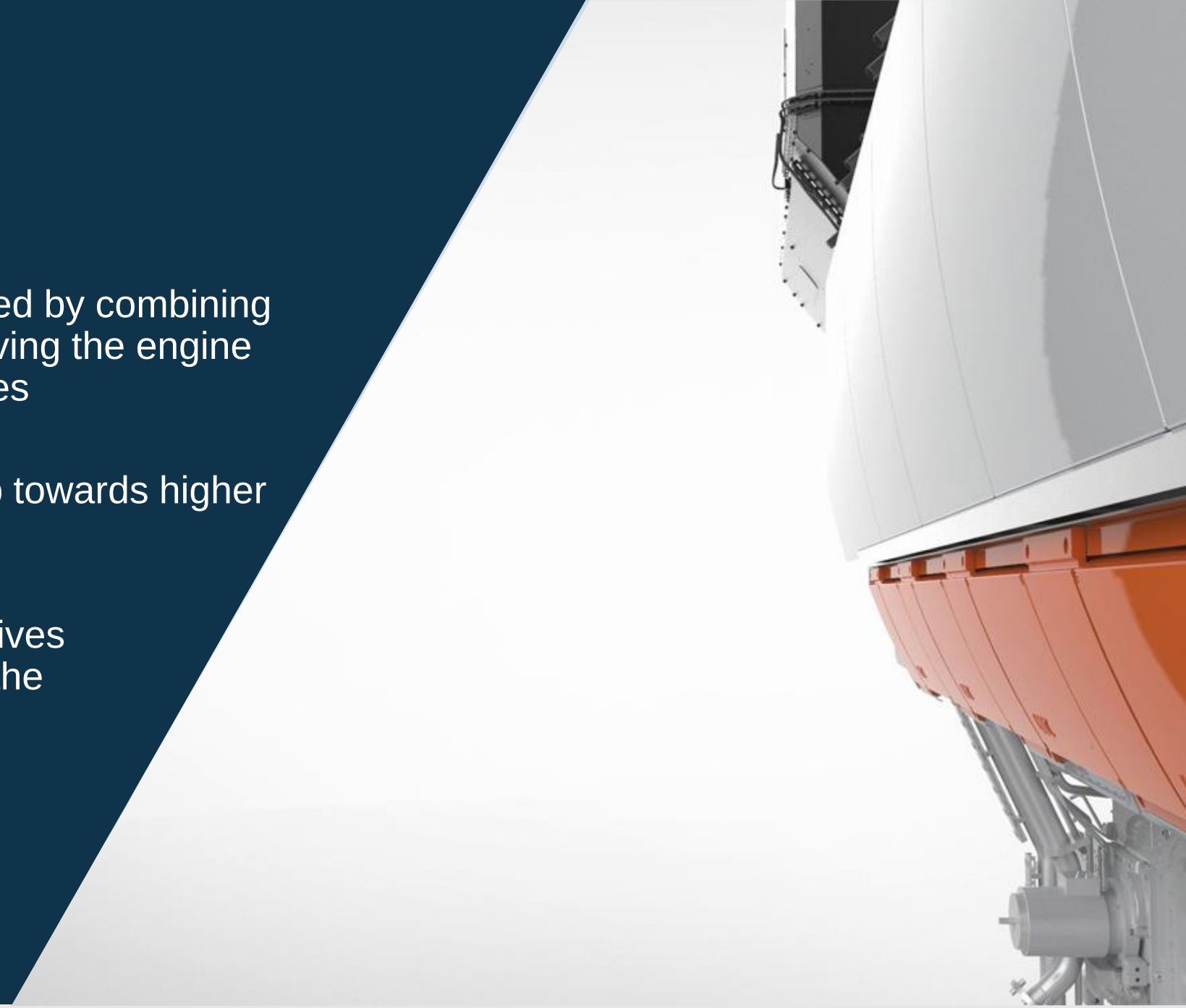


Turbocharging & Automation

- 2-stage turbocharging with over 75% turbocharging efficiency
- UNIC 2 control system which enables the use of all new technologies
  - In-house development

Conclusions

- Excellent performance is gained by combining the right technologies, and having the engine designed for these technologies
- The Wärtsilä 31 is a clear step towards higher power density and efficiency
- The flexibility of the platform gives something to build on far into the future



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