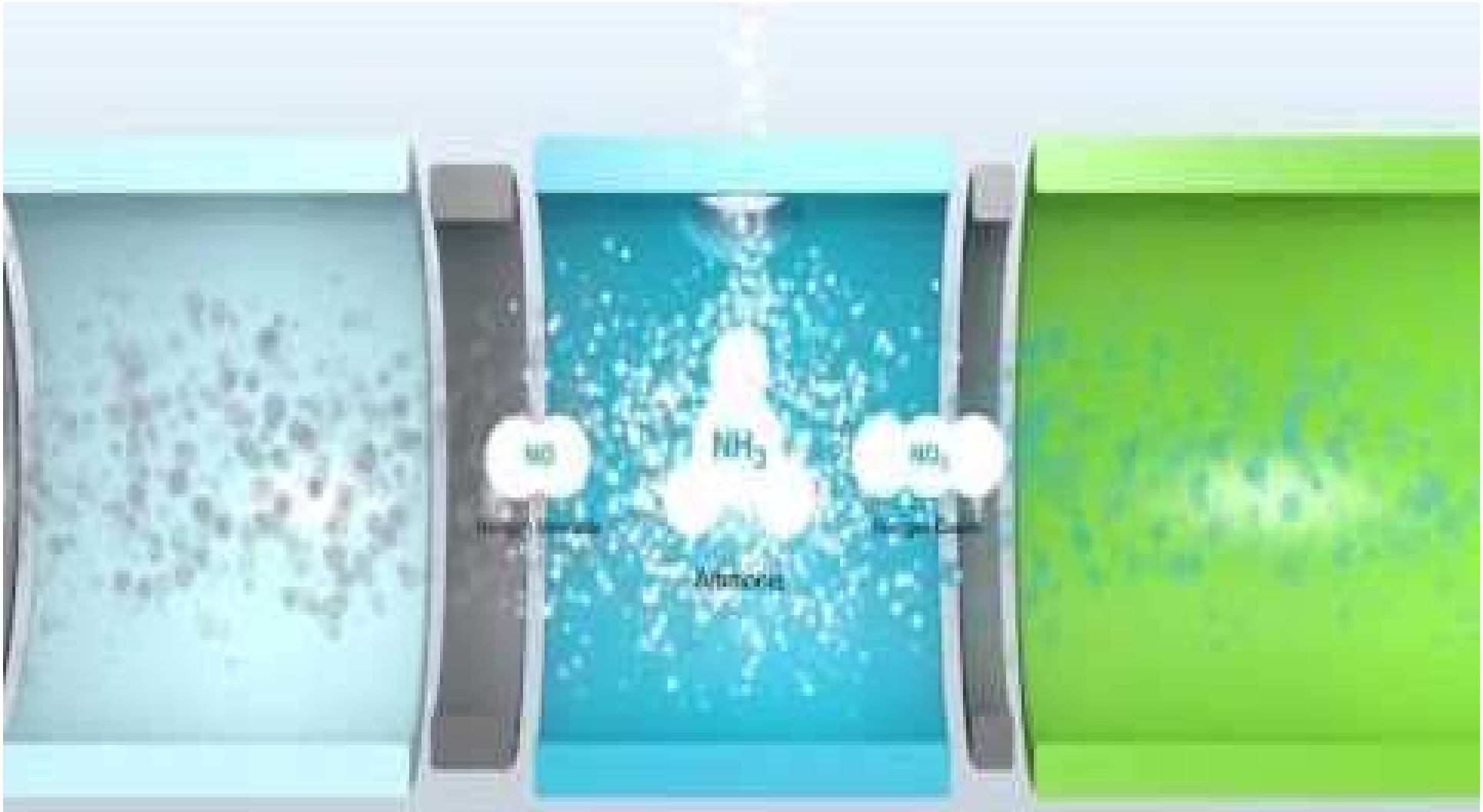
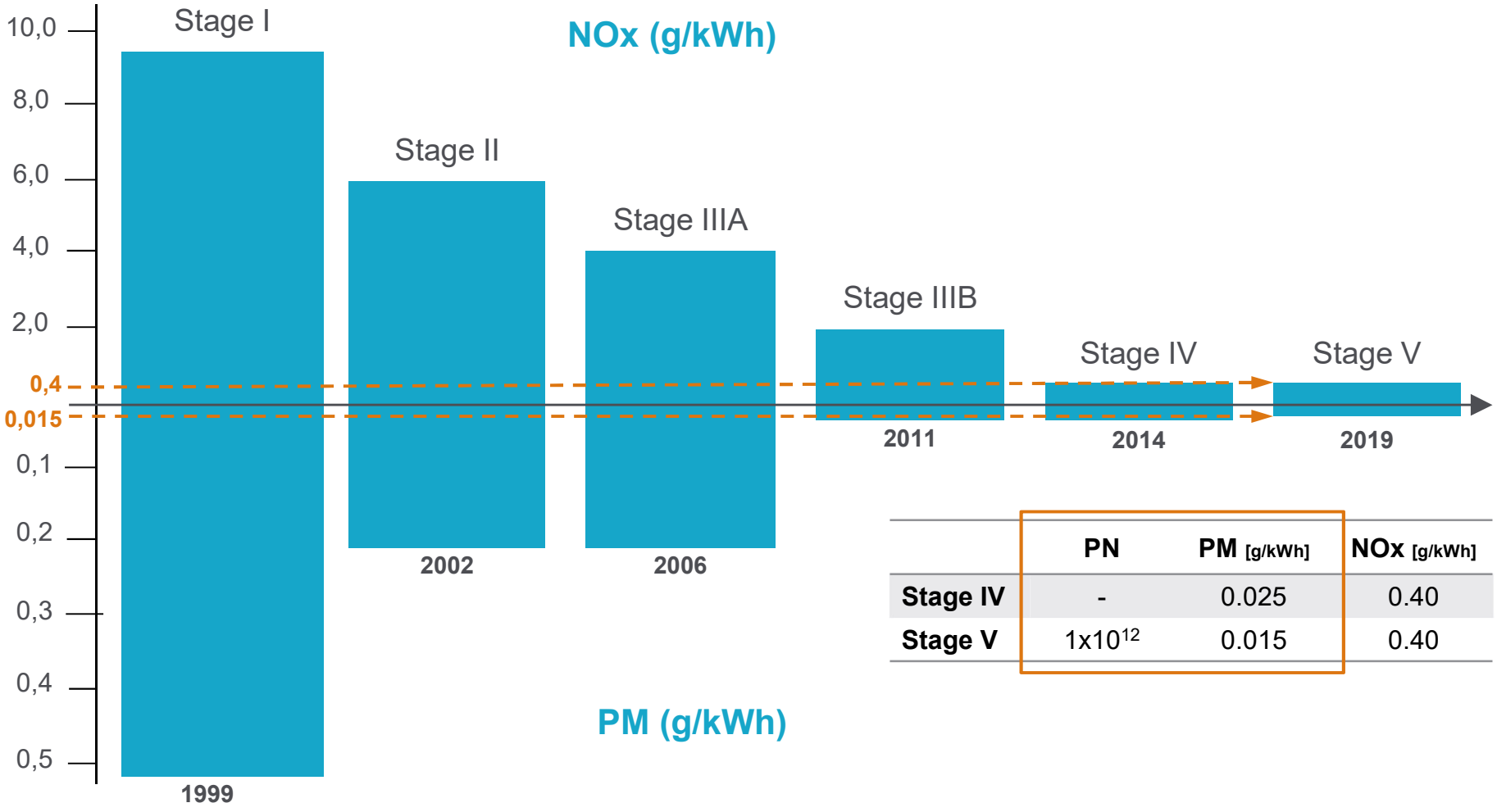
VOLVO PENTA STAGE V SOLUTION

Engine concept and range presentation – April 2019



Ammonia (NH_3) is added via DEF (Diesel Exhaust Fluid/AdBlue®).

Regulation development



	PN	PM [g/kWh]	NOx [g/kWh]
Stage IV	-	0.025	0.40
Stage V	$1x10^{12}$	0.015	0.40

Eu Stage V legislation

Major changes from Stage IV

- Particle number limits (and lower PM) <560 kW
- In Service Monitoring (testing but no pass-fail criteria)
- Limitation for replacement engines
- Includes engines > 560kW with limits according to below
  - NOx: 3,5 g/kWh
  - PM: 0,045 g/kWh

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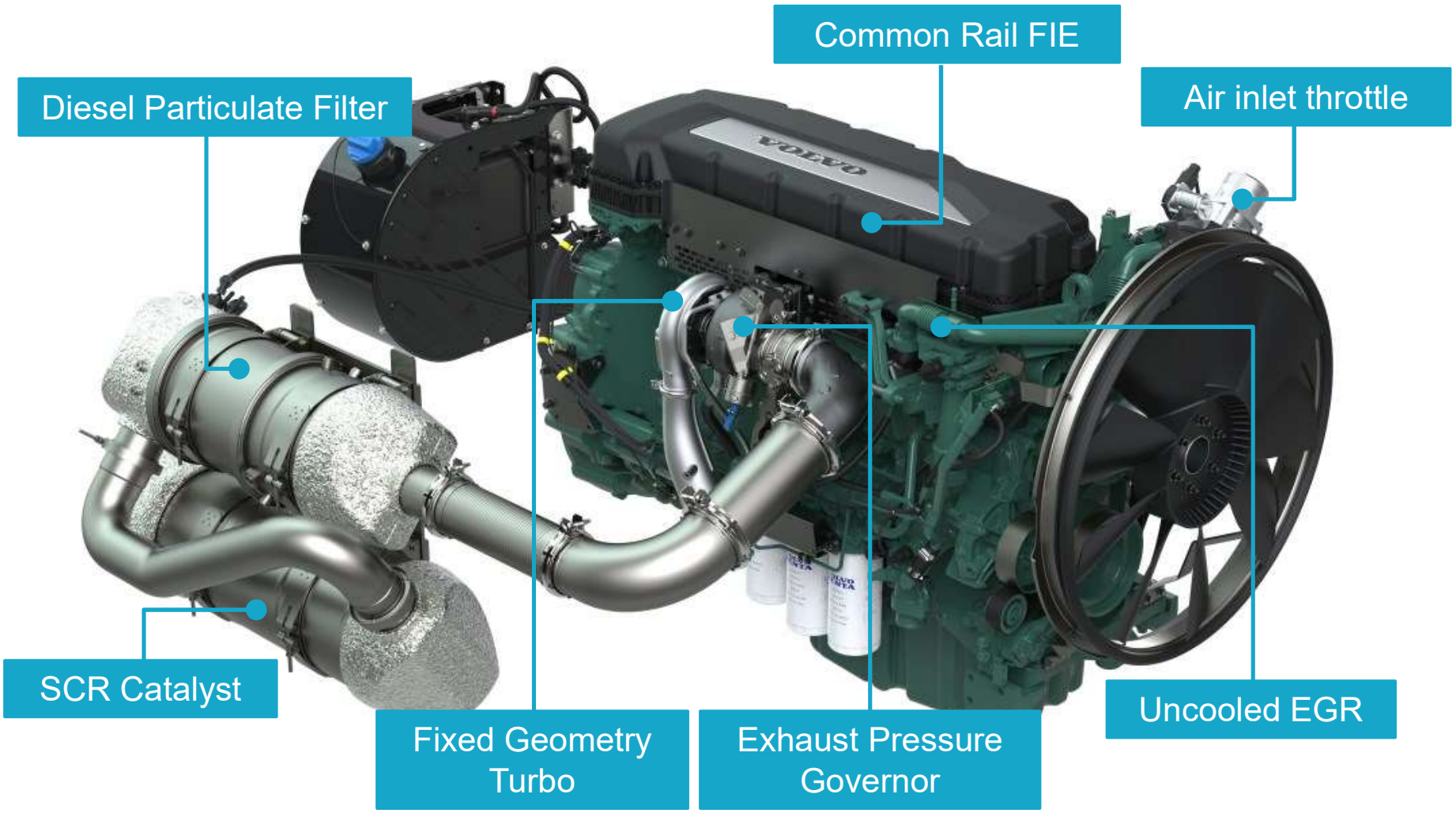
STAGE V CONCEPT

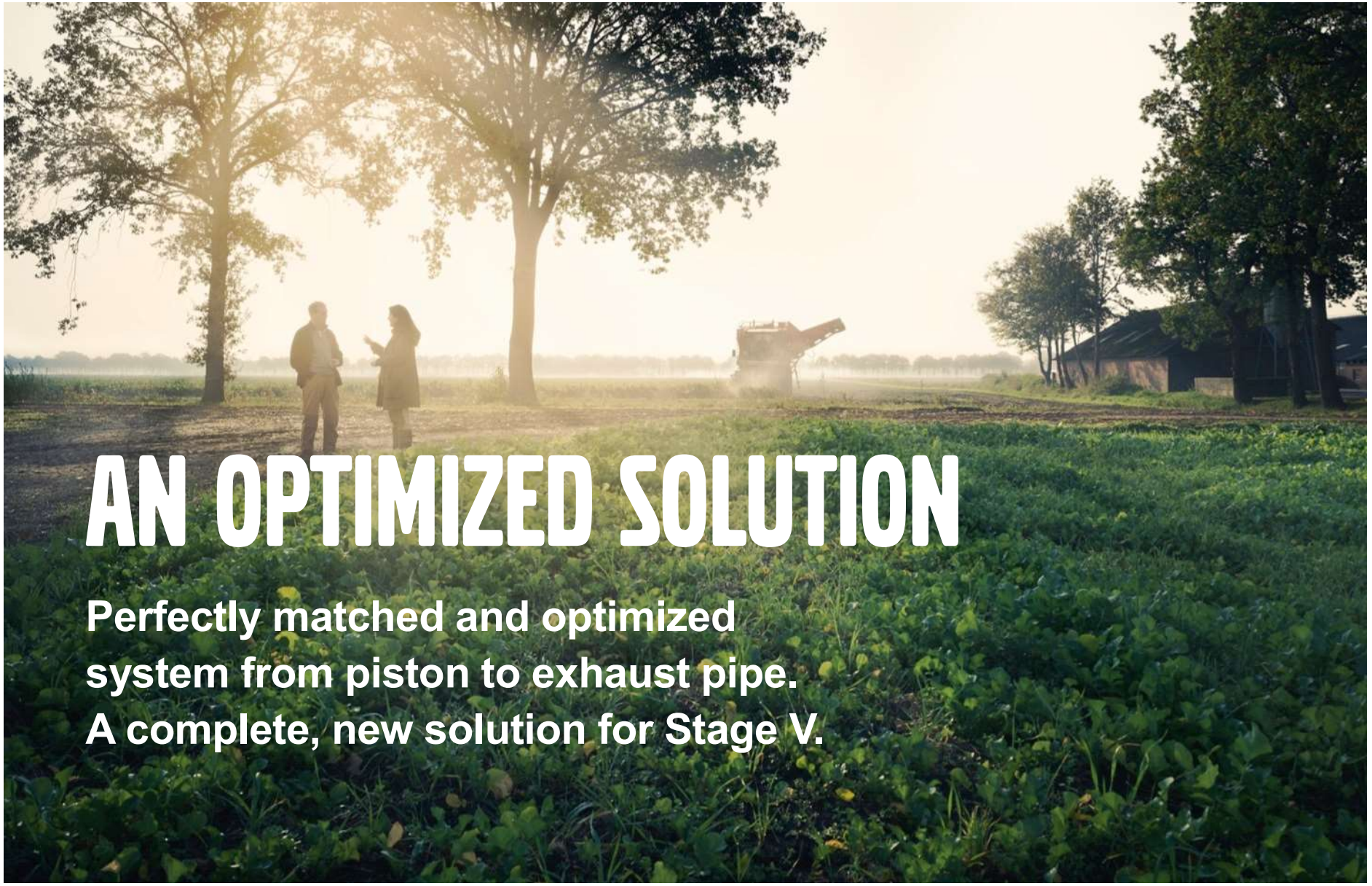


INTRODUCING THE
VOLVO PENTA STAGE V SOLUTION

Reliable solution

Optimized performance

Easy to install, operate and maintain


AN OPTIMIZED SOLUTION
Perfectly matched and optimized
system from piston to exhaust pipe.
A complete, new solution for Stage V.

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Optimized

- Low complexity base engine designed to match an advanced aftertreatment system. Not the same base engine as for Stage IV.
- Uncooled EGR together with EPG and throttle raise exhaust temperatures to eliminate need for diesel injection in exhaust.
- Heat management makes sure that passive regeneration is maximized.
- Fuel consumption is reduced by up to 5% (vs Stage IV) across the entire range.

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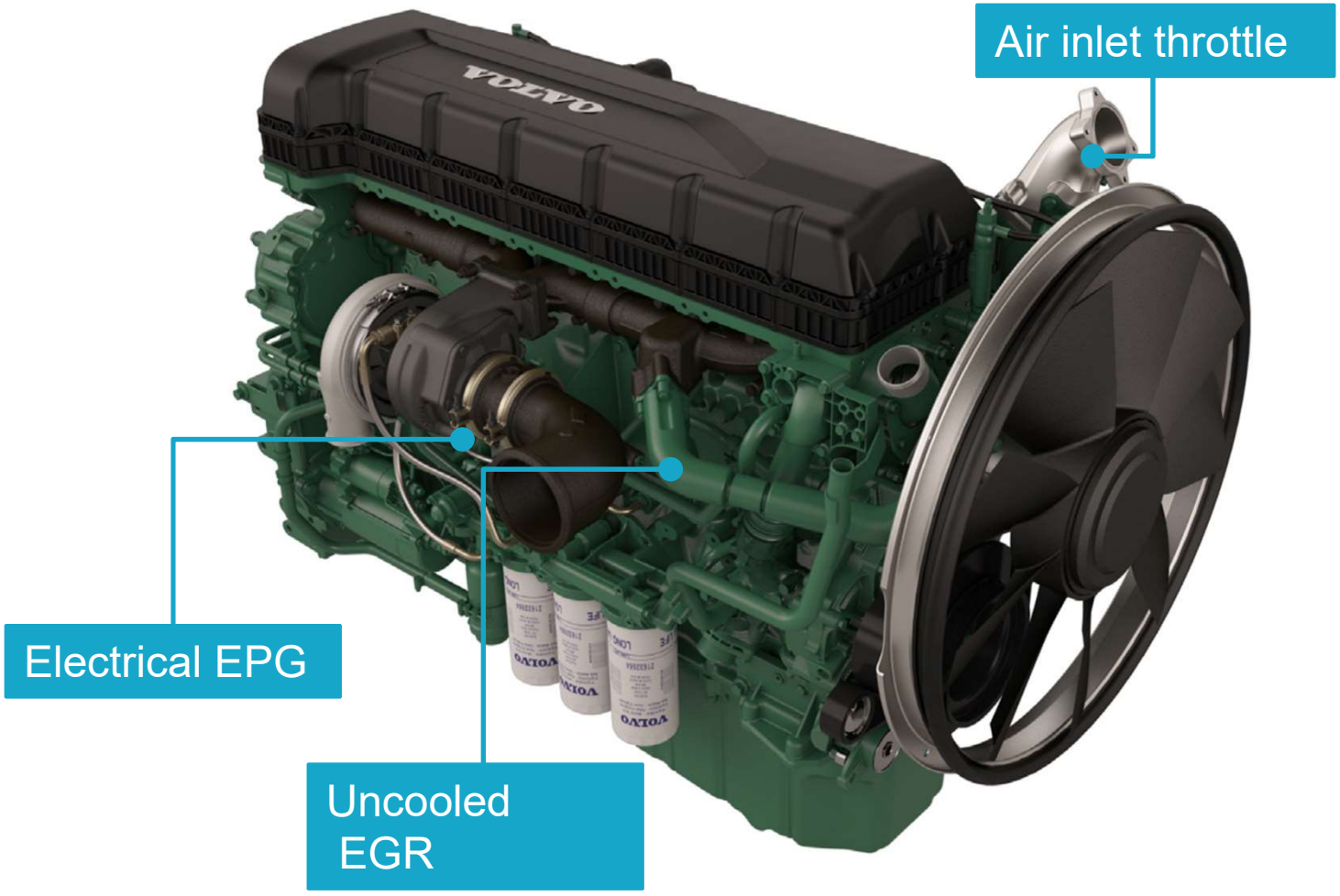
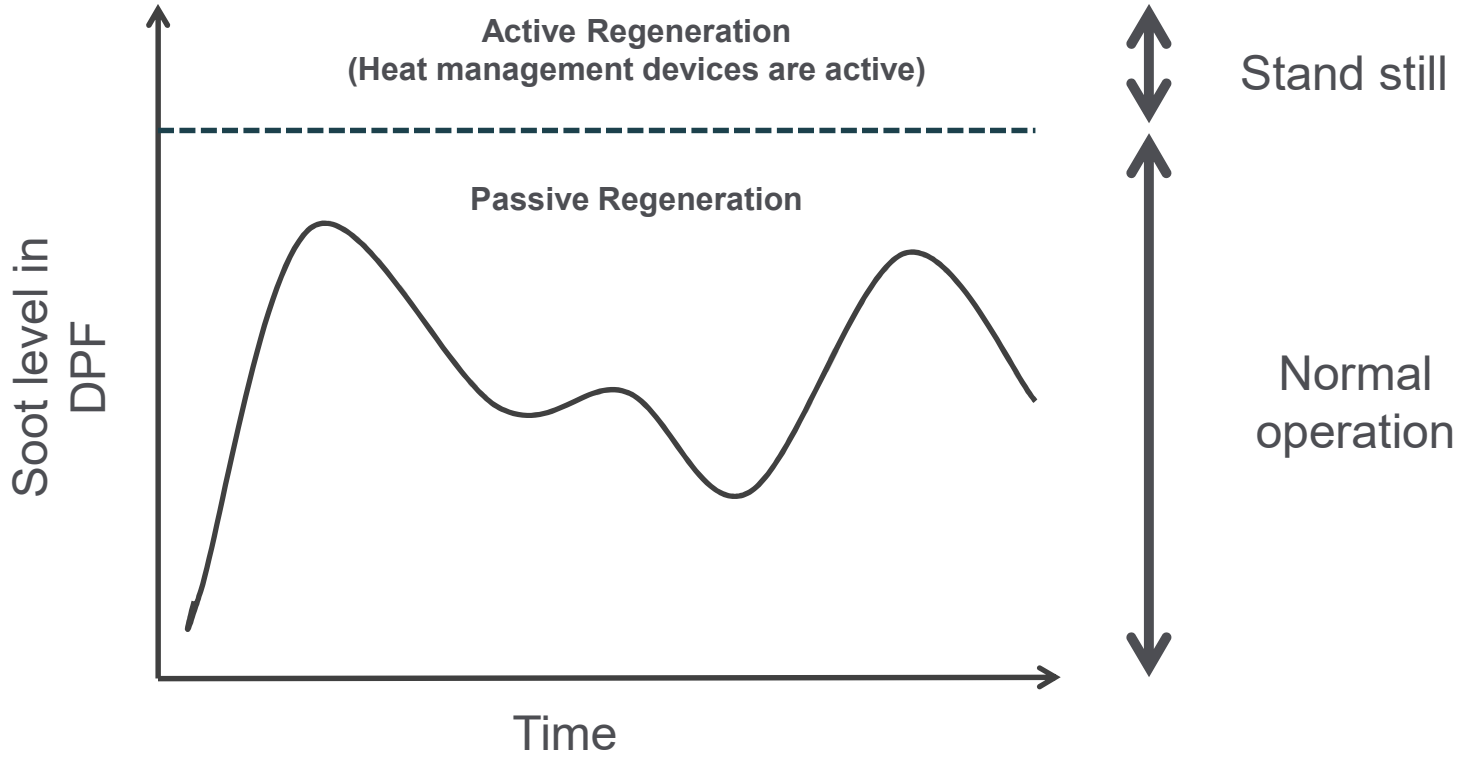
HEAT MANAGEMENT DEVICES



Stage V Regeneration strategy

Modes with regards to Soot Level in DPF

Volvo Penta EATS/Engine designed to stay in passive regeneration mode
→ High exhaust temp, High engine out NOx, Low soot, sulphur tolerant SCR.

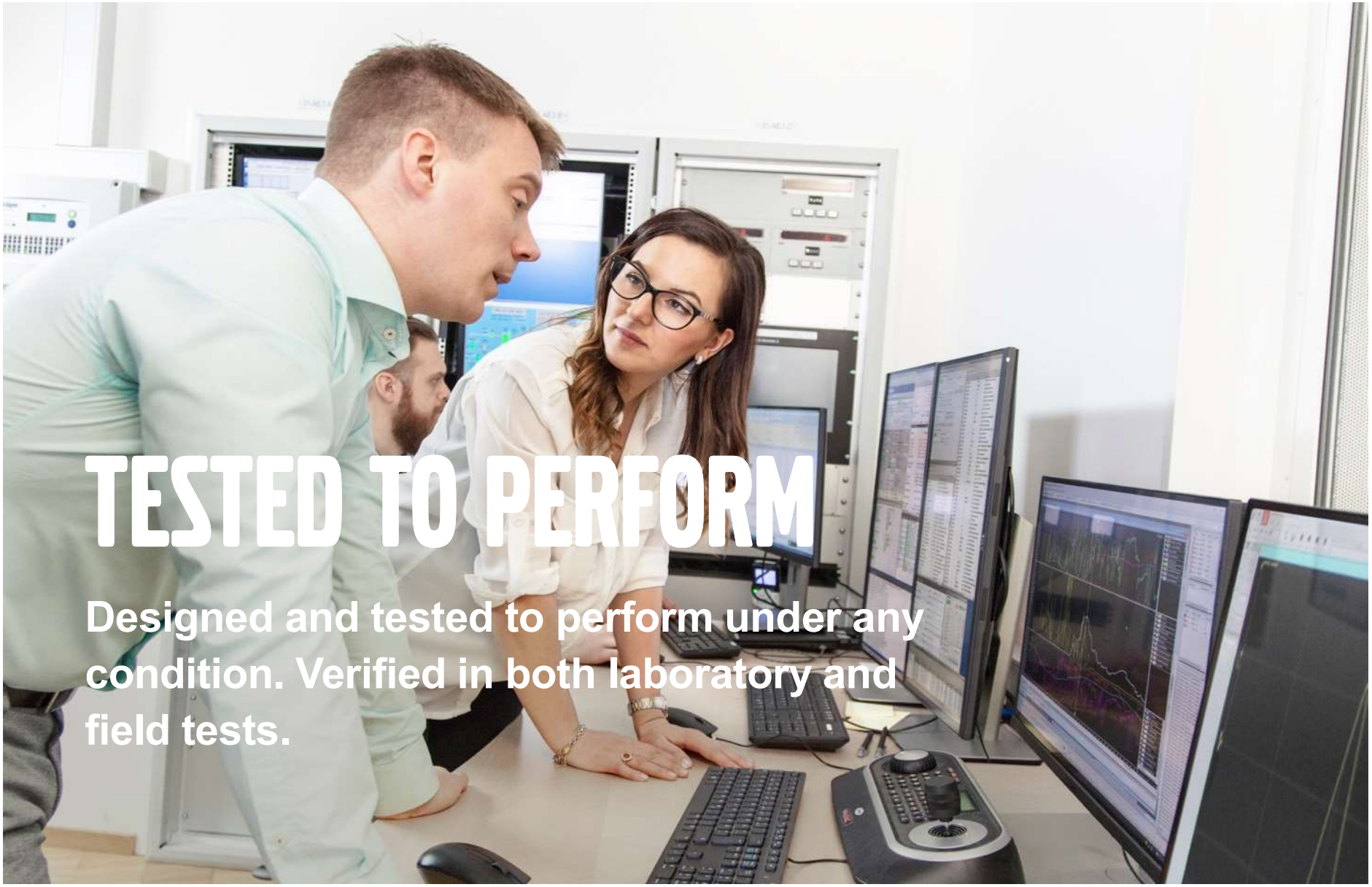


Built for Off-road

- Experience in tough applications as mining and forestry has taught Volvo Penta what matters in the field. No weak links!
- With years of experience combined with the cutting-edge knowledge of the Volvo Group.

A complete offer

- Volvo Penta offers everything our customers need in terms of hardware for the installation of engines and aftertreatment, as well as cooling packages. Volvo Pentas application engineers are ready to support OEMs to make sure the engine operates optimally in any condition.
- Similar interface compared to our engines for other emission levels and markets makes it easy for global OEMs.


TESTED TO PERFORM
Designed and tested to perform under any condition. Verified in both laboratory and field tests.

Tested to perform

- Great load acceptance and response.
- Experience from demanding applications ensures maximized productivity and driveability.
- Continuous improvements on decreasing parasitic loads in order to minimize fuel consumption.
- Highly efficient aftertreatment system removes need for sulphur regeneration of the SCR which would need even higher temperatures than DPF regeneration.

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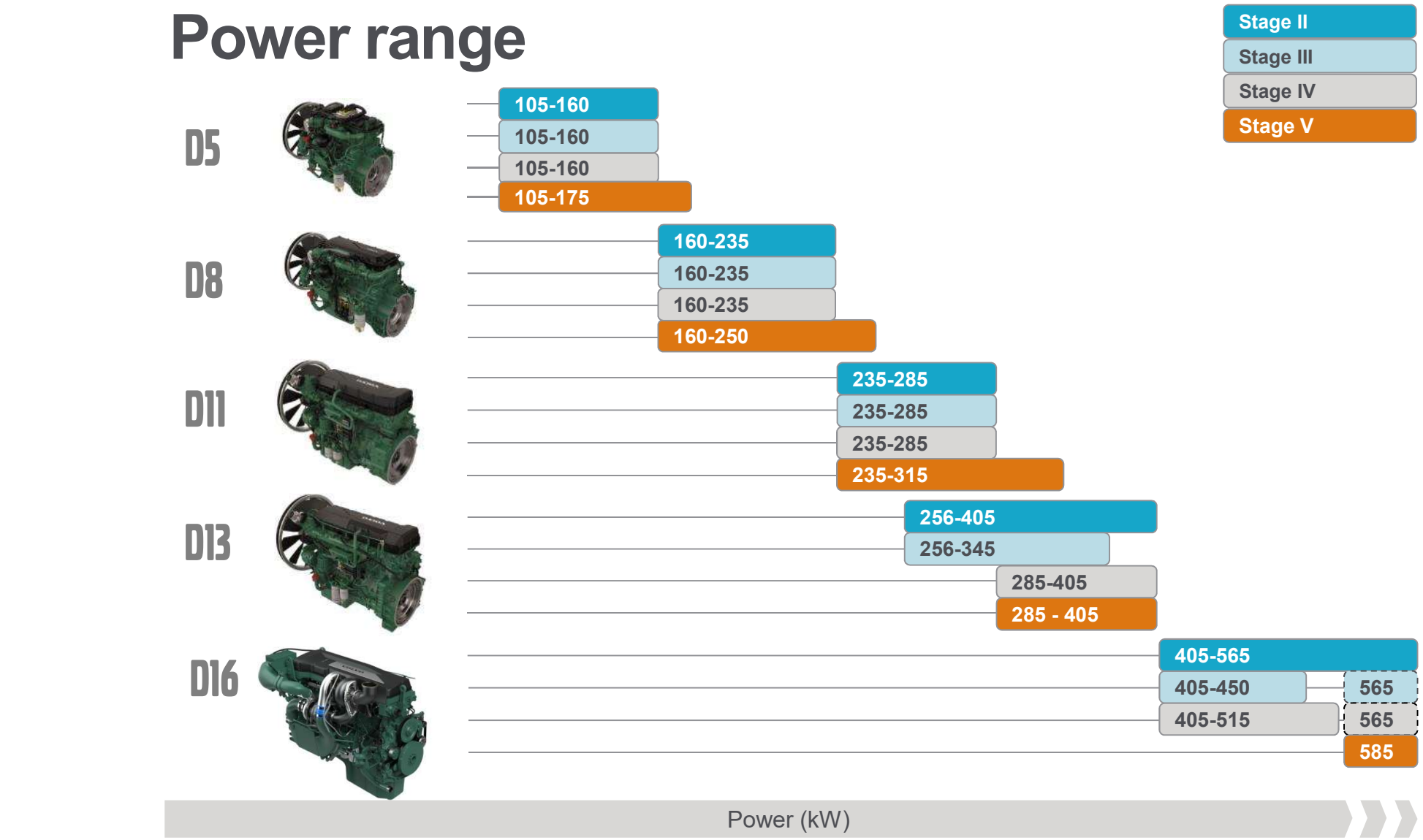
Power range

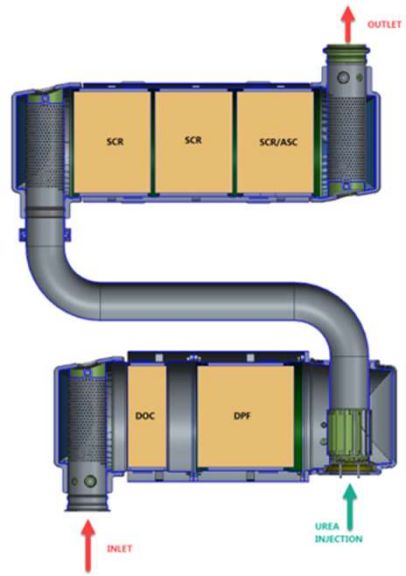

Stage II
Stage III
Stage IV
Stage V
D5
105-160
105-160
105-160
105-175
D8
160-235
160-235
160-235
160-250
D11
235-285
235-285
235-285
235-315
D13
256-405
256-345
285-405
285 - 405
D16
405-565
405-450
565
405-515
565
585
Power (kW)

Stage V Engine concept D5-D13

ENGINE	TECHNOLOGY
Same concept D5 - D13 Based on proven technology	- Common rail injection system - Fixed Geometry Turbo - Uncooled EGR - Exhaust Pressure Governor - Air inlet throttle

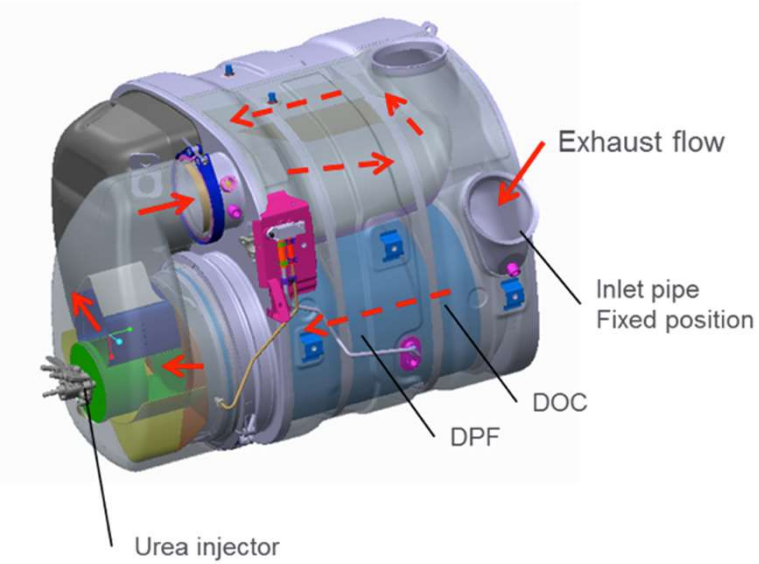
Stage V EATS D5–D11

EATS	TECHNOLOGY
Same concept D5-D11 Based on proven technology	- DOC/DPF/SCR/ASC - Two-box muffler - Vanadium SCR - Airless Urea dosing system



Stage V EATS D13

EATS	TECHNOLOGY
D13 One-box solution Based on proven technology	- DOC/DPF/SCR/ASC - One-box muffler - Vanadium SCR - Airless Urea dosing system.



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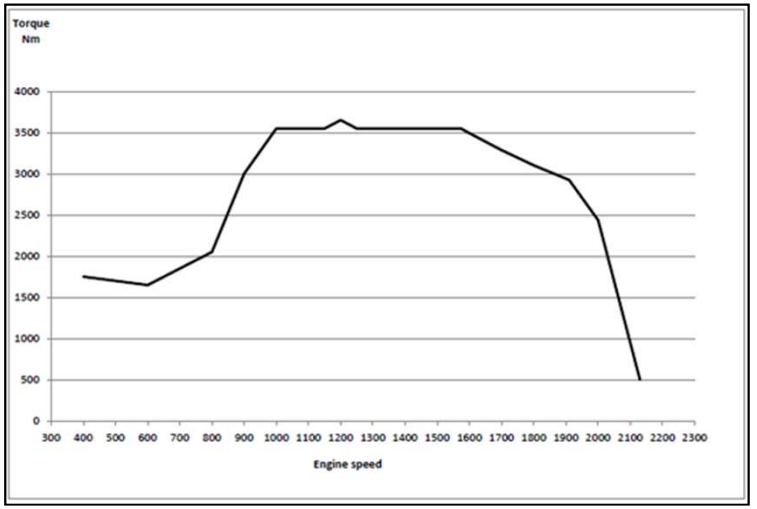
D16 engine and EATS concept

ENGINE	EATS
Dual Stage Turbo (based on field proven TWD GE engines) Dual water cooled CAC Common rail fuel injection No EGR	SCR only (Vanadium) Airless urea dosing system

- Powerful engine: 585 kW
- Low hardware complexity
- World class fuel consumption
- World class torque from low end to high end

D16 Major highlights

- High torque already at low engine speed
- Compact, simple installation and easy to service
- Extended oil service interval 1000h
- Using a two-stage turbo engine allow for higher power ratings with SCR, due to lower exhaust temp



Stage V summary

		DPF	SCR	Power	SOD
D5				105-175 kW	w1950
D8				160-250 kW	w1926
D11				235-315 kW	w1945
D13				285-405 kW	w1920
D16		**NO**		585 kW	2020Q2

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