

New Generation Two-stage Turbocharging for Gas Engines



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2-stage Turbocharging for Power

Power generation as innovator for 2-stage turbocharging



Engines for power generation are used for different applications as

- continuous base load power generation,
- captive power & heat for industry,
- flexible power & heat for municipalities and participation on the regulatory energy market.

And various requirements have to be met as

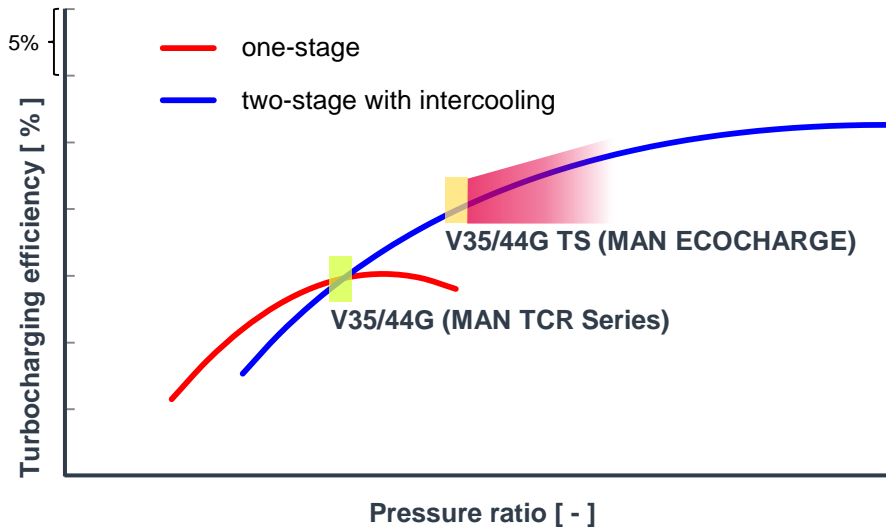
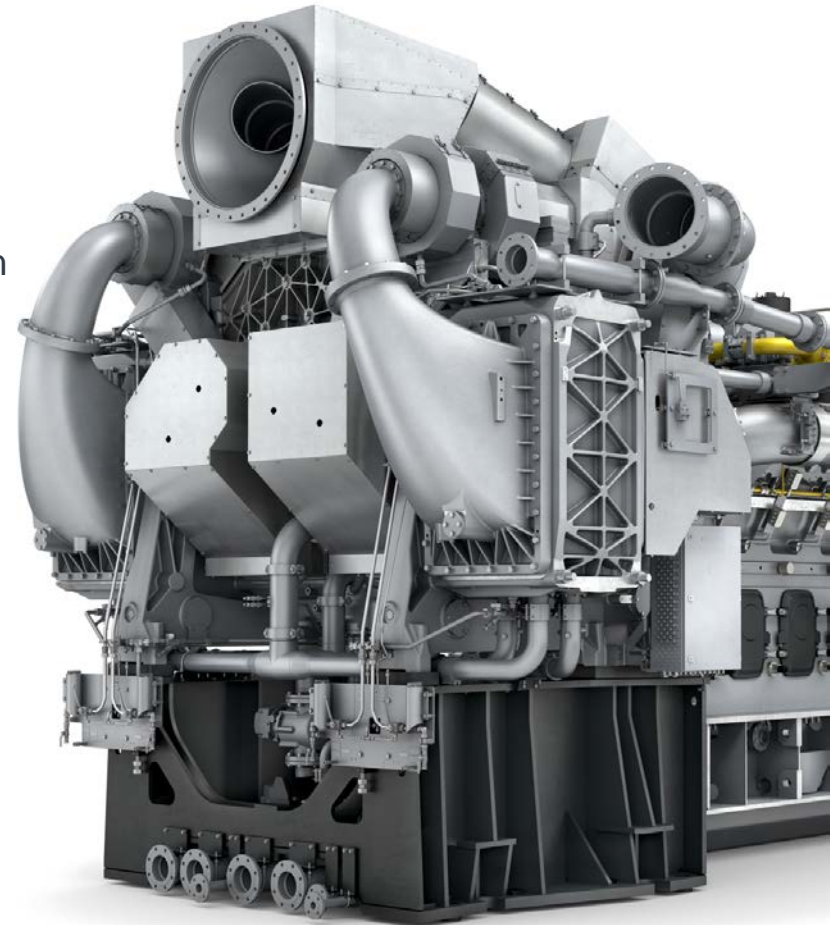
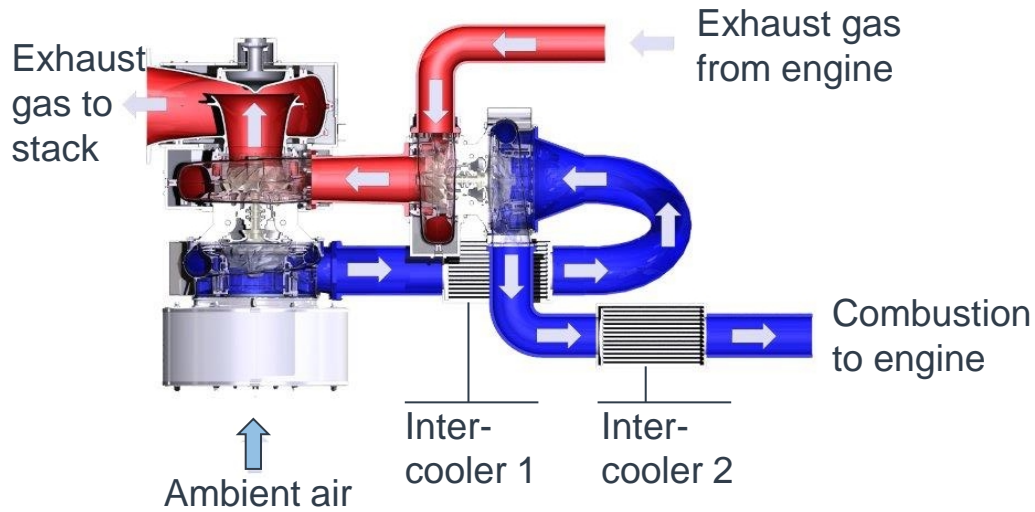
- to have a high power density (for low CAPEX),
- to be very efficient (for low OPEX),
- to be clean, especially in emissions
- and to work also at extreme ambient conditions, i.e.
 - high ambient air temperatures ($>40\text{ }^{\circ}\text{C}$)
 - high site elevations ($>1000\text{ m}$)

 **New 2-stage TC supports these requirements**



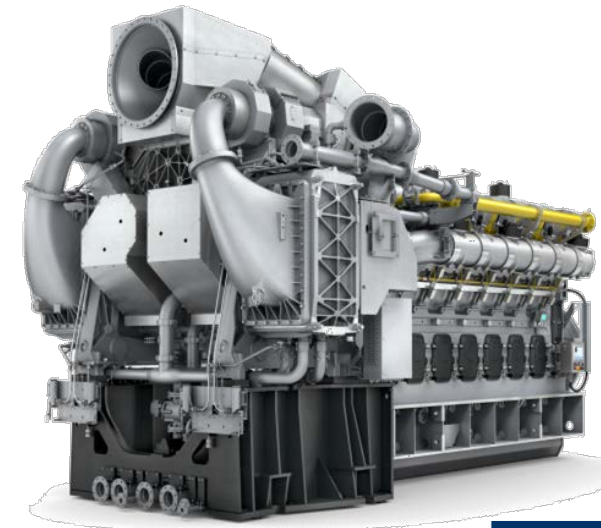
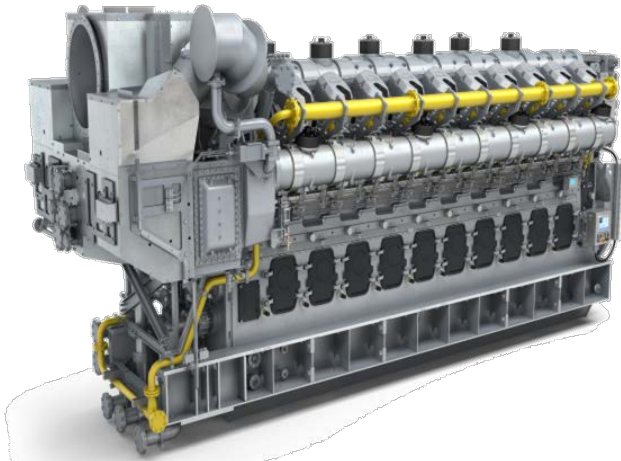
New 2-stage Turbocharging on Gas Engines

Compact 2-stage TC module for improved performance



Gas Engines for Power Plants

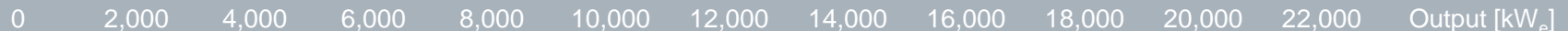
MAN 35/44G and MAN 35/44G TS



Engine type	20V 35/44G	20V 35/44G TS	Delta
Engine Speed (rpm)	750	750	
Frequency (Hz)	50	50	
Power Output per Cyl. (kW _m)	530	620	
Electr. Genset Power (kW_e)	10,420	12,214	+ 17%
Electr. Heat Rate (kJ/kWh)* Optimized for single cycle Power Generation (SC) Gas fuel (TA Luft)	7,375	7,158	- 3.0%
Electr. Heat Rate (kJ/kWh)* Optimized for Combined Cycle (CC) Gas fuel (TA Luft)	7,493	-	n/a
Electr. Heat Rate (kJ/kWh)* Optimized for CHP Gas fuel (TA Luft)	7,447	7,361	- 1.2%
Application	SC, CC, CHP	SC, CHP	

* el. tol. 5% acc. ISO 3046 conditions, 100% load, w/o attached pumps

6,945 – 12,214 kW_e



References and Experience

48/60TS the first large 2-stage turbocharged diesel engine



Project	Engines	Country	Status 06/2016
EBS Bemland	3 x 18V48/60TS	Suriname	In operation since 12/2013
Belawan	4 x 18V48/60TS	Indonesia	In operation since 10/2014
Nigelec	4 x 18V48/60TS	Niger	In start-up
Dhaka Southern	3 x 18V48/60TS	Bangladesh	In start-up
Dhaka Northern	3 x 18V48/60TS	Bangladesh	In start-up
EBS Bemland Extension	1 x 18V48/60TS	Suriname	In operation since 02/2016
Desh Energy	3 x 18V48/60TS	Bangladesh	In start-up
Dhaka North	6 x 18V48/60TS	Bangladesh	In construction
ACC 7, Phase1A	2 x 18V48/60TS	Saudi Arabia	In construction

- In total 29 engines sold, 8 engines in operation
- In total ~90,000 hours of commercial operation
- Lead engine ~18,500 hours comm. operation

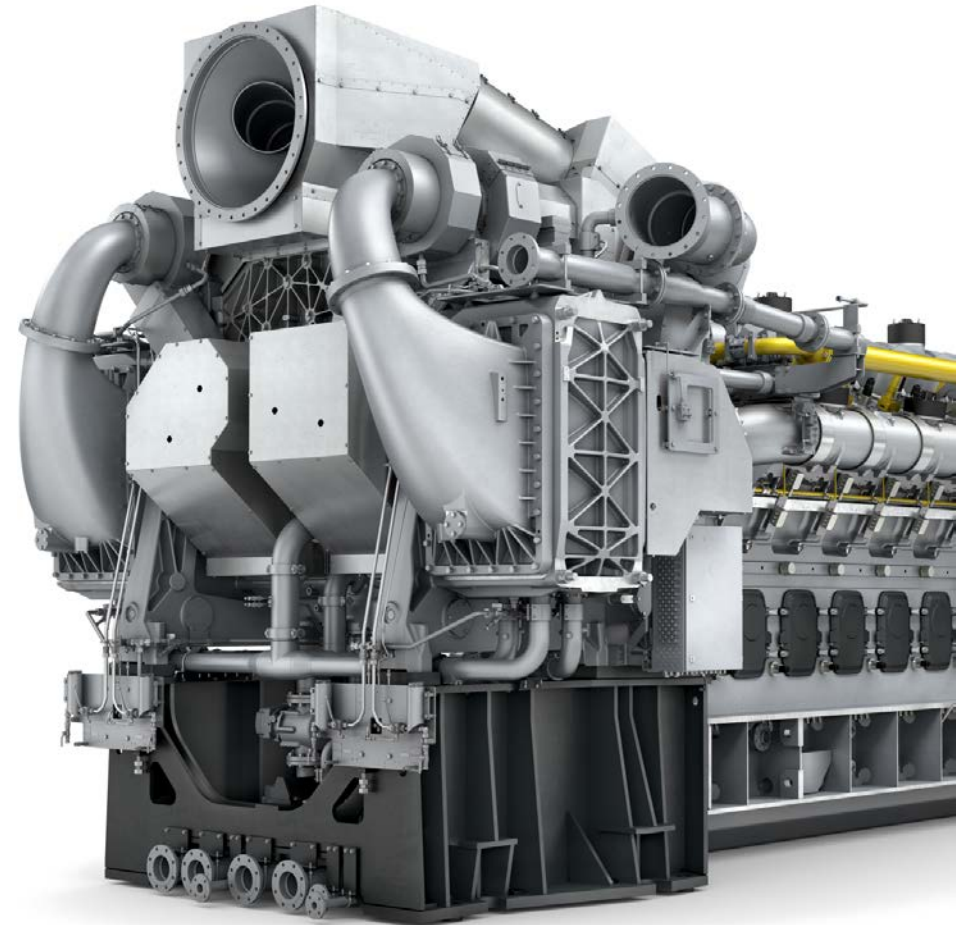


2-stage Turbocharging for Power

Gas engine applications benefit from experience from 48/60TS



- **MAN Diesel & Turbo is the pioneer in developing and operating 2-stage turbocharging for large bore engines**
- **Engine design and turbocharger design goes closely hand in hand, both is the core competence of MAN Diesel & Turbo**
- **Profound experience from 48/60TS operation supports introduction of 2-stage turbocharging for gas engines**



Disclaimer



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**Thank you very much!
Questions?**



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