GT²: Two-stage Charging as a Downsizing Concept for Large SI Engines

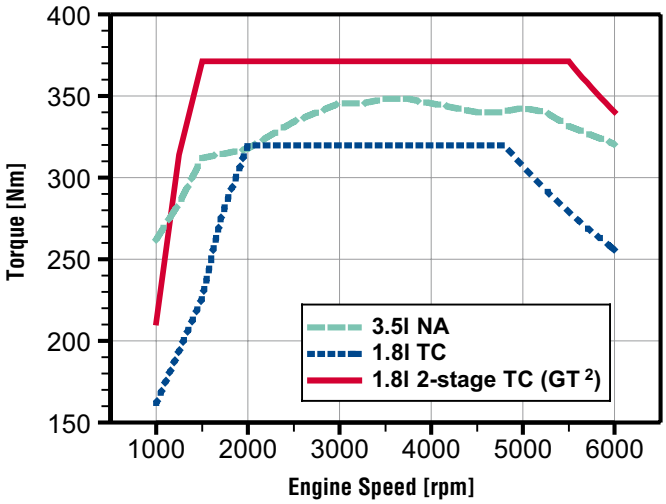

Fig. 7: Full load engine torque curves

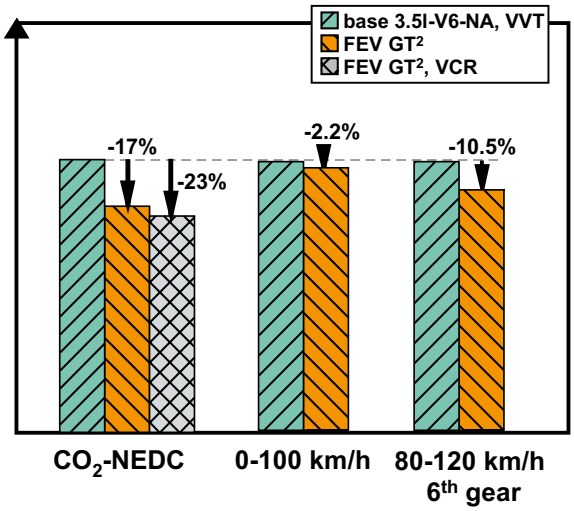

Fig. 8: Comparison of CO_2-emissions and performance of the GT²-concept

Downsizing in combination with turbocharging has been established by most of the vehicle manufacturers as a cost effective measure for obtaining further CO_2 emission reductions. A partial combination of mechanical boosting and turbocharging has been introduced into the market as well. Taking into account the limits of modern turbocharger maps and the response time at low engine speeds, the specific power is limited to approximately 90 kW/l with both concepts. This is equivalent to a downsizing level of about 40 % compared to a vehicle equipped with a larger, naturally aspirated engine that has similar driving performance. This limit can be expanded through the introduction of two-stage turbocharging for further CO_2 reduction.

The "SGT" (**S**pray **G**uided **T**urbo) vehicle development platform was created by FEV for developing future powertrain technologies. The SGT is equipped with a direct-injection, turbocharged 1.8 L-SI engine with a central injector position and ε = 1-operation. The production two-stage turbocharger system was integrated into the vehicle in cooperation with BorgWarner. In addition to reducing the compression ratio to ε = 8.5, the charge motion level in the combustion chamber was adjusted in order to achieve a faster conversion of energy. The required control functionalities for the turbocharger system were integrated and applied, based on a rapid Pro d-Space system, in the same manner that already conducted on the complete engine control software.

The GT²-vehicle (**G**asoline-**2**-stage **T**urbo) delivers a reduction in CO_2-emission of 17 % in the European driving cycle, compared to a 3.5 L-6-cylinder naturally aspirated engine [Fig. 8]. Variable compression ratio can further improve this potential to approximately 23 %. The GT²-vehicle offers enhanced performance compared to a naturally aspirated engine that is approximately twice as large and the results can be seen in its high specific power of 120 kW/l and maximum torque of 370 Nm@1500 rpm (BMEP = 26 bar) [Fig. 7 and Fig. 8]. The fuel consumption will be reduced under real driving conditions, due to the high torque reserves at low engine speeds, enabling the intuitive selection of higher gears by the driver. The steady-state torque above 1150 rpm of the GT²-vehicle is superior compared to the reference naturally aspirated engine

The GT²-concept demonstrates enhanced driving performance, enabling further CO2 reduction in both driving cycles and under real customer operating conditions.

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