

# Mastering engine downsizing

A fun-to-drive DI gasoline vehicle with reduced fuel consumption

## Key achievements

- Demonstration of a downsizing approach combining several well-known technologies — direct injection, turbocharging and variable valve timing.
- A downsized (1.8-litre) four-cylinder DI gasoline engine with the performances of a 3-litre V6 engine and significantly lower CO<sub>2</sub> emissions and fuel consumption in a European Driving Cycle (20% reduction).
- Engine performances: 340 N.m at 1,500 RPM, 147 kW at 5,500 RPM, lowest BSFC 238 g/kWh, 195 g/km CO<sub>2</sub> on NEDC.

## Expertise

Implementation of the different stages of development: definition of vehicle and engine specifications, design and manufacture of prototype parts, engine development tests, development of engine control algorithms, and vehicle calibration.

## Technological engine definition

- Turbocharged gasoline engine with direct injection in homogeneous mode (collaboration with HTT Honeywell Turbo Technologies).



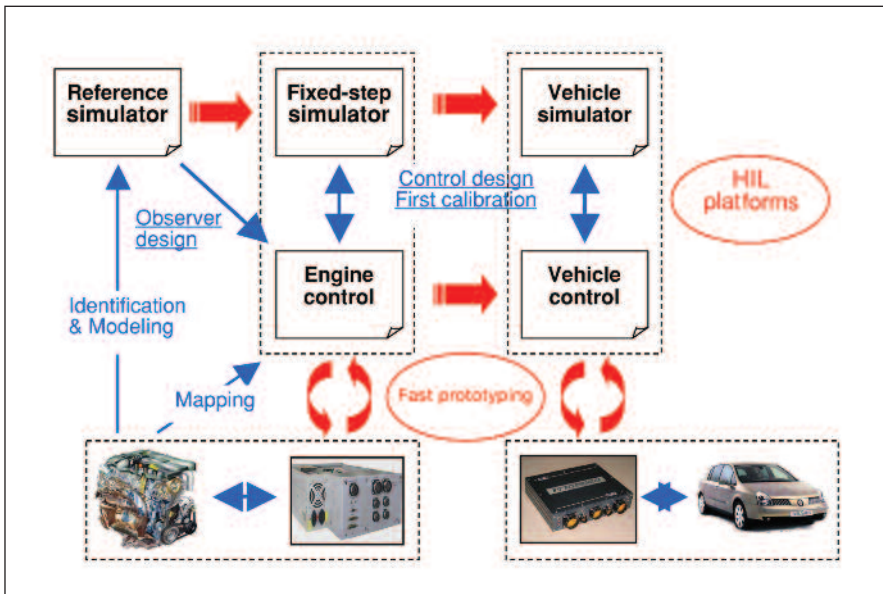
Vel Satis demonstrator vehicle.

- Twin variable valve timing for intake and exhaust valves.
- Single-scroll turbocharger design.
- Transmission adaptations (after completion of IFP-Drive\* simulation).
- Redesign of piston head shape.
- Original compact intake plenum specifically for short turbolag.
- Dedicated valve timing and event duration definition for scavenging process optimization.
- Specific 1,000°C-compatible exhaust line (collaborations with HTT Honeywell Turbo Technologies for turbocharger and Faurecia for exhaust manifold).

## Simulation-based process for engine control design, calibration and validation

- Use of high frequency 0D engine and vehicle simulators using IFP-Engine\* and IFP-Drive\* libraries (real-time compatible).
- Matlab/Simulink/RTW software platform for control development.
- Step-by-step process (co-simulation, real-time HIL) ensuring rapid, robust development.
- In-house full-pass rapid prototyping system in combination with xPC target kernel.

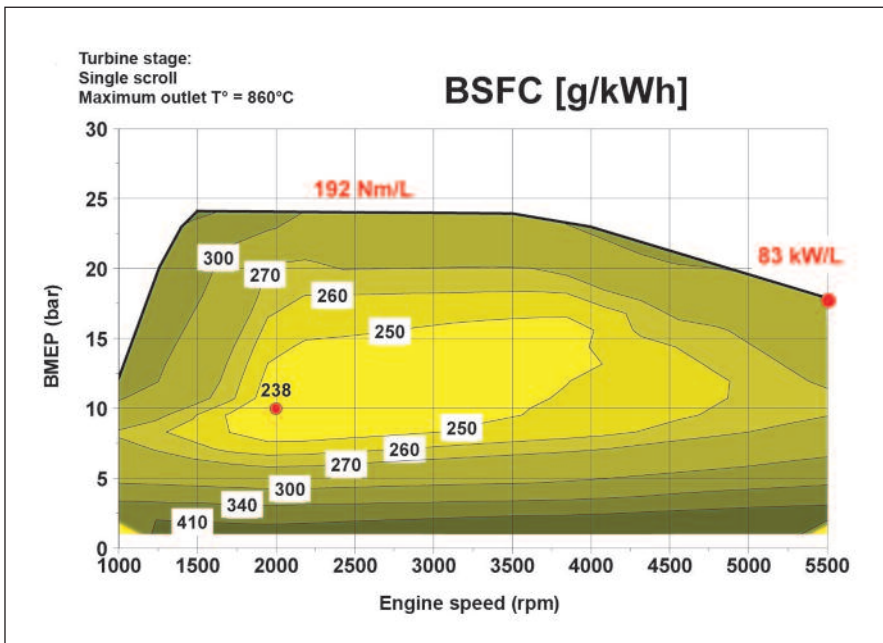
\* available in the LMS Imagine.Lab AMESim platform marketed by LMS Company.



Control development and validation process.

## Development of an advanced torque-based control structure

- Design of observers and non-linear controllers for unmeasured relevant variables: in-cylinder trapped air mass, air scavenging and burned gases.
- Control of trapped air mass to reach the torque corresponding to the driver's command (pedal position).
- Control of residual burned gases at low load to minimize fuel consumption and pollutant emissions.
- Control of scavenging at high load to improve combustion efficiency and reduce turbolag.
- Supervision of quantity of each gas (fresh and BRG) in cylinder to achieve performance while reducing fuel consumption and pollutant emissions and optimize the warm-up phase.
- Dynamic knock strategy to adapt spark advance to in-cylinder conditions in steady-state and transient conditions.
- Fuel/air ratio control for optimal catalytic exhaust conversion.
- Final road calibration for enhanced driveability.



Specific fuel consumption map of 1.8 l GDI turbo engine.

The information contained in this document is not contractual

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