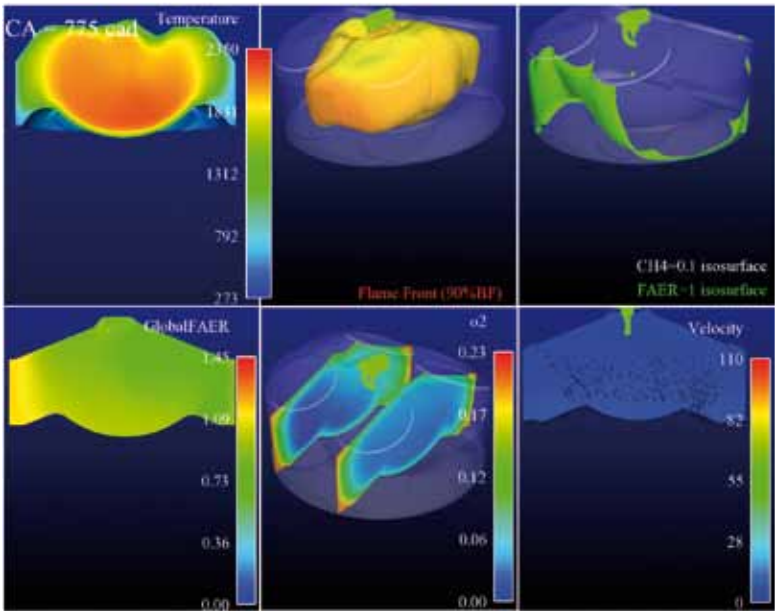
Natural Gas Vehicle Solutions

A potential for energy diversification

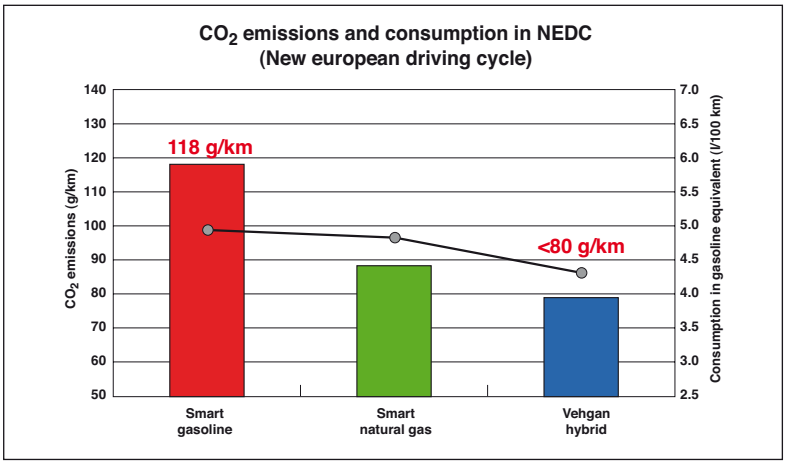
With no major engine modifications and good energy efficiency, as well as an excellent performance in terms of CO_2 emissions, natural gas-powered vehicles are set to become increasingly widely used, particularly for public transport fleets.

Its significant experience and expertise in the fields of fuel formulation and modeling, assessment of engine and fuel suitability, engine testing and vehicle optimization in order to develop new engine calibration strategies, means that IFP Energies nouvelles (IFPEN) is in a position to offer industry players a comprehensive range of engineering tools and services for the design of ultra-low CO_2 NG vehicles:

- drawing on its dual expertise in engines and fuels;
- optimizing solutions based on an innovative system development approach adapted to the specific architecture of these vehicles in line with industry's requirements;
- extending its expertise from small urban to heavy-duty vehicle ranges.



Combustion simulation for a CNG DI engine.



Comparison of CO_2 performance in gasoline NEDC Smart vehicle, IFPEN NGV Smart and IFPEN Vehgan vehicle.

A concentration of dedicated technologies

IFPEN has been promoting the development of NGV combustion applied to internal combustion engines for a number of years. Innovative solutions concern, for example, low NOx combustion systems compatible with increasingly stringent emission standards, advanced injection and distribution systems, the use of new fuel blends and after-treatment.

The following innovative solutions are developed from the design to complete vehicle integration stage, using advanced test bench equipment and specialized software tools.

Waste collection vehicle, running on natural gas.

Concomitant injection of CNG and liquid fuels

In addition to the CIGAL™ concept, a methodology developed by IFPEN leading to improved combustion efficiency, IFPEN is working on a number of developments:

- maximizing performance and efficiency with simultaneous injections of gaseous and liquid fuels: increased volumetric efficiency and high knocking resistance;
- developing a dedicated natural gas engine:
  - new combustion chamber design piston, CR, valves;
  - implementation of a natural gas injection system;
  - aerodynamic flow adaptation on cylinder heads;
  - turbocharger matching for all combustion modes.

Direct CNG injection

- development of C3D tools;
- validation of direct injection systems;
- optimization of combustion chambers;
- high-performance single cylinder engine application.

Effects of methane/H_2 blends

- combustion boost;
- stabilisation of combustion with a lean-burn mode for high A/F ratio and a reduced "quenching" distance;
- efficiency with decreased thermal losses in lean-burn condition and improved cycle form efficiency.

Innovative CNG polymorph tank

Polymorph composite storage system design derived from IFPEN's expertise in the field of polymers.

Storage: composite tank inside the chassis.

Dual-fuel CNG/diesel application

- C3D development based on experience gained with CIGAL™;
- dedicated single cylinder engine;
- innovative injection strategies on the basis of engine range;
- engine control for multicylinder application.

New combustion chamber concept for HD application

Heavy-duty application

- based on diesel engine parts;
- adaptation of the typical diesel swirl motion into TKE for stable SI-combustion.

Specific bowl study

- IFPEN patent;
- lean-burn for F/A ratio <0.6;
- Hythane® blend validation.

Less than 80 g/km CO_2: CNG demonstrator vehicles at IFPEN

Clever – a two-seat vehicle powered by an IFPEN dedicated CNG engine

An efficient concept car for city traffic

- minimal road space requirements;
- lightweight and low fuel consumption for low emissions;
- passive safety equivalent to that of a modern compact car and adequate passenger comfort;
- individual mobility and driveability.

IFPEN's solutions

- development of a dedicated 213cc CNG engine;
- development of a new engine control system;
- engine and vehicle calibration.

Achievements

- maximum torque is 16 Nm achieved at 6300 rpm;
- maximum output power is 12.5 kW achieved at 8600 rpm;
- vehicle CO_2 emissions: about 60 g/km in NEDC.

This demonstrator has been developed within a European project led by BMW.

Clever vehicle with tilting cabin in curve.

Vehgan – a mild hybrid urban vehicle

A concentration of IFPEN technologies

- strong downsizing;
- dedicated CNG engine;
- mild hybrid version with recuperative braking: dedicated IFPEN engine management developed with the latest tools (Hardware in the Loop model-based calibration).

Fun-to-drive urban vehicle

- quiet start/stop;
- electrical assistance for excellent low-end torque;
- driving range of 200 kilometers.

An efficient concept: mild-hybridization

- improves driver comfort during start/stop phases by reducing noise and vibrations;
- provides close control of torque flow through the powertrain for vehicle start-up;
- enables selection of high-efficiency engine running modes to reduce energy consumption;
- enables braking energy recovery.

Environmentally-friendly vehicle

- CO_2 emissions reduced by 32% compared to a standard gasoline engine;
- braking energy recovery;
- fuel economy.

IFPEN Vehgan demonstrator.

This demonstrator has been developed by IFPEN in partnership with Ademe, GDF Suez, Inrets and Valeo.

Prius II - a prototype natural gas hybrid vehicle

Produced by IFPEN in partnership with GDF Suez, this sedan emits only half the greenhouse gas emissions of equivalent vehicles in its class.

Proven technological solutions

- 2 tanks of gas: one 22-liter tank made of composite materials, another 14-liter steel tank that gives the vehicle a range of over 250 km;
- high and low pressure natural gas piping in accordance with R110 regulations;
- specific natural gas injectors;
- engine control system including dedicated injection timing management and incorporating appropriate maps.

IFP Energies nouvelles CNG Prius II.

Average natural gas consumption

- 2.3 kg/100 km;
- 3 Nm^3/100 km;
- 63 g CO_2/km (-25% c.t. gasoline).

Gasoline consumption

- energy equivalence: ~3.5 l/100 km (~80 g CO_2/km);
- CO_2 equivalence: ~2.6 l/100 km.

Facilities and laboratories for gaseous fuel engines

- engine test benches:
  - engine steady-state and transient test benches for cars and HD vehicles;
  - benches specially designed for several gaseous fuel tests (H_2, CH_4, LPG, etc.);
  - chassis-dynanometers (pollution and ECU tuning).
- after-treatment laboratory;
- simulation and computation resources.

HD bench for single cylinder engine.

HD bench for HP multicylinder engine.

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