**PROJECT**

**INGAS**

**Integrated Gas Powertrain - Low Emission, CO2 Optimised and Efficient CNG Engines for Passenger Cars (PC) and light duty vehicles (LDV)**

**Funding:** European (7th RTD Framework Programme)

**Duration:** Oct 2008 - Mar 2012

**Status:** Complete with results

**Total project cost:** €21,337,191

**EU contribution:** €12,116,971

**Call for proposal:** FP7-SST-2007-RTD-1

**CORDIS RCN : 90082**

**Background & policy context:**

Natural Gas Vehicles were introduced on the market more than ten years ago; nevertheless, today's market share of compressed natural gas (CNG) vehicles is relatively small but rapidly increasing. The market introduction of dedicated (mono-fuel) CNG vehicles requires the development of technologies able to solve problems today not yet solved concerning gas storage, gas feeding, combustion system and after treatment and, at the same time, to take into account the quality of natural gas.

**Security of Energy Supply**

From this point of view, natural gas represents a real alternative to crude oil being available in large quantities also in countries different from the Middle East.

**Clean Fuel**

Natural gas is a clean fuel since toxic compounds like sulphur, or potential toxic, like benzene and higher molecular weight hydrocarbons, or highly reactive such as olefins, are absent.

**Reduced Greenhouse Gases**

The highest hydrogen content of methane molecule, with respect to any other hydrocarbon based fuel, allows achieving a substantial reduction of the carbon dioxide (CO2) exhausted by NG vehicles of about 23% compared to gasoline.

**Objectives:**

Main objective of Integrated gas powertrain (InGas) Collaborative Project was to deploy a custom designed engine integrated with specific aftertreatment systems applied to a light duty vehicle able to achieve a 10% higher fuel conversion efficiency than that of a corresponding 2006 diesel vehicle and complying with an emission level lower than Euro 6. Additional features are advanced storage systems and vehicle architectures, as well as multi-grade fuel tolerance and fuel flexibility.

**Methodology:**

To achieve the InGas targets, three main combustion technologies were compared:

1. Sub-Project A1 CNG technologies for passenger cars developed a natural gas car powered by a 1.4 liter displacement engine using the sequential multi-point port gas injection and following the stoichiometric approach;

2. Sub-Project A2 Turbo DI CNG engine developed a natural gas car powered by a 1.8 liter displacement engine using the direct gas in-cylinder injection and following a lean burn approach;

3. Sub-Project A3 Boosted lean burn gas engine developed a natural gas light-duty vehicle powered
by a 1.9 liter displacement engine using port gas injection or low pressure direct gas injection and following the ultra-lean combustion approach.

Three main enabling technologies were compared and assessed:

1. Sub-Project B0 Fuels for advanced CNG engines defined / supplied the gas mixture of the requested quality, conduct analysis and propose solutions in order to affect in a flexible way storage, combustion, after treatment and performance of the CNG vehicles;

2. Sub-Project B1 Gas storage for passenger car CNG engine developed advanced gas storage and filling systems including specific components and gas sensors;

3. Sub-Project B2 After treatment for passenger car CNG engine developed an after treatment system for natural gas vehicles having special regards to CH4 conversion efficiency and NOx abatement under stoichiometric and lean combustion operations.

**Parent Programmes:**

*FP7-TRANSPORT - Transport (Including Aeronautics) - Horizontal activities for implementation of the transport programme (TPT)*

**Institute type:** Public institution  
**Institute name:** The European Commission  
**Funding type:** Public (EU)

**Lead Organisation:**

<table>
<thead>
<tr>
<th>Centro Ricerche Fiat - Societa Consortile Per Azioni</th>
</tr>
</thead>
</table>
| **Address:** Strada Torino, 50  
10043 ORBASSANO (TO)  
Italy |
| **Organisation Website:** [http://www.crf.it](http://www.crf.it) |
| **EU Contribution:** €2,309,939 |

**Partner Organisations:**

<table>
<thead>
<tr>
<th>Technische Universitaet Graz</th>
</tr>
</thead>
</table>
| **Address:** Rechbauerstrasse  
8010 Graz  
Austria |
| **Organisation Website:** [http://www.tugraz.at](http://www.tugraz.at) |
| **EU Contribution:** €161,256 |

<table>
<thead>
<tr>
<th>Katcon Global Sa</th>
</tr>
</thead>
</table>
| **Address:** Avenue De Luxembourg 21  
4940 Bascharage  
Luxembourg |
| **EU Contribution:** €124,484 |

<table>
<thead>
<tr>
<th>Rheinisch-Westfaelische Technische Hochschule Aachen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Address:</strong> Templergraben</td>
</tr>
</tbody>
</table>
52062 Aachen
Germany

 Organisation Website: http://www.rwth-aachen.de
 EU Contribution: €229,729

Engie

Address: Place Samuel De Champlain 1
         92400 Courbevoie
         France

 Organisation Website: http://www.gdfsuez.com
 EU Contribution: €189,531

General Motors Powertrain - Germany Gmbh

Address: Bahnhofsplatz 1
         65428 Ruesselsheim
         Germany

 EU Contribution: €104,092

Daimler Ag

Address: Mercedesstrasse
         70327 Stuttgart
         Germany

 Organisation Website: http://www.daimler.com
 EU Contribution: €825,372

Mems Ag-Matter Engineering For Metering Systems

Address: Rebmoosweg 29A
         5200 Brugg
         Switzerland

 EU Contribution: €99,900

E. On Ruhrgas Ag

Address: BRÜSSELER PLAZ 1
         45131 ESSEN
         Germany

 Organisation Website: http://www.eon-ruhrgas.com
 EU Contribution: €291,405

Consiglio Nazionale Delle Ricerche
<table>
<thead>
<tr>
<th>Organisation Name</th>
<th>Address</th>
<th>EU Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNR</td>
<td>Piazzale Aldo Moro 185 Roma, Italy</td>
<td>€149,100</td>
</tr>
<tr>
<td>Bundesanstalt Fuer Materialforschung Und -Pruefung</td>
<td>Unter Den Eichen 87, 12205 Berlin, Germany</td>
<td>€363,900</td>
</tr>
<tr>
<td>Ceske Vysoke Uceni Technicke V Praze</td>
<td>Zicova 4, 16636 PRAHA 6, Czech Republic</td>
<td>€148,635</td>
</tr>
<tr>
<td>Politecnico Di Torino</td>
<td>Corso Duca Degli Abruzzi, 10129 Torino, Italy</td>
<td>€150,000</td>
</tr>
<tr>
<td>AVL List GmbH</td>
<td>Hans-List-Platz, 8020 Graz, Austria</td>
<td>€1,572,554</td>
</tr>
<tr>
<td>Saab Automobile Ab</td>
<td>Saab Automobile Ab, 461 80 TROLLHATTAN, Sweden</td>
<td></td>
</tr>
<tr>
<td>Organisation Name</td>
<td>Address</td>
<td>EU Contribution</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Delphi Automotive Systems Luxembourg Sa</td>
<td>Avenue De Luxembourg 4949 Bascharage Luxembourg</td>
<td>€267,425</td>
</tr>
<tr>
<td>Politecnico Di Milano</td>
<td>Piazza Leonardo Da Vinci 32 20133 Milano Italy</td>
<td>€121,473</td>
</tr>
<tr>
<td>Ventrex Automotive Gmbh</td>
<td>Johann Sebastian Bach Gasse 1 8010 Graz Austria</td>
<td>€245,100</td>
</tr>
<tr>
<td>Instytut Katalizy I Fizykochemii Powierzchni Im. Jerzego Habera Polska Akademia Nauk</td>
<td>Ul. Niezapominajek 8 30239 Krakow Poland</td>
<td>€357,411</td>
</tr>
<tr>
<td>Universitaet Paderborn</td>
<td>Warburger Strasse 100 33098 Paderborn Germany</td>
<td>€275,400</td>
</tr>
<tr>
<td>Continental Ag</td>
<td></td>
<td>€305,476</td>
</tr>
<tr>
<td>Organisation</td>
<td>Address</td>
<td>EU Contribution</td>
</tr>
<tr>
<td>--------------</td>
<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td>Vahrenwalder Strasse 9</td>
<td>169 HANNOVER Germany</td>
<td>Organisation Website: <a href="http://www.conti-online.de">http://www.conti-online.de</a></td>
</tr>
<tr>
<td>Ifp Energies Nouvelles</td>
<td>16 rue 4 avenue de Bois-Préau 92500 RUEIL MALMAISON France</td>
<td>Organisation Website: <a href="http://www.ifp.fr">http://www.ifp.fr</a></td>
</tr>
<tr>
<td>Dinex Ecocat Oy</td>
<td>Vihtavuorentie 162 41331 Vihtavuori Finland</td>
<td></td>
</tr>
<tr>
<td>Politechnika Wroclawska</td>
<td>Wybrzeze Wyspianskiego 27 50370 Wroclaw Poland</td>
<td>Organisation Website: <a href="http://www.pwr.wroc.pl">http://www.pwr.wroc.pl</a></td>
</tr>
<tr>
<td>Haldor Topsoe As</td>
<td>Nymoellevej 55 2800 Lyngby Denmark</td>
<td></td>
</tr>
<tr>
<td>Siemens Ag</td>
<td>Wittelsbacherplatz 2 80333 MUENCHEN Germany</td>
<td>Organisation Website: <a href="http://www.siemens.com">http://www.siemens.com</a></td>
</tr>
</tbody>
</table>
Alpha Composites Gmbh

Address:
Planckstraße 15
32052 Herford
Germany

Organisation Website: http://www.xperion.de

EU Contribution: €366,400

Fev Europe Gmbh

Address:
Neuenhofstrasse 181
52078 Aachen
Germany

EU Contribution: €1,097,802

Adam Opel Ag

Address:
Bahnhofsplatz 1
IPC-R1-05 RÜSSELSHEIM
Germany

Organisation Website: http://www.opel.com

EU Contribution: €235,836

Chalmers Tekniska Hoegskola Ab

Address:
- 41296 GOTENBURG
Sweden

Organisation Website: http://www.chalmers.se

EU Contribution: €150,120

Technologies:

Road vehicle propulsion
Fuel efficient engine with aftertreatment systems

Development phase: Implementation

Key Results:

The main outcomes of the project are:

- validator vehicle (Fiat Bravo) with innovative 1.4 liter Turbo Charged Port Fuel Injected Multi-air stoichiometric CNG (Compressed Natural Gas) engine;

- validator vehicle (Mercedes E200/NGT) with innovative 1.8 liter Turbo Charged Direct Injected stoichiometric CNG engine and start-stop device;

- after treatment for innovative 1.6 liter Turbo Charged Port Fuel Injected lean burn CNG engine;

- full well-to-tank and combustion analysis versus NG (Natural Gas) composition and innovative NG
- quality sensor;
- innovative CNG (Compressed Natural Gas) storage module implemented on Fiat Grande Punto with 1.4 liter CNG engine;
- innovative after treatment with an improved 3-way catalyst (with lower precious metal content than conventional one) and heat exchanger to enhance methane conversion efficiency.

Some of the major results are:

- an improved engine performance and improved end torque of CNG engines, this bridges the gap that it had compared to diesel and gasoline engines;
- CO2 emission and fuel consumption of current CNG engines has been improved;
- development of an improved 3-way catalyst;
- an innovative storage system provide halved weight in comparison to conventional solutions, without any penalty in terms of vehicle trunk space and/or safety, at only a small cost increase;
- the project developed technology to adopt 65% of bio methane instead of fossil CNG, thus achieving a well-to-wheel figure equal to zero.

**Innovation aspects**

Market introduction of dedicated (mono-fuel) CNG vehicles requires the development of technologies able solving problems regarding: gas storage, gas feeding, combustion system and after treatment plus, at the same time, taking into account the quality of natural gas.

**Policy implications**

Natural gas (NG) is a clean fuel. It represents a real alternative to crude oil, as it is available in large quantities also in countries different from the Middle East. If reserves/production ratio is considered, there are sufficient world reserves of natural gas for the next six decades. This is much more than those of crude oil (about four decades of world reserves). These world reserves are sufficient to allow significant using Natural Gas to power transportation vehicles.

**Strategy targets**

Innovating for the future (technology and behaviour): Promoting more sustainable development

**Policy objectives**

The European activities on alternative fuels basically have two policy drivers: (1) security of energy supply and (2) reduction of greenhouse gas emissions. It should be noted that energy efficiency and alternative fuels are complementary approaches.

Documents:

- [INGAS Final Report (31May2012) (Final report)](attachment)

**STRIA Roadmaps**: Low-emission alternative energy for transport

**Transport mode**: Road transport

**Transport sectors**: Freight transport

**Transport policies**: Environmental/Emissions aspects

**Geo-spatial type**: Other