LIFE DI-CNG
Demonstration and validation of Direct Injection of CNG in vehicle engines and its environmental benefits

AFTER LIFE COMMUNICATION PLAN
LIFE DI-CNG Fact Sheet

LIFE DI-CNG is co-financed by LIFE+, the financial instrument for the environment of the European Commission (LIFE13 ENV/LU/000460)

Duration: 2014-2018

Budget: € 7,969,959

Goal:
Installation of a pilot production line for the industrialization of the DI-CNG injectors and demonstration of the DI-CNG potential and its environmental benefits

Website:
1. INTRODUCTION

Decarbonization is a major social challenge for the 21st century, not only for the automotive industry but also for the energy sector, petrol and gas industries as well as for the energy intensive materials’ and manufacturing industries.

With emissions regulations aiming at 95g CO$_2$/km in Europe by 2021, there is an immense pressure on the automotive industry to meet these requirements. Since achieving strict emissions targets will require a variety of powertrain technologies, automakers are also taking a closer look at alternative fuels such as bio-methane.

Today Natural Gas Vehicles (NGVs) are all equipped with conventional Port Fuel Injection (PFI) systems, which offers a strong functionality but with a loss in low-end torque when compared to a modern Gasoline Direct injection (GDi) engine. This loss is noticed by drivers both in the engine performance and in the drivability. Compressed Natural Gas (CNG) is an attractive energy source. Customer acceptance and engine performance of NGVs can be boosted through a novel gas injection system.

The Delphi Technologies Direct Injection (DI) CNG systems addresses this issue. It offers significant benefits over PFI CNG and reaches similar engine performance than GDi. Further benefits of monovalent DI-CNG vehicles are reduced vehicle costs and increased effective CNG range.

CNG is attractive as an alternative fuel for automotive application because of its interesting physical and chemical properties. It is mainly composed of methane, CH$_4$. It has the highest hydrogen to carbon ratio of any fossil fuel and therefore offers optimum composition to reduce CO$_2$ emissions. The gravimetric specific heating value of methane is higher than for gasoline or diesel fuel. When compressed to 200 bar CNG also gains volumetric specific heating values enabling tank storage for a useful vehicle range. Most interesting for engine applications is the high knock resistance of methane. Several modifications of the DI-CNG engine architecture are required to achieve a compression ratio of 13:1 that is demanded to take full benefit of methane’s properties. The DI-CNG engine technology is fully compatible with bio-methane.

CNG is widely accepted by the public thanks to industrial applications for stationary heat and power generations. A CNG grid is available in all industrial countries and fulfils high quality standards for safe transport, storage and handling.
2. LIFE DI-CNG PROJECT

a. Context and objectives

The context was the comparison of direct injected CNG to direct injected gasoline in specific internal combustion engines.

The key objectives of the LIFE DI-CNG project aimed to demonstrate a significant reduction of GHG (Green-House-Gas) emissions and the reduction of pollutants such as particulate emissions. The achievements compared to state-of-the art gasoline engines were:
- 23 to 25% reduction in CO$_2$ emissions
- over 90% reduction in particulate matter

Delphi Technologies developed the DI injector and installed and a pilot line production line. Both major objectives of the project allowed to industrialize the DI-CNG injector technology.

b. Activities

The demonstration of the DI-CNG technology was executed in collaboration with different research partners. Several engine and vehicle platforms were equipped with DI-CNG injectors that were built on a semi-automated pre-industrial manufacturing and assembly line suitable for small scale production of DI-CNG injectors.

The reduction of emissions that was achieved with this technology, depended on the OEM (Original Equipment Manufacturer) engine configuration; and calibration and exhaust after treatment strategy. An extensive demonstration of the DI-CNG technology potential was investigated in the Horizon 2020 GasOn project (www.gason.eu) by several project partners on a larger variety of engine configurations.

An assessment of the carbon footprint of this technology was performed in form of a Life Cycle Assessment (LCA). This study was extended to cover fuels made from renewable feedstock or renewable energy.

3. RESULTS

The DI-CNG injector hardware was developed and validated. A software for piloting the opening and closing of the injector was created and implemented. The key injector’s specifications such as flow behavior, leakage rate and durability were controlled. The production processes were developed, a pilot production line designed and implemented. It served to build several badges of industrialized injectors.
Delphi Technologies entered into several partnerships for the joint development of DI-CNG engines and the demonstration of DI-CNG potential at vehicle level. The results were summarized as follows: The DI-CNG engine technology demonstrated performance characteristics (power, torque) similar to modern GDi engines. Engine performances higher than 100 kW/L were reached without compromising the injector’s durability, reliability and engine safety. Drivers can expect higher torque at lower engine speeds, meaning faster acceleration compared to the current PFI CNG technology. The partners demonstrated that a reduction of 31% CO₂ compared to GDI, and 15% reduction compared to PFI-CNG engines, can be expected. Methane is a low-carbon clean burning gaseous fuel; its improved combustion efficiency allows for 90% lower particulate emissions. The use of bio-methane offers further potential to reduce green-house-gas emissions.

4. REPLICABILITY AND TRANSFERABILITY

The principle for DI-CNG combustion is similar to GDi. The development and production of monovalent DI-CNG vehicles is based on the solid know-how from the supply chain of the internal combustion engines; the technology can be produced on existing manufacturing lines. Monovalent DI-CNG engines have the potential to be an interesting alternative powertrain to support the decarbonisation of the transport sector.

The installation of the pilot line enables Delphi Technologies to manufacture batches of DI-CNG injectors at a high production quality in a reproducible manner. The injectors will serve to support DI-CNG engine and vehicle development. The knowledge gained during the DI-CNG injector design and manufacturing process’ development will be leveraged to install a full production line once the industry’s demand is confirmed.

DI-CNG injectors and DI-CNG engines are dedicated for passenger and light duty vehicles. A key factor to the success is further investments to support the growth of CNG fuelling and bio-methane distribution infrastructures.
5. AFTER-LIFE COMMUNICATION STRATEGY

a. Objectives

Following the very promising results obtained during the project concerning the innovative DI-CNG injector, Delphi Technologies will continue to conduct communication activities related to the project outcome in order:
- to raise awareness on the environmental friendliness of the DI-CNG technology,
- to ensure a good market uptake/promotion of the technology and its replicability/transferability across the world.

These activities will mainly take place through the leadership of Delphi Technologies in Luxembourg and will address a large audience with specific focus placed on automotive and engine manufacturers (for example Ford; Fiat; Audi...). Several dissemination tools will be used such as the participation in exhibitions and conferences. Delphi Technologies will also contribute to the networking with industry at the occasion of on-going or future R&D projects.

Following initiatives are planned:
- to publicize articles in specialised journals and press releases,
- to distribute information materials, such as leaflets, flyers and posters, during fairs, conferences and exhibitions.
- to organise guided visits with potential clients and users to show the prototype and the pilot production line,
- to use the information boards produced during the project to promote the technology.

<table>
<thead>
<tr>
<th>Dissemination Tools</th>
<th>Targeted Audience</th>
<th>Estimated Cost [per year]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Public Authority</td>
<td>Potential Clients</td>
</tr>
<tr>
<td>Expositions [2]</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Conferences [4]</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Contact/meetings/projects with Automotive Industry</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
b. Dissemination activities during the project

<table>
<thead>
<tr>
<th>Activity</th>
<th>Results</th>
<th>Targeted Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific Publications</td>
<td>9 publications</td>
<td>Automotive experts</td>
</tr>
<tr>
<td>Conference Presentations and Organizations</td>
<td>Automotive and gas vehicle community</td>
<td>5 conferences</td>
</tr>
<tr>
<td>Leaflets, Posters, Information Boards</td>
<td>500 leaflets, 13 posters (1 linked to LCA), 7 information boards</td>
<td>General and specialized public</td>
</tr>
<tr>
<td>International Fairs</td>
<td>Participation to 3 fairs, reaching approx. 500 participants</td>
<td>Specialized audience (automotive)</td>
</tr>
<tr>
<td>Guided Visits to Pilot Line</td>
<td>More than 50 guided visits</td>
<td>General public / stakeholders / clients / public authorities</td>
</tr>
</tbody>
</table>

c. Short term and long term dissemination activities after the project

**Participation to fairs and exhibitions**
In 2019 Delphi Technologies was/ will be present with a booth at the CES (8-11 January 2019) in Las Vegas and the IAA (12-22 September 2019) in Frankfurt. During both shows Delphi Technologies presented/ will present the DI-CNG injector and its achieved performances in the context of the LIFE+ programme. During these events, Delphi Technologies will be able to meet relevant stakeholders and to present overviews on some aspects of the DI-CNG project.
In 2020 Delphi Technologies plans to participate at the Transport Research Arena (27–30 April 2020) in Helsinki, which is the biggest European Research and Technology Conference on transport and mobility.
Other exhibitions in 2020 dedicated to green transport and/ or automotive transport will be specifically targeted. At this stage, the plans for fair and exhibition participations in the year 2020 and beyond are not finalized yet.

**Participation to seminars and conferences**
The specialized conferences in 2019 were Delphi Technologies plans an active participation and a booth are: the VDA Technical Congress (14-15 March 2019) in Berlin; Vienna Motor Symposium (15-17 May 2019), Aachener Kolloquium Fahrzeug- und Motorentechnik (7-9 October 2019) An active participation in smaller conferences is possible but not formally planned at this stage. During those conferences the DI-CNG injector and its achieved performances in the context of the LIFE+ programme will be displayed on the booth.
The calendar of conference participations in 2020 is not finalized at this stage.

**Project’s website**
The webpage is highlighted on the Delphi website and will be maintained 5 years after the end of the project.
**Articles and press releases**

Since the technology’s Technology Readiness Level (TRL) is increasing, scientific publications are still targeted, although more focus is put on marketing to potential customers. Different articles will be prepared highlighting the demonstrated benefits of the DI-CNG technology, and published in the Luxembourgish media (such as PaperJam Trends, linked to innovations) and the dedicated European press.

**Printing of information material**

The dissemination materials prepared during the project will be used within these After LIFE actions. Depending on the needs, material might be translated into additional languages (vs. French and English) The Layman’s report summarizing key project results was translated in English, French and German languages and will be available on the web page after the project termination.

**Guided visits**

The pilot line will remain implemented in the Delphi Technologies premises at least until December 2019. Some guided visits including representatives of vehicle manufacturers, the Luxembourg Authorities and the EC took place since the installation of the pilot line. These visits will continue until the line will be dismantled.

**On-site panels for dissemination to the general public**

The information boards will be maintained at the Delphi Technologies premises to continue informing on the project achievements.

**Pilot line**

The pilot production line will serve to build injector engineering samples in case development projects for production programs with vehicle manufacturers will be initiated.

**Local community**

The LIFE project and its achieved results will be presented by representatives from Delphi Technologies to:

- ILEA (Industrie Luxembourgeoise des Equipementiers de l’Automobile) during their all members meeting in May 2019,
- The Luxembourg Minister of Mobility and his staff during a meeting to be set up for June 2019,
- The local Automobility Cluster during their “Automobility breakfast” event in autumn 2019.

**d. Medium term and long term dissemination activities after the project**

Delphi Technologies supplied its DI-CNG injectors to Ford and Fiat Research Centers in the frame of the Horizon 2020 GasOn project. Both OEMs developed DI-CNG engines and monovalent DI-CNG vehicles. The GasOn project will terminate in summer 2019. The key results on engine performance and vehicle emissions testing will be presented via this the GasOn web page were the LIFE DI-CNG developments will be put forward.

During 2019 and 2020, Delphi Technologies aims to disseminate LIFE DI-CNG and GasOn project results in joint publications and conference presentations together with many GasOn consortium partners.

On a longer-term perspective, Delphi Technologies is seeking for commercialization of DI-CNG injectors. The initial plan is to have the first car with a DI-CNG injector in the market by 2022.