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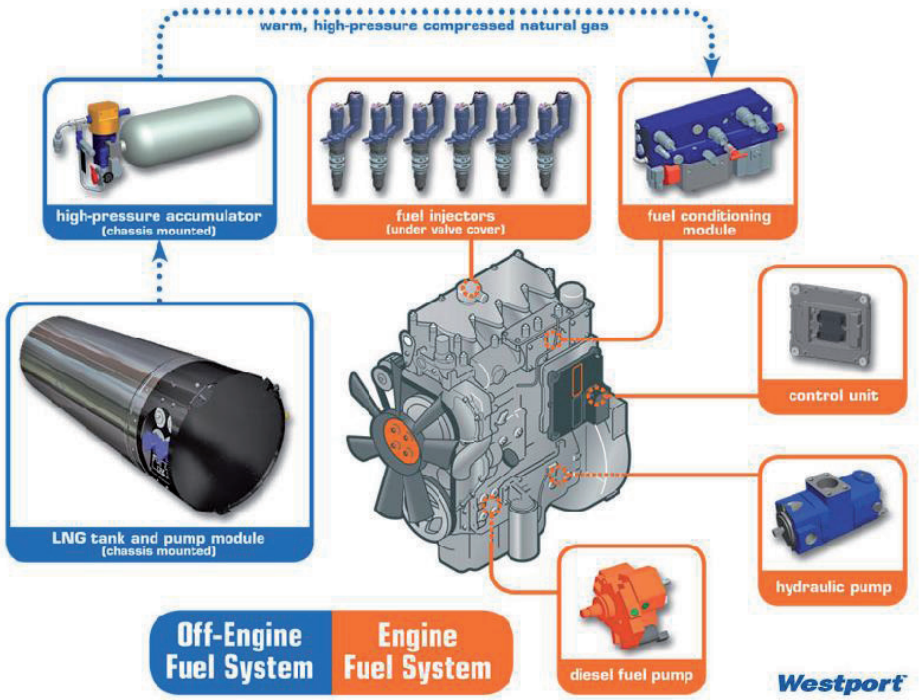
SWEDISH TRANSPORT ADMINISTRATION

IEA AMF project ***Enhanced Emission Performance and Fuel Efficiency for Heavy Duty Methane Fuelled Engines*** has been carried out during the period May 2009 - May 2014.

The project is split in two phases, a literature study and testing in Canada, Finland and Sweden of state-of-the-art engine technology for methane as fuel. Testing was carried out on-road with vehicles in normal operation, during various driving conditions and in sophisticated emission laboratories. Methane is a global fuel with a high potential for use in heavy-duty vehicles, but additional development is still needed to reach adequate performance regarding fuel efficiency and/or exhaust emissions.

The transport sector contributes to a significant share of GHG emissions. To reduce this portion, increased use of alternative fuel and improved energy efficiency is key actions. Among the alternative fuels no one could be appointed as the "silver bullet", all alternatives have to be considered. Methane is looked upon as one suitable alternative for the transport sector and can be used either in the form of gas (CNG) or liquid (LNG). When methane is a substitute for diesel fuel in heavy duty vehicles at the current state of technology development the climate benefit (reduction of GHG) will be small or even negative. However, if methane is of non-fossil origin and used as compressed biogas (CBG) or liquefied biogas (LNG), the emissions of GHG could be significantly reduced.

Two types of engine technology have been investigated, spark ignited engines and compression ignited diesel dual fuel engines. Engines operated according the dual fuel technology can be divided in "fumigation technology" and "direct injection technology", both technologies use the diesel part just to ignite the mix of air/fuel after combustion. The advantage with dual fuel technology is a possibility to reach similar energy efficiency as for diesel engines, which is about 10% more than from heavy duty spark ignited engines.



Participating members: **Sweden, Finland, Canada**, Japan (LEVO and JGA), Germany and IEA Bioenergy (DG Energy)

High pressure direct injection system

When the project started it was not possible to approve engines, working according to dual fuel technology, in accordance with ECE/EU emission regulations. Exchange of experience with informal working groups in ECE and EU has now open up for this possibility by amending ECE Regulation 49 and corresponding EU Regulations.

Key findings from the project can be summaries as follows:

- Spark ignited engines meeting latest EU/US emission requirements are commercial available on the market and emissions of GHG will in best cases not increase (compared to similar diesel engines). When biogas is used GHG will be reduced but depending upon the origin of gas.
- Fumigation (DDF) technology available on the market will not meet mandatory emission requirements. Ratio of diesel replacement is not according to expectations. Modification of vehicles in use (retrofit) will not decrease GHG emissions nor improve energy efficiency
- Pilot injection (DDF) technology is so far only available on the North America market. Technology more advanced than fumigation but might be the only alternative for OEM. Limited driving performance when run out of gas.

The project clearly indicates that dual fuel technology is in need for additional development to meet requirements from the market related to ratio of diesel replacement and emission performance, especially emissions of methane. In addition, energy efficiency has to be improved and the air/fuel management must be more tolerant to different specification of the gas/liquid used as fuel.

Remaining questions from the project was identified as follows:

- Since development of engines are ongoing, it would be recommended to have a continuous follow up of new technology in this field
- The durability of emission performance of methane fuelled heavy duty engines is not in line with corresponding diesel engines, mainly due to performance of catalysts, and need to be further validated.
- For countries not implementing latest emission requirements, retrofit of diesel vehicle in-use by adding technology for dual fuel and thereby reduce emissions of particles might be solution to improve ambient air quality. Dealing with retrofit application has not been a part of this project but should be considered.
- In case when LNG/LBG is used as fuel (to extend the drive range of the vehicle) special concern must be given to “bleed off” (evaporation of the liquid gas)

in cooperation with

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