IP Green Heavy Duty Engine (GREEN)

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ABSTRACT

IP GREEN is a European partnership, funded by the European Commission ranging from academia via suppliers to HD engine manufacturers. GREEN prepares European industry for future emission legislation with emphasis on simultaneous improvement of fuel consumption by competitive technologies.

Numerous changes in engine design and component are combined with a new approach for engine control technology, which in combination with a system approach that allows combustion and aftertreatment to be dealt with as one system, will enable rapid progress in GREEN.

By applying strict targets for emissions and fuel consumption well defined performance targets will be reached. Simultaneously GREEN build for the future by securing compatibility with future fuels and, emissions at off-cycle conditions is a concern additionally covered by the GREEN activities.

Key-words: Flexible diesel/gas engine, integrated system, model based control, emissions, renewable fuels

INTRODUCTION

The development of HD engines undergoes a rapid step in its evolution. Increased demand for fuel efficiency, emissions and global competition are driving forces. The HD (Heavy-Duty) engines operate under constraints much more severe than those of passenger cars such as:

- higher durability (> 600.000 km) of the engine and of the related aftertreatment,
- higher mechanical and thermal stress of the engine (heavier load factor)
- higher pressure on reliability (up-time), investment and fuel economy

The above constraints characterize the HD engines for their more general applications: not only trucks and urban vehicles but also the rail traction and the inland waterway vessels of the directive 2002/765.

New technologies will help us meeting future emission and fuel consumption targets by:

- a new combustion process enabled by variable components;
- new control strategies
- considering the engine and the exhaust aftertreatment as ONE system;
- considering sustainable fuels

THE INTEGRATED PROJECT GREEN

OBJECTIVES
The main objective of the IP GREEN (contract nr TIP4-CT-2005-516195) is to perform research leading to sub-systems for a heavy-duty engine.
The objectives should be achieved with strict boundary conditions for: i) a competitive cost base, ii) highest fuel conversion efficiency of the Diesel cycle, to achieve near-zero real world, including off-cycle, pollutant emissions and significant reduction of CO2 and other green house gases.

The project put emphasis on diesel engines for trucks and rail applications and on natural gas engines for city transport applications. The combination of innovation and durability is strongly supported.

The research targets have been chosen to look beyond all legislation known today. Targeting possible sharpening after year 2010 with focus on near zero real world emission (for Diesel NOx 0.5 g/kWh, PM 0.002 g/kWh, ETC Cycle BSFC 204 g/kWh and for natural gas corresponding targets are set).

Figure 1 illustrates the drives for the research and development together with the targets for IP GREEN.

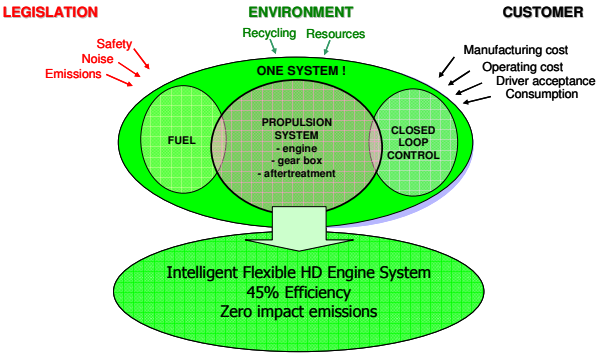

Figure 1, illustration of drives and project target

THE CONSORTIUM

The consortium of the Integrated Project GREEN consists of 27 partners from 12 countries (see APPENDIX). The project started the 1st march 2005 and will end the 29th February 2008. The total budget is 22M€ and of which 12M€ is funding received from the European Commission.

STRUCTURE OF IP GREEN

The project is structured of four subprojects each focusing on a different technology solutions to meet the targets

- A1 – "HD Gas Engine for urban area" with the specific objective to reach low gaseous emissions and Diesel engine equivalent fuel consumption by developing variable valve motion management, cooled EGR for gas engines and developing and a very close to valves multipoint port-gas injection and comparing with DI injection.

- A2 – "Enhanced Flexible Engine" with the specific objective to find the best combination and concept to reach emission limits beyond EURO 5, regarding flexible engine components / sub-systems and further exhaust aftertreatment systems.

- A3 – "Innovative Control and Air Utilisation" with the specific objective to develop the sub-systems for a new combustion process with complete air utilisation and to develop the models for a model based closed loop emission control, thus to create the conditions to regard engine and aftertreatment as one system in the future.

- A4 – "High BMEP Engine" with the specific objective to investigate the advantages and possibilities of a very high brake mean effective pressure to reduce fuel consumption as best as possible.

Along with the subprojects there are two different supporting workpackages focusing on advanced EOCV (Electromagnetic Operated Control Valve), fuel tests and rail specifications & rail engine development. Figure 2 show the structure of the project together with some of the deliverables. At project start a number of cross contributions was defined where partners from different subprojects and workpackages may interact and share knowledge. The target for the project beyond 2008 is fuel neutral, fully flexible engines for Heavy Duty applications and rail engines to meet the demands in a longer perspective.

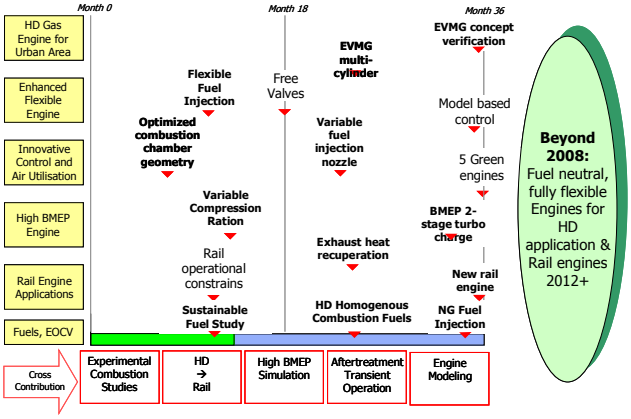

Figure 2, structure of the IP GREEN

PROGRESS AND DELIVERABLES

The project just recently passed 18 month and it has shown to already been very successful. Technical progress and breakthroughs have been shown in different areas such as:

- Fuel injection systems – studies of variable injection strategies
- Combustion systems – investigation of impact of new flexible technologies such as VVA (Variable Valve Actuation) and FIS (Fuel Injection Systems)
- Aftertreatment – engine and aftertreatment considered as one system
- Efficiency – studies on increased peak cylinder pressure
- Breakthrough technologies

SYNERGIES AND COLLABORATION

In addition to the activities with in IP GREEN a close collaboration is kept with other ongoing integrated projects. Figure 3 show the projects that are closest related to the theme of IP GREEN. IP NICE supports with new and improved CFD models that could be validated using results from the IP GREEN. IP RENEW is consulted when it comes to alternative fuels and IP GREEN contribute back to RENEW with results from fuel

studies. With IP SILENCE boundaries for urban noise could be discussed.

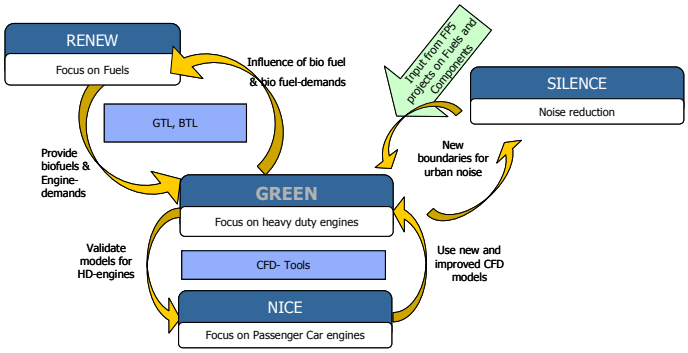

Figure 3, interaction with other ongoing Integrated Projects.

EXPECTED FINAL RESULTS AND IMPACT

The expected final result of the IP GREEN is fuel neutral, fully flexible engines for Heavy Duty applications which imply:

- NOx and PM levels 2012+
- Fuel consumption 5% below Euro III

For gas engines:

- Low emissions and global warming index far beyond the state-of-the-art

The final result also includes improved Rail engines for 2012+ with emission performance converging towards Heavy Duty applications.
The OEM partners will utilize the achieved results in their future product developments and the suppliers will use the results correspondingly for future automotive component development.

APPENDIX

Partners of the Consortium

AVL List GmbH	Austria
Robert Bosch GmbH	Germany
Chalmers Tekniska Högskola AB	Sweden
Centro Ricerche Fiat S.C.p.A.	Italy
České vysoké učení technické v Praze	Czech Republic
DaimlerChrysler AG	Germany
Delphi Diesel Systems Ltd	United Kingdom
Deutz AG	Germany
Eidgenoessische Technische Hochschule Zuerich	Switzerland
FEV Motorentechnik GmbH	Germany
Ford Otomotiv Sanayi A.S.	Turkey
Holset Engineering Company Ltd	United Kingdom
Institut Francais du Pétrole	France
Iveco SpA	Italy
Iveco Motorenforschung AG	Switzerland
Johnson Matthey plc	United Kingdom
Metatron s.r.l.	Italy
MTU Friedrichshafen GmbH	Germany
National Technical University of Athens	Greece
NONOX BV	Netherlands
Politecnico di Torino	Italy
Ricardo UK Ltd.	United Kingdom
Rheinisch-Westfaelische Technische Hochschule Aachen	Germany
Union Internationale des Chemins de fer	France
Union of European Railway Industries	Belgium
Universidad Politécnica de Valencia	Spain
Volvo Powertrain Aktiebolag	Sweden

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