

PRIME MOVER GAS RE-ENGINEERING
CASE STUDY

In my experience in the automotive industry this project was unique. The three parties involved formed a Joint Industrial Project. This meant that each company provided 1/3 of the funds and had joint ownership of the designs.

The three parties and their objectives were:

- Mobil CNG wanted to increase sales of CNG. A partnership with the market leader in heavy goods vehicles would be of benefit.
- British Gas wanted to increase the sales of LNG as they have a plant producing this but with limited sales. Again partnership with Scania was significant.
- Scania (GB) had only very limited supply of new gas powered trucks from the parent company and needed a fast route into this expanding market. We also needed to find a way of extending the life of trucks returned from contracts in an environmentally friendly way.

Although not part of the Joint Industrial Project we were helped and encourage throughout by the Energy Savings Trust – a Government body with the objective that its name implies – more of them later.

The project started in April 2000 and on 31 January and 1 February 2001 we had a Ride and Drive for the Press and Fleet engineers at the Transport Research Laboratory where 6 trucks were available. Since then we have been busy with demonstration programmes within major fleets.

In starting the project we made a very definite decision to select one truck and reengineer it – not a range of trucks, as this would have taken too long.

The truck selected was the
Scania P113 MA 4x2 Prime Mover

The main criteria in selecting this truck were

- We had some coming back from contracts at the end of 2000 and beginning of 2001
- The lack of refuelling stations meant that we had to have a return to base operation
- To be economic in terms of installing compressors or LNG refuelling stations we needed to have 30-40 trucks operating from a location
- To maximise government grants we needed to have trucks distributing in urban or high pollution areas.

As the selected prime mover is used by the major British supermarkets – Safeway, Tesco, Asda and sub-contractors to them it was the obvious choice.

Before starting the development work we established objectives:

- Low noise signature
- Low tail-pipe emissions
- Economical to operate
- Minimum range of 350 miles
- Recyclable componentry
- Power/torque as diesel

With the overriding requirement that we had to be finished in 12 months.

Having established the objectives we now needed to put people and contractors and suppliers in place.

The team that we put together was

Project leader – Brian McMurray. An experienced engineer who had previously worked on a Perkins gas engine project. Since leaving Perkins he had formed his own consultancy LambdaX.

Development and Design	: Scott Gibbin Ltd UK
Engine Management System	: IMPCO USA
CNG Composite Tanks	: Lincoln Composites USA
Natural Gas Catalyst	: Kemira Finland
Production	: Feather Diesel Services UK

(A list of contacts at each of these companies is attached to this paper).

The work to be done was broken down in to 3 modules.

Engine Internals

Engine Externals

Chassis

The overriding requirement of the project was to utilise leading edge technology to produce a best-in-class product.

A brief description of the work done on each module.

Engine Internals

Cylinder Head

Modifications to the cylinder head were minimal with some local machining to allow a spark plug to be fitted into the injector pocket which was also opened up to provide access to the plug using an off-the-shelf socket.

Piston

The compression ratio was reduced from 17:1 to 12:1 by machining a dedicated combustion bowl into the existing diesel piston.

New Parts

The diesel fuel injection system and turbo are recycled for future diesel use. The only new engine parts fitted are inlet valves, valve guides, valve stem seals and gaskets.

Engine Externals

Externally, the engine was fitted with the Impco Eclipse heavy-duty engine management system, Holset waste-gated turbo with a water-cooled bearing and a dedicated natural gas lean-burn catalyst manufactured by Kemira.

Packaging

Packaging was of prime importance and a modular approach was adopted to simplify initial assembly, field servicing, down time and parts handling.

Reliability

Considerable attention was given to providing high levels of redundancy in the engine management system with the objective of ensuring reliability approaching that of the diesel, which has the benefit of over a century of development. “The truck must make its delivery on time” were the words of a well-known fleet engineer, which were repeated many times during the concept stage of the Impco Eclipse System.

Emissions

The emission strategy demanded that Pm and Nox be reduced by the engine’s combustion system while close-coupling the catalyst

enabled the brick to maintain the temperatures required for high conversion rates of CO and HC including methane.

Chassis

Fuel Storage

Chassis components focussed mainly on the fuel storage systems that from concept catered for both CNG and LNG versions of the truck. Leading-edge technology was again used with carbon fibre and super insulated fuel vessels being purchased from the US.

The obvious question now is – Did the Project Achieve its Objectives?

Low Noise Signature

Noise tests were carried out at Millbrook Proving Ground in January 2001. the following results were achieved:

LEVELS IN dB(A)

Position	Diesel	Gas
7.5 metres from front	71.1	60.6
7.5 metres from left	69.6	59.8
7.5 metres from right	69.6	60.0
Internal at driver's ear	60.6	54.7

An overall reduction of about 10 dB(A), which is equivalent to halving the noise. This is an important factor for trucks to be able to make night time deliveries.

Low Tail Pipe Emissions

Three trucks, 1 diesel as a baseline and 1 LNG and 1 CNG, were tested at Millbrook Proving Group. The results were very satisfactory.

g/kWhr

	HC (Hydro Carbons)	CO (Carbon Monoxide)	Nox (Nitrox Oxide)	Co2 (Carbon Dioxide)	PM (Particulate Matter)
Diesel	0.864	1.442	7.014	756.3	0.373
LNG	0.180	0.017	1.532	698.0	0.013
CNG	0.212	0.018	0.962	674.0	0.007
Euro 5	0.55	4.0	0.962	674.0	0.07

Euro 5 levels are included as a standard against which to measure. The current intention is to introduce Euro 5 in Europe in 2008. We feel we are well ahead of the game.

Economical to operate

Specific fuel consumption under 190g/kwhr @ 1,100 to 1800 rpm

This is at least equal to the diesel version of the truck.

Minimum range of 350 miles.

The truck using either gas fuel has achieved a range in excess of 400 miles. The CNG pressure to achieve this is 250 bar as opposed to the more usual 200 bar.

Recyclable Componentry

The only items from the truck to be reengineered that have been discarded are the diesel tanks. The diesel fuel injection system and turbo are reconditioned and put into the Scania service exchange programme.

Of the new items fitted to the re-engineered trucks some have more than one life, eg, the fuel tanks, which are expensive have a 15 year life and can be re-used several times. The engine management system will have at least a second life.

I think we have achieved our objective..

Power/Torque as diesel

	Power	Torque
Diesel	320hp	1425Nm
Gas	350hp	1550Nm

The achievement here allows us to run these vehicles plated to 38 tonnes.

Government Assistance

At the start of this paper I mentioned how the British Government actions through the Energy Savings Trust had been very important to this project.

The Government introduced a programme entitled Transport Action Clean-up Campaign. This was intended to operate in pollution hot spots and to reduce pollution levels by retro-fitting of pollution reducing devices to existing vehicles.

The major areas targeted are:

- Greater London
- Birmingham and West Midlands
- Greater Manchester
- Leeds/Bradford

As a result of the emission levels achieved by our trucks a grant of 75% of the reengineering costs is available.

This Government aid allows, in combination with the used truck, a relatively low cost of entry to the market for natural gas powered vehicles. It certainly will encourage a real growth in the market.

On the back of this Government grant we are now quoting to some major customers new diesel trucks with reengineering to natural gas after 3 years and then 3 years running as a gas truck. Again this encourages the experience without taking the full plunge.

Summary

The feeling of all of us involved in the project is that we have achieved our objectives as specified at the start and particularly within the time frame allocated.

The final proof of any project, however, is the sale of the trucks that are reengineered. I am pleased to say that we have orders that we will start delivering this month for 40 CNG and 10 LNG. I am also confident that there are more in the pipeline.

The next step is to select the next truck configuration to start again.

FRANK ANDREW

Director

Scania (Great Britain) Limited

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Email Contact Details

Brian McMurray (UK)	lochinar@skynow.net
Feather Diesel (Richard Rayner) (UK)	richardrdfs@cs.com Feather_diesel@compuserve.com
IMPCO (Lorne Gettel) (USA)	LorneGettel@compuserve.com
Scott Gibbin (John Bowles) (UK)	scott-gibbin@dial.pipex.com
The Leasing Group (LNG) (UK)	roy.james@bg-group.com
Mobil CNG (Tom Jaworski) (UK)	tom_p_jaworski@email.mobil.com
Energy Savings Trust (David Lemon)	davidL@est.co.uk
Kemira (Kauko Kanninen) (Finland)	kauko.kanninen@kemira.com
Lincoln Composites (Bill Dick) (US)	bdick@lincolncomposites.com
Ffa/ausgas/dmc	