



# Driving Innovation - Gas Vehicle Technology

## **Energy Challenge** and **Greenwatt Technology**

Biogas to Biomethane: Transport & related Opportunities in the West Midlands

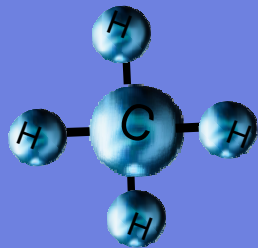
Presented by T L Fletcher BSc  
23<sup>rd</sup> October 2008

# Motivating Forces

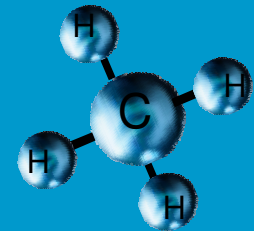


The move to Natural Gas is not solely driven by reduced operating costs:

The economic and environmental climate is the greatest motivating factor

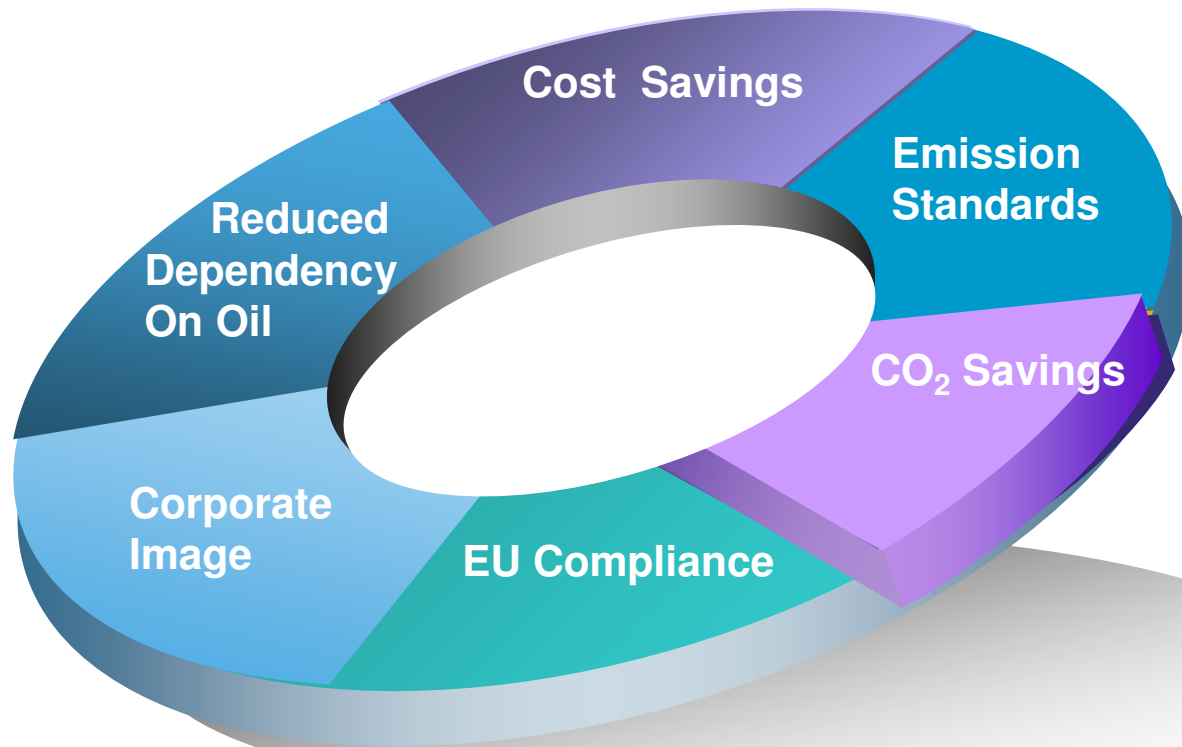


Escalating fuel costs and possible disruption in supply of imports from politically unstable countries accelerated the demand for alternative fuelled vehicles. We now have ability to use 100% renewable



Government initiatives

# Advantages



# EU Limit Values



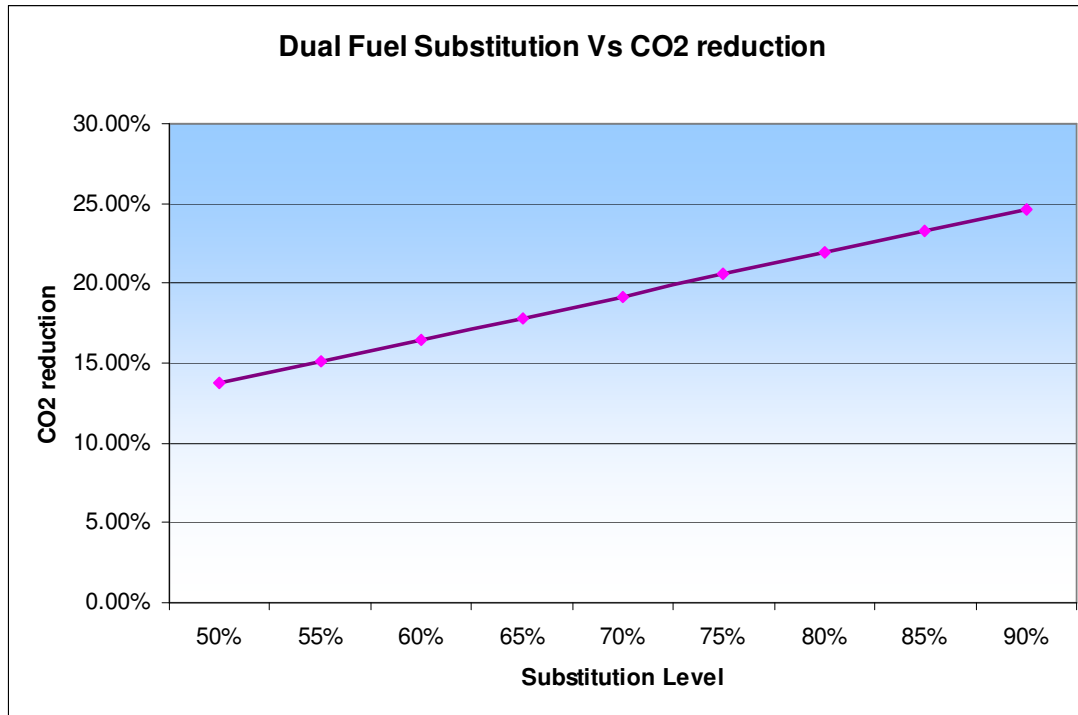
	Unit	EURO 3 Diesel	Indicative % reduction using Dual Fuel, Natural Gas	EURO 4 Diesel	Indicative % reduction using Dual Fuel, Natural Gas	EURO 5 Diesel	Indicative % reduction using Dual Fuel, Natural Gas
<b>CO</b>	g/kWh	<b>5.45</b>	98%	4.0	98%	4.0	98%
<b>HC</b>		-	-	-	-	-	-
<b>NMHC</b>		<b>0.78</b>	50%	0.55	50%	0.55	50%
<b>CH<sub>4</sub></b>		<b>1.6</b>	Limit Achieved	1.1	Limit Achieved	1.1	Limit Achieved
<b>NO<sub>x</sub></b>		<b>5.0</b>	35%	3.5	30%	2.0	30%
<b>PM</b>		<b>0.16/0.21</b> <sup>1) 3)</sup>	50%	0.03 <sup>2)</sup>	30%	0.03 <sup>2)</sup>	30%
<b>SMOKE</b>	M <sup>-1</sup>	-		-		-	

1) For engines having a swept volume of less than 0.75 dm<sup>3</sup> per cylinder and a rated power speed of more than 3000 min<sup>-1</sup>

2) For natural gas engines only

3) Not applicable for gas engines – Euro 3 stage

# CO<sub>2</sub> Emission Reduction



Substitution Rate %	CO2 reduction%	Saving per vehicle per year (Kg)
50%	13.75%	8587
55%	15.08%	9417
60%	16.42%	10254
65%	17.83%	11135
70%	19.17%	11971
75%	20.58%	12852
80%	21.92%	13689
85%	23.33%	14569
90%	24.67%	15406

**RCV: based on 25000 miles per year and 4.75 mpg**  
**1 litre of diesel emits 2.61kg CO<sub>2</sub>**

# OIGI® Dual Fuel Technology



In our experience substitution of diesel by natural gas is typically 70% - 85%.

Substitution Levels are equal with either CNG or LNG storage.

**7.5 tonne  
vehicles**

**Buses &  
Coaches**

**Refuse  
Vehicles**

**18 tonne  
vehicles**

**44 tonne  
vehicles**



Dual Fuel components are ECE R110 certified and in alignment with ISO standards

Storage

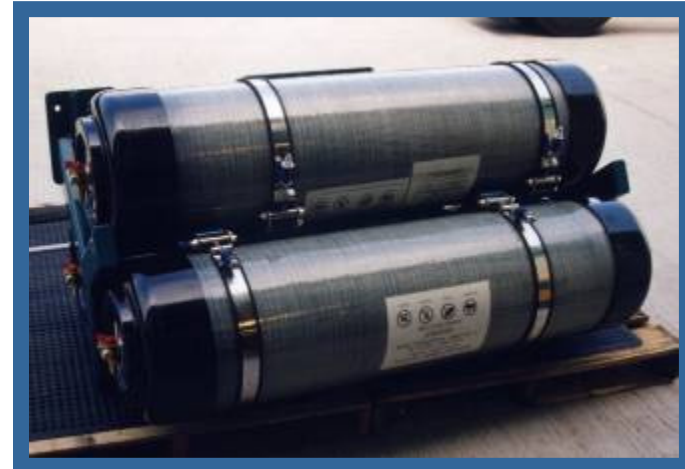


## LNG Tank



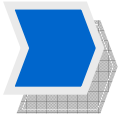
Cryogenic,  $-160^{\circ}\text{C}$ , 100psi

or

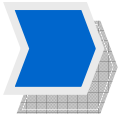


High pressure ambient temperature 3600psi

# Umbilical Trailer



The umbilical design allows the vehicle to fully jack knife and contains safety break away units for operational safety



Allows a 6x2 tractor configurations to use CNG as fuel source or as an alternative or addition to LNG



Designed in answer to poor refuelling infrastructure in UK

Infrastructure



LCNG Station



# Infrastructure



## Liquid Bio-fuel from Landfill



# Emission Compliance



## EURO 3

- Available since 2003
- Fully tested and VCA certified
- Operated successfully for past 5-years
- Completed in excess of 16 million miles

## EURO 4 & 5

- Solutions complete
- Continuing testing programme at Hardstaff
- Testing in conjunction with Loughborough University
- Tests to date confirm SCR exhaust performance of 60% of NOx conversion efficiency

## EURO 6

- Indication from Loughborough University is that Hardstaff Exhaust system can be Euro 6 compliant

# Health & Safety



## H&S is an integral part of project planning by Hardstaff

- Hardstaff sits on the CEN/TC326 LNG Standardisation Committee to develop the European Standards for LNG/LCNG Refuelling Station and Storage System
- Hardstaff are part of a working team currently preparing ISO TC22/SC25 Dual Fuel
- Vehicle Fuel Systems built to stringent European Standard i.e. ECE R110
- Gas Properties make it safer than most other fuel e.g. limited range of flammability, lighter than air
- CNG containment does not require additional PPE
- Plant Design & Build will be HAZOPS (Hazardous & Operability Studies)
- RISK assessment will be conducted on all processes

# Marketing Strategy



Identify key end-users

Demonstration programme

Provision of data for governmental and institutional bodies

Joint marketing strategy

## **BENEFITS TO END-USER:**

- Retains existing diesel engine (transitional step from 100% diesel)
- Not infrastructure dependent
- Can be retrofitted
- Environmental compliance with significant reductions in greenhouse gases and other pollutants, with highest CO<sub>2</sub> gains
- Economic benefits
- Worldwide acceptance
- Stepping stone for OEM's
- Benefits for low emission and congestion charge zones

# Market Opportunities



**OIGI® Dual Fuel** technologies can be adapted to any fully electronically controlled fuel injection system, including: -

- ▶ Euro 2,3,4 and 5 light and heavy duty vehicles
- ▶ Refuse Collection Vehicles (RCV)
- ▶ Buses and Coaches
- ▶ OIGI® technologies can also be adapted to passenger vehicles



# Global Opportunities



*CHINA*  
*TAIWAN*  
*AUSTRALIA*  
*SWEDEN*  
*HOLLAND*  
*NORWAY*  
*ITALY*  
*SPAIN*  
*FRANCE*  
*GERMANY*  
*CROATIA*

**UNITED KINGDOM**

# Summary



- Fuel Supply
- Gas Stations
- Technology
- Vehicles
- After Sales



**Parallel Paths Process and Integrated Strategies**  
*(collaboration behaviour removing barriers to optimal performance)*



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