



The Development of a **Bio-LNG** supply network across the UK

Natural Gas is one of the world's principal sources of energy;

In both compressed (CNG) and liquefied (LNG) form, natural gas is a viable alternative vehicle fuel - **available today**;

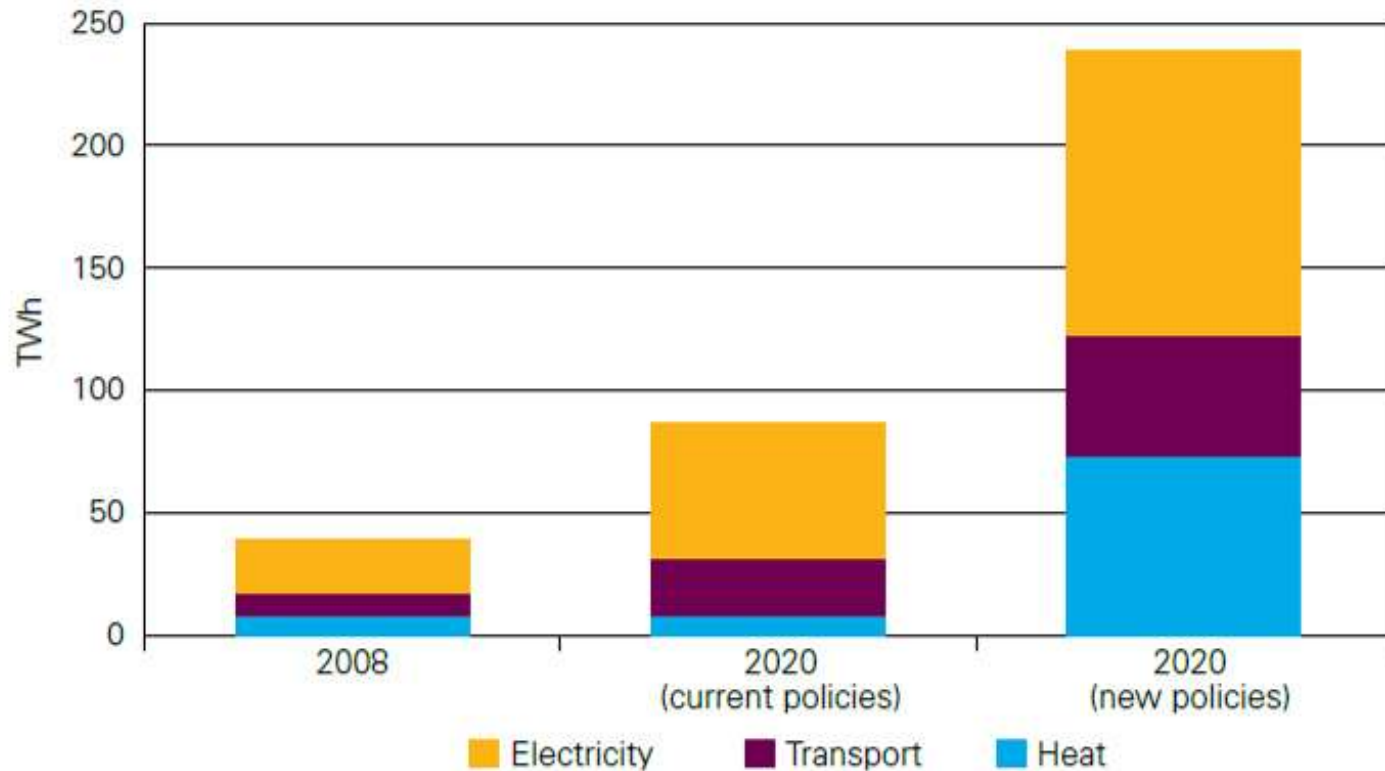
When compared to diesel and petrol natural gas powered vehicles produce less CO<sub>2</sub> and other greenhouse gas emissions per vehicle mile travelled.



*Dual Fuel vehicle technology supports the EU and UK Policy to reduce carbon emissions in road transport, and actively promotes the use of sustainable fuel.*

# RENEWABLE ENERGY

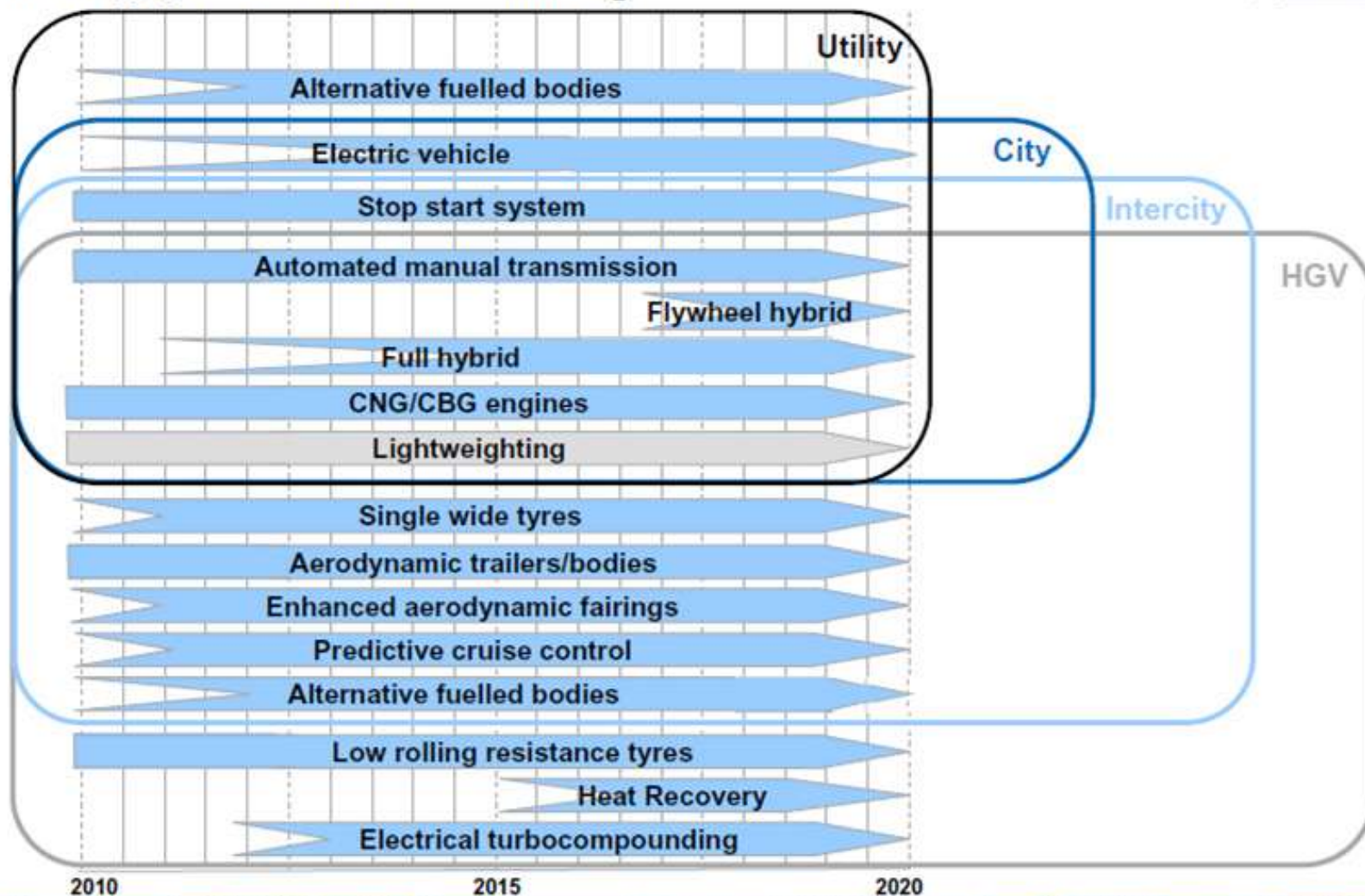
The size of the challenge – a potential scenario to reach 15% renewable energy by 2020



Source: Energy Trends June 2009 and DECC internal analysis

# 2020 Technology Roadmap Summary – Challenging scenario

Technology gives > 5% reduction in CO<sub>2</sub>



# VEHICLE TYPES AND FUEL ALTERNATIVES

Vehicle type	Present fuel	LPG	Liquid bio fuels	Full electric	Hybrids (energy recuperation)	Bio-natural gas (CNG & LNG)
Cars	Petrol & diesel	Yes (conv.)	Yes (%)	Yes (city cars)	Yes	Yes (CNG)
Vans	Diesel	Yes (conv.)	Yes (%)	No	Yes	Yes (CNG)
Delivery trucks	Diesel	No	Yes (%)	No	Yes	Yes (CNG)
Urban buses	Diesel	No	Yes (%)	Yes (wired)	Yes	Yes (CNG)
Coaches	Diesel	No	Yes (%)	No	No	Yes (LNG)
Heavy on road trucks	Diesel	No	Yes (%)	No	No	Yes (LNG)
Heavy off road trucks	Diesel	No	Yes (%)	No	No	Yes (LNG)
Railway locomotives	Diesel & electric	?	Yes (%)	Yes (wired)	No	Yes (LNG)
Ships	Diesel	?	Yes (%)	No	No	Yes (LNG)



Due to longer-term policy decisions from the Government, the demand for NGVs in the UK continues to rise, with vehicles supplied as a result of:

- ➔ OEM sales
- ➔ Conversions of new vehicles with support from OEM
- ➔ Aftermarket retrofitting



**Hardstaff AB** Production Facility  
Gothenburg, Sweden, formed January 2011

**Demand for LBM as a vehicle fuel will increase with widespread take-up of NGVs.**

- Biomethane is almost pure methane gas produced from upgraded landfill gas or raw biogas.
- It is fully exchangeable with natural gas and can operate using current vehicle technology.
- Biomethane produced from waste offers a more favourable greenhouse gas balance than any other fuel.
- CO<sub>2</sub> savings are double that of fossil natural gas.



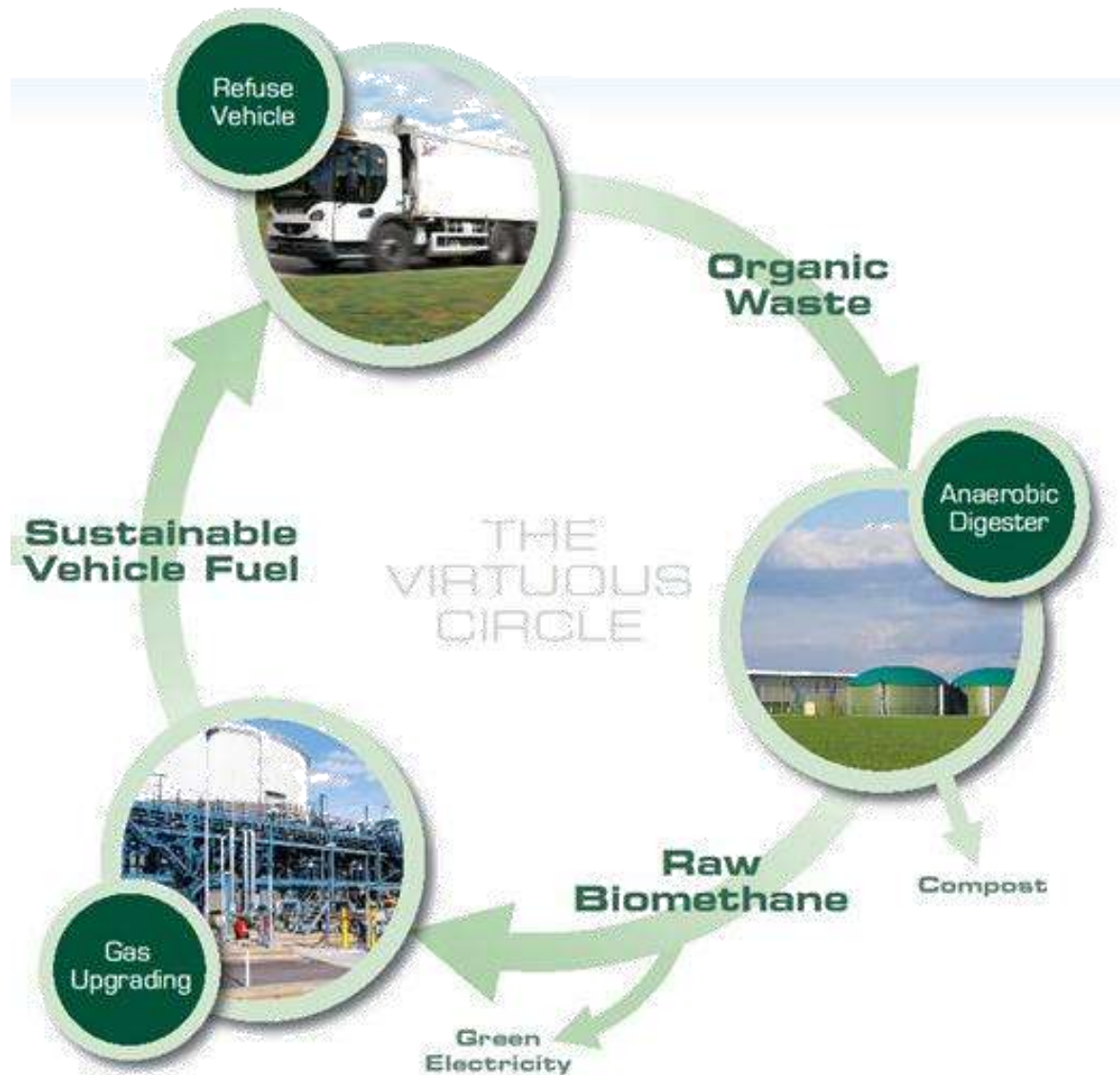
**Hardstaff Group Dynevor Arms, South Wales: Sustainable Fuels and Infrastructure Development**

**LNG/LBM** is cooled to approximately  $-162^{\circ}\text{C}$  and stored in a liquid form:

- it is a rapidly growing part of the Natural Gas market;
- it supports pipeline gas in times of peak demand;
- it is fully transportable by road tankers;
- it serves areas where pipeline gas is not available.







## “There is a growing awareness and perception of Natural Gas as a vehicle fuel”

- LBM has a high energy density.  
(higher quality gas with a higher methane concentration more closely matches the energy content of diesel)
- It is less costly than diesel.
- Fuelling times are equivalent to diesel.
- It can be transported by tanker to fuelling stations where pipeline gas is uneconomical.
- It provides immediate environmental benefits.





**12-20% lower CO<sub>2</sub>**  
Double when using Bio-Methane

**Reduced fuel costs**

**100%** diesel operation fall-back

**Enhanced** corporate image

**Retains** vehicle performance

**Significant reductions**  
in all regulated tailpipe pollutants

**Lower** noise emissions



- Hardstaff OIGI® Dual Fuel is a patented combustion technology that simultaneously burns two fuels - natural gas or biomethane and diesel.
- Supported by world leading OEM
- Applied to new or in-service vehicles  
*(retrofitted option allows industry to take advantage of potential benefits without expense of buying new vehicles.)*
- Fully warranted

**Cleaner and renewable fuels with  
minimal entry impact**

## MARKET INTEREST (Hardstaff experience)

LNG/LBM will play a significant role in NGV growth!

- ECONOMICS
- ENVIRONMENT
- PERFORMANCE
- AVAILABILITY



Market interest has risen dramatically in the following areas:

- Bakeries
- Food Delivery/Supermarkets
- Waste Management
- City & County Councils
- Bus & Coach
- Home Delivery
- Construction Industry
- Transport & Distribution



- Station technology is widely available;
- Slow growth of fuelling stations impair the take-up of NGV's;
- The number of fuel stations will grow as the numbers of NGV's increase;
- Location of stations is not dependent upon access to pipeline infrastructure:
  - LNG stations (preferred choice for long-range vehicles)
  - L-CNG (liquefied to compressed natural gas) stations dispensing both CNG and LNG

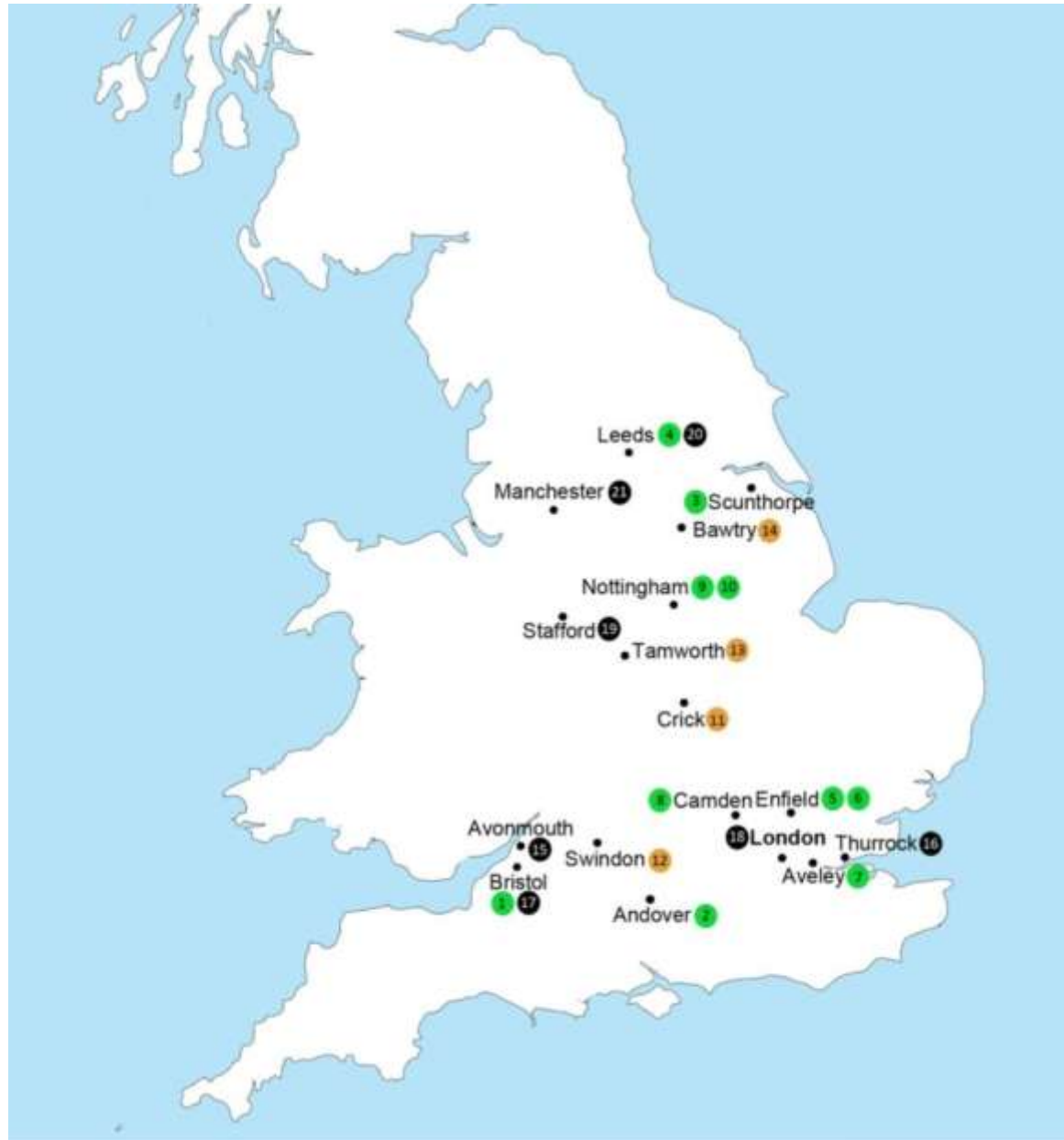




# REFUELLING STATION LOCATIONS

1. Bristol
2. Andover
3. Scunthorpe
4. Leeds
5. Enfield
6. Enfield
7. Aveley
8. Camden
9. Nottingham
10. Nottingham
11. Crick
12. Swindon
13. Tamworth
14. Bawtry, North Notts.
15. Avonmouth
16. Thurrock, West London
17. Bristol
18. West London
19. Stafford
20. Leeds
21. North Manchester

- Station Location
- Imminent Stations
- Future Stations (2013/14)



- Location and limitations.
- Accessibility of pipeline gas.
- Planning.
- Customer requirement.
- Cost in low capacity requirement
- Health and Safety.
- Flexible growth.
- Sustainability.



- Fast fill systems with no mains connection.
- Refilled using road tanker.
- Dispenses LNG or LBM and is the perfect solution for refuelling vehicles that require small quantities of LNG/LBM.



**‘Infrastructure can be sized to suit individual requirement as the fleet expands’**

# L-CNG STATION

**LNG** is delivered by road tankers and is off-loaded and stored at a very low temperature (typically  $-150^{\circ}\text{C}$ ) in the cryogenic storage vessel.

The **LNG** is pumped using the high pressure reciprocating pump to 300 bar through the atmospheric vaporizer. The vaporizer converts the high pressure **LNG** into a gaseous form by absorbing the required heat energy from the surrounding atmosphere to evaporate it.

The high pressure gas; **CNG** is stored in buffer cylinders ready for refuelling.





**LNG/LBM** stored in cryogenic tank containment



**CNG/CBM** storage mounted  
to the underside of the trailer



**CNG/CBM** stored in pressurised cylinders



- LNG/LBM as a transport fuel will preserve valuable oil supplies;
- It will benefit the environment by significantly reducing the effect of road transport emissions;
- It will continue to form part of government plans for a sustainable transport future;
- It will compliment other alternative technologies as they continue to develop.



**‘The refuelling infrastructure is embryonic and requires significant investment to promote NGV growth and LNG/LBM as a viable road fuel’**



# MOVING FORWARD

- **NGVs are now widely recognised.**
- **As volumes increase more product will be available.**
- **Coordinated Government stimulus**
- **Incentives for the Infrastructure**
- **NGVs are available NOW with immediate benefits to the environment**
- **Methane powered vehicles recognised for their CO<sub>2</sub> and air quality benefits.**





We have established technologies that are within the criteria of the LCV Technology Roadmap for low carbon HGV's.



Motivated by industry economic challenges, energy availability and the environmental impact, interest in the Hardstaff Dual Fuel technology continues to grow worldwide.



The key to developing the initiatives next step is to engage support from governments, stakeholders and end-users with a view to developing paths that achieve the commercial realisation of the product in the most economic and environmentally responsible way.



Working collectively, stakeholders efforts will benefit both industry and the environment by limiting or significantly reducing the effect of road transport emissions.



- Announced on 8 October 2010
- Formal launch was on 3<sup>rd</sup> March 2011 by Renewable Energy Assurance Ltd
- Designed to allow ‘tracking of Biomethane from injection point to customer’
  - Integrity - no ‘double counting’
- It is expected that the Green Gas Certificate will be bought by the gas purchaser and not sold separately
- Allows the gas purchaser to work with the producer to market Biomethane to customers

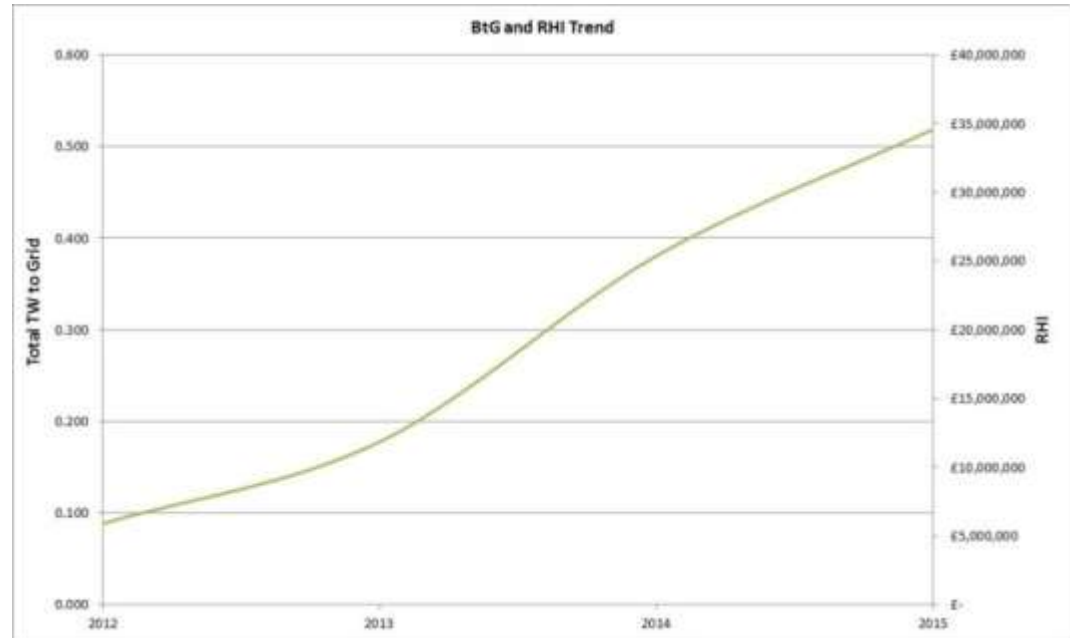


## GGCS Launch Members

- National Grid
- British Gas
- E.ON
- Thames Water (Didcot)
- Adnams Biogroup (Adnams)
- Milton Keynes City Council
- CNG Services Ltd
- <http://www.greengas.org.uk/>
- 4 projects going ahead in 2012/13 all using the REAL Green Gas Certificate Scheme

The are 5 main sectors:

- Agricultural
  - Waste
  - Animal manure
  - Crops for Energy
- Commercial food waste
- Food manufacture
- Biodegradable waste
  - Local authority garden/food waste
- Sewage sludge



This is the growth in Germany from start in 2006...we can follow this path

Source: John Baldwin, CNG Services

It is possible that there will be around 40 BtG projects in UK in period to 2014/15 when RHI tariff is reviewed

**Forecast is for no Biomethane as vehicle fuel projects**





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