



The NetZero Biomethane for Transport Revolution in the Water Industry

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CNG Services Ltd

Low Carbon Innovations

cng services Ltd

THE CRANE & SERVICE FOR ENVIRONMENT

Over the next 20 years, CSL's projects will contribute towards a CO₂ emissions saving of.....

17,500,000 tonnes

Celebrating over 16 years of innovation in gas

- CNG Services Limited (CSL) provides consultancy, design and build services to the biomethane industry, all focused on reducing Greenhouse Gas (GHG) emissions
- In the past 10 years our efforts have produced a material impact with an estimated 20 year project life reduction in CO₂ emissions of 17,500,000 tonnes through:
 - Biomethane injection into the gas grid
 - Running trucks on Bio-CNG
 - Acting as developer and design and build contractor for the Highlands Bio-CNG Project
- Part owner of CNG Fuels Ltd, a company set up to build a national network of Bio-CNG stations on the high pressure grid
 - National network of CNG Stations
 - 84% saving in GHG compared to diesel
- Part owner of Barrow Shipping Ltd, GB's leading shipper of biomethane and a company that only buys and sells biomethane, no fossil gas
- CSL is an ISO 9001, 14001 and 45001 approved company and has also achieved Achilles certification. CSL is GIRS accredited for design and project management and has been certified as a competent design authority by DNVGL



Certificate Number 17464
 ISO 9001
 ISO 14001
 ISO 45001



1. What is Biomethane?

- Bio-gas from an anaerobic digester contains typically 65% methane, 35% CO₂
 - Lager shandy
- Natural gas contains around 90% methane, with ethane, propane, butane, CO₂ and nitrogen making up the rest
 - Blended whisky - made from dinosaur poo in a prehistoric AD, contaminated over the millenia
- Biomethane is bio-gas without the CO₂, containing around 98% methane
 - Malt whisky, the elixir of life, we all want to drink it
 - 110 biomethane plants in GB
- The XL extract on the right show biogas, electricity generation, biomethane and truck consumption to give an idea of the scale

Biogas and AD Data		
Biogas Composition (%CH ₄)	58%	
Biogas Production Rate (60% CH ₄ , 40% CO ₂)	700	Nm ³ /h
Biogas Production Rate	738	Sm ³ /h
AD Operation	100%	
AD Annual Production Hours	8,760	hours
Annual Biogas Production	6,468,923	Sm ³ /annum

CHP Data		
CHP Efficiency (LCV to Electricity)	38%	
CHP Availability	95%	
Annual Electricity Generation	12,799,676	kWh/annum

Biomethane Data		
CH ₄ Capture	99%	
Biomethane Methane Content	97%	%CH ₄
Energy in 1m ³ of Biomethane (97% CH ₄ , 2% CO ₂)	36.647	MJ/m ³
Density of Biomethane (97% CH ₄ , 2% CO ₂)	0.709	Kg/m ³
Energy in 1 kg of Biomethane	51.688	MJ/Kg
1kWh of Energy	3.6	MJ
kWh Energy in 1 kg of CBM	14.358	kWh/kg
Biomethane Production	424	Sm ³ /h
Annual Biomethane Production	3,603,022	Sm ³ /annum
Annual Biomethane Production	2,554,543	kg/annum
Annual Biomethane Production	36,678,122	kWh/annum

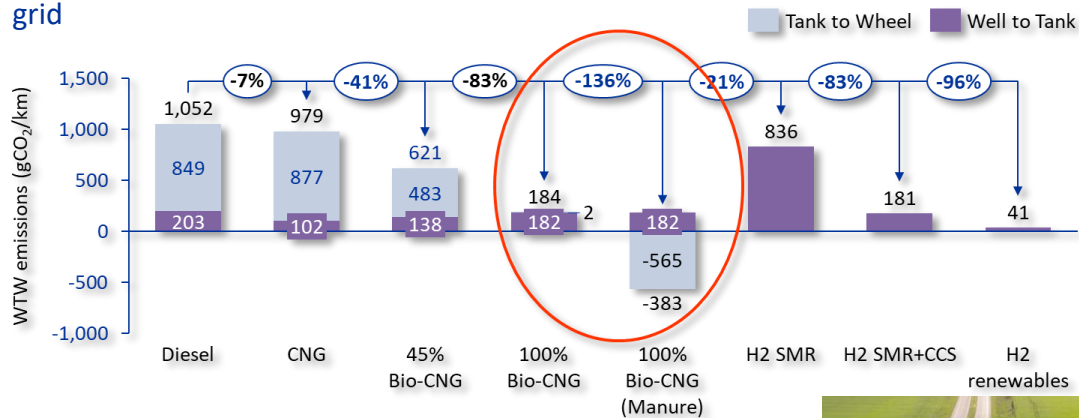
6x2 Tractor Unit		
Typical 6 x 2 truck consumption	3.1	km/kg
Typical annual km in GB	160,000	km/annum
Consumption per truck per annum	51,613	kg
Number of trucks based on kg	49.5	Trucks

And its very easy to capture the waste CO₂ from making biomethane (its almost 100% pure) and use this in greenhouses or to make fertiliser (see Simon's presentation)so it becomes a carbon negative fuel

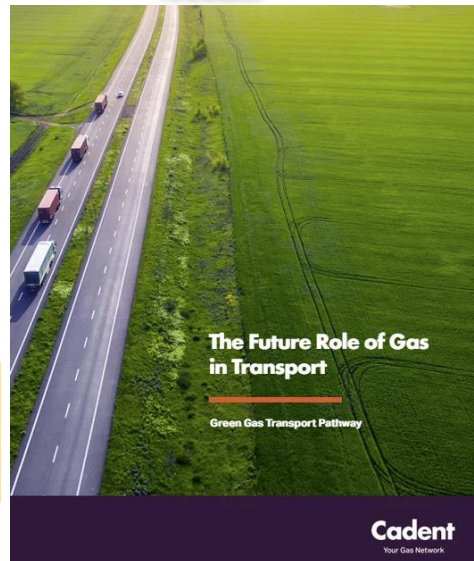
And, as the offshore CCS projects are completed there will be the option of CCS

2. Today's Biomethane Trucks have CO₂ Emissions Over 80% Lower than Diesel

- Modelled Well-to-Wheel (WTW) emissions for CNG trucks¹ suggest that a 100% emissions saving is possible when using 100% biomethane, compared to diesel equivalents. This is comparable to real-world trial data² which estimated WTW emissions savings of 76-81% with pure biomethane
- The CO₂ emissions associated with biomethane are primarily incurred during the production process, from the electricity consumption of the plant required to clean and compress the gas. This is largely dictated by the carbon intensity of the grid



1. Element Energy, *Development of a Well to Tank Emissions Model for Heavy Duty Vehicles*, 2018 and Element Energy for TSC and DfT, *Hydrogen to Smart Mobility: Review of Opportunities for Hydrogen for Heavy Vehicles*, 2019; 2. Cenex, An Innovative UK Research Project to Assess the Viability of Gas Vehicles, 2019; 3. Wet manure has an emission factor of -103 gCO₂e/MJ under the Renewable Energy Directive



- HGVs are difficult to decarbonise with the **most challenging requirements for driving range and carrying capacity**
- There are alternatives to diesel:
 - Battery electric vehicles (BEVs) are commercially available and well-suited for light, short-range transport sectors (cars, vans and trucks up to 8t) but there are few or no options for long-haul freight and farm tractors
 - Hydrogen fuel cell electric vehicles (FCEVs) are expected to provide a solution for HGVs in the long term but the technology readiness is low and its not an option at present
 - Methane** – in the form of bio-compressed natural gas (Bio-CNG) – is currently the only proven, commercially available option for long haul vehicles

Comparison of range and availability of low carbon fuel technologies in UK/Europe

	Maximum range (km)			Vehicle availability					
	Cars	Vans	HGVs	Cars and vans	HGV sector (gross vehicle weight in tonnes)				
					3.5-8	8-18	18-26	26-38	Over 38
BEV	600	200	300-885*	Green	Yellow	Yellow	Yellow	Yellow	Red
Bio-CNG		600	700	Green	Green	Green	Green	Green	Green
H ₂ FCEV	660	350†	500-1200*	Green	Yellow	Yellow	Yellow	Yellow	Yellow

Green: Vehicles commercially available Yellow: Vehicles in development/trial Red: Not currently available

*Theoretical – vehicles not currently in production
†H₂ range extender

<https://documents.cadentgas.com/view/957927673/>

Moving from diesel is very hard – Bio-CNG is a great start

3. Consequences of NetZero for sewage treatment works design and operation

The direction of travel through the 2020's is clear....never burn biogas and never vent any CO2

This means no biogas CHP.....all biogas upgraded to biomethane and injected into the grid and 100% of CO2 captured. Not a single molecule of CH4 released to air

No diesel on waste water or clean water sites by 2025

- When ROCs run out, convert the biogas engines to natural gas from the grid and only operate these when there is low wind/low solar
- Invest in good insulation as heat will no longer be in abundance from CHP waste heat
- Heating of the digester should be from heat pumps or – if you are lucky – from an EfW plant nearby
- And yes, this includes steam for thermal hydrolysis.....this technology exists, just needs a bit of effort
- The tariffs for electricity will catch up to the carbon value, don't worry too much about that
- So, upgrade 100% of the biogas and inject biomethane into the gas grid
- Do not have any diesel on waste water or clean water sites by 2025
- Projects in the sewage biogas industry we have supported/instigated include:
 - Thames Water – Didcot pilot
 - Severn Trent Water – Minworth, Derby, Stoke Bardolph, Strongford
 - Wessex Water – Avonmouth, Trowbridge
 - United Utilities - Davyhulme
 - Welsh Water – Five Fords
 - Northumbrian Water – Howdon, Bran Sands
- There are 2 options for biomethane HGVs – inject into the grid and take it out where the trucks are – or run trucks directly on compressed biomethane. Both can and do work , depends on individual circumstances. The key is the trucks – they exist today



4. Iveco Bio-CNG 6 x 2

CNG Fuels

Taken from network on Bio-CNG stations, mass balanced from the AD plant to the filling station



Whisky Industry in Scotland (pre livery)
Launch April 2021

New fleet runs direct on compressed biomethane made from whisky waste

Bio-CNG Station Roll-Out Plan - UK Network



Operational 2020

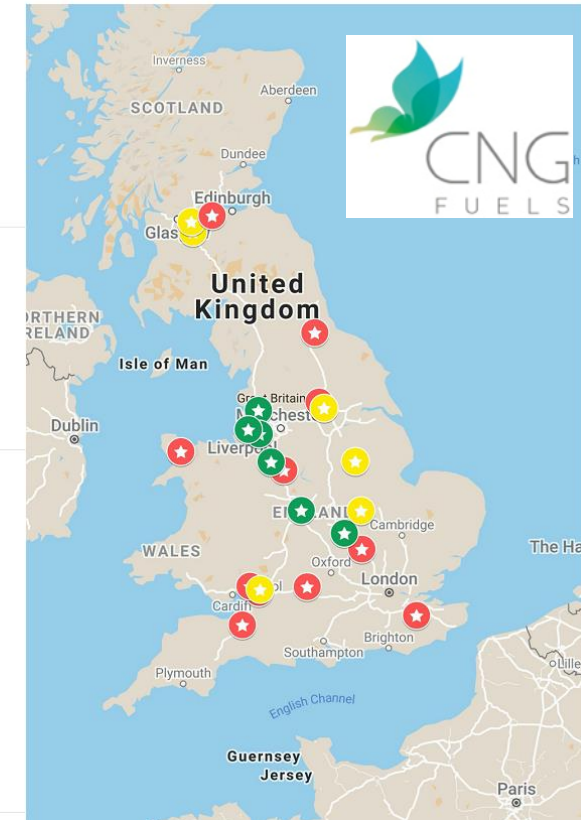
- Leyland
- Crewe
- Northampton
- Warrington
- Erdington
- Knowsley

Operational 2021

- Larkhall
- Eurocentral
- Castleford
- Corby
- Newark
- Avonmouth (North)

Operational 2022

- Avonmouth (South)
- Swindon
- Leeds
- Bangor
- Stoke
- Milton Keynes
- Magor
- Livingston
- Newton Aycliffe
- Bridgwater
- Kent



5. Scania 6 x 2 Bio-CNG



- 640 Litres CNG @ 200Bar giving 350km range
- General £25k premium over diesel tractor unit
- Currently available up to 410hp, 2000Nm Torque

Ideal for the Following Applications:

- Specialized Tanker Haulage – Pharmaceutical/Chemical, Food and Beverage, Bitumen, **Water treatment** and Waste/Recycling industries
- AD/Biomass Haulage – Feedstock, **Digestate** and Compressed Upgraded Biogas haulage

Hythane (12% H2, 88% Bio-CNG)

- The Scania truck can run on 12% Hydrogen (by volume) with no modifications
- Make H2 direct from solar/wind/hydro and earn a premium of £6.87 per kg of H2 as a Development fuel under the RTFC
 - Floating solar + batteries + hythane/Bio-CNG
 - How lovely is that?
 - Do it today



CNG Storage cylinders between the front 2 axles

6. Conclusions for the Sewage AD industry

1. Do not burn biogas, do not have base load biogas CHP
 - Convert engines to grid gas and only run when its not windy/sunny
 - NWL, STW all have done this
2. Electricity grid and heat pumps for all heating
 - Including steam (with a bit of effort)
 - Insulate digesters to reduce heat requirement
3. All biogas upgraded to biomethane and injected into grid or used directly into trucks
 - No CO2 venting
 - No CH4 venting
4. Hythane
 - 12% H2 made by renewable electricity is valuable addition to 88% Bio-CNG
 - Interruptible H2 as truck runs on 100% Bio-CNG
 - Do it now, no technology issues
5. The technology and vehicles are available today and the RTFC fiscal regime is attractive
6. Implement from 2021, no need to wait, nothing better is turning up for biogas
 - Making electricity from biogas then making H2 or having EV trucks is not as efficient as direct biomethane
7. No diesel used at all by 2025 in the whisky, dairy and sewage industries
 - This is deliverable today, no need to wait

There are relatively minor technology challenges but its all deliverable, most by 2025 but all by 2028

Maximise biogas production (eg with Thermal Hydrolysis)

Minimise heat losses and recover heat

No burning of biogas

No CH4 vented to air on site

No venting of any CO2 from biogas

No diesel on site

Make H2 from solar/hydro/wind with batteries and create hythane

Run all trucks on Bio-CNG