

Low Carbon Innovations

cng services ltd



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 gas industry, all focused on reducing Greenhouse Gas (GHG) emissions.

We only work on projects that reduce GHG.

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.
- Converting industrial customers from oil to gas.
- Generating electricity from gas pressure that would be wasted.
- Providing connections to back up gas power generation plants.
- Developing Europe's largest CNG virtual pipeline in the Highlands of Scotland.

This brochure shows a selection of our innovations.

Given the Net Zero requirement by 2050, we will continue to focus on the above areas but we will also develop new innovation projects.

- Production of hydrogen and its injection into the gas grid and into industrial customer appliances.
- Running trucks on bio-hythane (a blend of biomethane and hydrogen).
- The combination of gas engine electricity generation plants with batteries to provide capacity for windless weeks and fast acting flexibility.
- Development of projects using industrial heat pump technology.

The following projects were made possible by a number of innovations pioneered by CSL which will continue to support a low-carbon future.

Over 20 years of the RHI, the net carbon saving from CSL biomethane injection projects will total...

15,200,000
tonnes of CO₂e



Leyland Bio - CNG Station

Bonby Remote
Compression Compound



Bonby Biomethane Plant



Roundhill Biomethane Plant



Currently, around 85% of the UK's homes and industry are heated by gas and biomethane is one of the most cost effective ways of decarbonising the gas network.

Whilst electric heat pumps will contribute towards the decarbonisation of domestic heat, large investments will be needed to reinforce the electricity grid and ensure that homes are suitable for heat pumps, estimated to be upwards of £300 billion.

With significant seasonal and diurnal swings in demand, having electric only solutions powered by conventional renewable generation methods such as wind and solar presents risk and the windless week in winter still necessitates the use of gas back-up generation on a large scale.

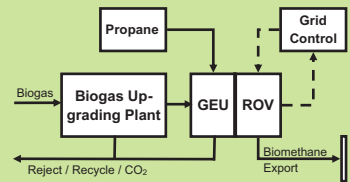
Biomethane is a product of Anaerobic Digestion (AD), where organic materials such as food waste, sewage and manure are broken down in the absence of oxygen. These materials generally have a carbon uptake in their lifecycle, hence are carbon neutral. Moreover, waste must be disposed of, regardless of whether it's used in AD. If left to decompose, methane could escape into the atmosphere which would be significantly more damaging than the CO₂ produced from its combustion.

There is potential for growth in using gas as a vehicle fuel, particularly in the haulage industry. Although electric vehicles have shown promising growth in the consumer market, there will be few viable electric heavy duty haulage vehicles for the foreseeable future. The Bio-CNG truck market is growing however, with many models available. Without experiencing the same range and cost barriers, there is great potential for a developing industry in Bio-CNG as a transport fuel. With the UK committed to ban sales of diesel vehicles by 2035, Bio-CNG presents a good alternative.

CSL Project Outlines

Biomethane to Grid (BtG)

A typical CSL biomethane to grid project scope encompasses the interfaces between an AD plant and Gas Distribution Network (GDN) as shown in the diagram (right). CSL designs and constructs the injection site and export pipeline; including the specification, purchase and integration of plant, mechanical and electrical design of the connections, management of suppliers, and carries out the required work to have the connection infrastructure adopted by the gas network.



Biomethane to Grid (continued)

Generally, the gas network will adopt assets from the Remotely Operated Valve (ROV) to point of connection on the gas grid, including the export pipeline. The ROV gives the network operator control over gas entering the network. Adopted assets require design approval following the network operator's management procedure. The Grid Entry Unit (GEU) is designed and approved following the IGEM GL/5 standard. If the biomethane is being injected into the gas grid at 19 bar and above, then gas export compressors are required.



Bio-CNG Stations

CSL has extensive experience in the design and build of Bio-CNG stations, including obtaining the consents for construction. A typical project involves connecting to a point on the gas network. The gas then flows from the grid via a pipeline to the site and is metered. It passes through a compressor, increasing the pressure to 300 bar before being stored and then sent to dispensers to fill trucks. It is most effective to feed a station connected to the high-pressure gas networks [>7 bar] due to the lower compression cost.

Since it is not always economically feasible to connect a Bio-CNG station directly onto the gas grid, the 'Mother-Daughter' station concept was created - transporting gas via trailer from a 'Mother' site to a convenient 'Daughter' site location, ready to be dispensed.

Virtual Pipeline

The Virtual Pipeline links to the motherdaughter station concept, taking gas from a central 'Mother' station via trailer to a remote site. Gas is compressed onto a trailer similar to filling at a CNG station. It is then offloaded at the daughter site into a storage vessel before flowing through a pressure reduction system to the desired pressure ready for use in site boilers. CSL have designed and built the UK's first virtual pipeline to deliver gas to four distilleries in Scotland.



Turbo Expander-CHP Plan

Project: St. Mary's Cray

Client: SGN

Concept: Perform feasibility study and conceptual design for replacing a conventional Joule-Thompson valve at a gas network pressure-reduction installation with a turbo-expander and associated CHP plant to recover energy.

Completion: 2010



Project Outcomes:

- It was identified that integrating a CHP system with a turbo expander would provide preheat to the gas, ensuring the outlet temperature remains within a network accepted range.
- The additional income from electricity sales was shown to be greater than the fuel cost.
- Following the study performed by CNG, the concept was used at the St. Mary's Cray site, operated by SGN. The new expander was hence able to recover 4.4 MW of energy - enough to supply around 5,000 homes, with an additional 1.5 MW provided by the CHP.
- The net CO₂ saving is equivalent of around 20,000 tonnes per year.

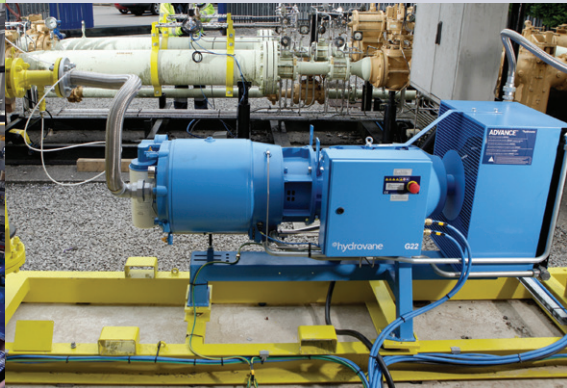
Within Grid Compression

Project: Skipton

Client: Northern Gas Networks

Concept: Install a compressor on a largely domestic 2 bar gas pipeline to demonstrate it could provide the necessary flow upstream to the 7 bar network to create capacity for biomethane injection.

Completion: 2012



Project Outcomes:

- A compressor and associated control system was designed to meet NGN's G17 criteria.
- The compression plant was installed and operated successfully. The concept is that during periods of low demand, the compressor turns on to move gas to the higher pressure network, creating capacity.
- The power demand was only 2% that of the additional injected biomethane into the grid - allowing for a net CO₂ saving.
- Within grid compression was proven capable of providing capacity to otherwise uneconomic BtG projects and to avoid flaring biogas in summer.

UK's First Biomethane Injection Project

Project: Didcot

Client: Centrica/Scotia Gas Networks (SGN)

Concept: Support development of the biomethane to grid (BtG) market in the UK. Design and manage a project to build an injection facility on the Didcot sewage treatment site to capture and utilise waste gas.

Completion: 2010



Project Outcomes:

- Successfully delivered the first biomethane to grid project in the UK - processing 70 m³/h of biogas and injecting 40 m³/h of biomethane.
- Created potential for future projects through initial success.
- Project performed in conjunction with SGN achieved network accepted design of grid entry unit and adoption of pipeline.
- Developed understanding and experience in the field, integrating sewage treatment site with clean-up and entry facility.
- Overcame issue of 0.2% Oxygen specification for grid injection.

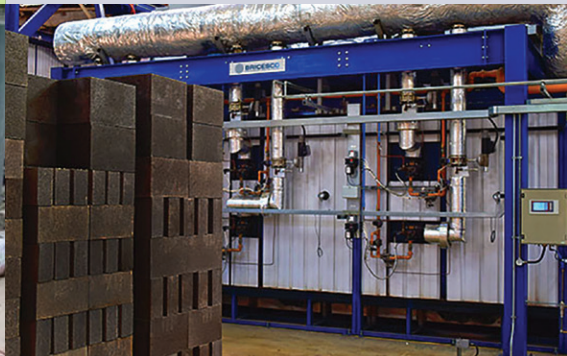
Fuel Conversion

Project: Friden

Client: DSF Refractories and Minerals Ltd.

Concept: Design and build of project to convert the site from heavy fuel oil to natural gas.

Completion: 2012



Project Outcomes:

- New 7km pipeline and site converted to gas.
- Based on the average fuel cost of 4.25 p/kWh, converting to gas saved £825,000 pa, with payback in the region of 3-5 years.
- Reduced CO₂ emissions by up to 25%, with further savings from the elimination of fuel deliveries by HGVs to the site.
- Overall, annual CO₂ emissions fell by 1,900 tonnes per annum.

First Commercial Biomethane Injection

First Commercial Biomethane Injection Project in the UK

Project: Poundbury

Client: SGN

Concept: Design and build the first commercial scale BtG site at Poundbury - for an injection of 400m³/h. Continue to develop projects to drive down capital costs and improve economics for future projects.

Completion: 2010



Project Outcomes:

- CSL completed an initial feasibility study and created the development concept, identifying the membrane upgrading technology for the project.
- Successfully delivered the first commercial scale BtG plant.
- First use of membrane CO₂ removal plant in the UK.
- Proof of attractive project economics, driving growth within the biomethane industry.
- Small on-site CHP plant provides heat and electricity for digestion process, making it the most energy efficient AD plant in the UK.
- Electricity generation (10MW per day) - 5MW per day for onsite use with the remainder exported to the local electricity grid.
- 4,000 tonnes potato waste, 26,000 tonnes maize silage, 4,000 tonnes grass silage and 7,000 tonnes food waste producing 850m³/h.
- Annual biomethane injected to grid - 3,500,000 m³.



4,600 tCO₂e saved per year*



Biomethane Injection into the LTS

Project: Holkham

Client: Future Biogas Ltd

Concept: 'Self-lay' a >7 bar pipeline to connect into 19 bar LTS network. Review compression technologies to ensure no oil carry over. Develop design for injection into the LTS with appropriate ROV and associated plant. Integration of all biomethane plant.

Completion: 2014



Project Outcomes:

- CSL completed the first self-lay pipeline to a high-pressure Local Transmission System (LTS) [19 bar] network.
- Developed and tested an ROV suitable for use on an LTS network, meeting all National Grid Distribution (now Cadent) standards.
- Initially LTS projects took 2-3 years with over £2,000,000 of investment. Project timescales have now been reduced to <12 months at a significantly reduced cost.
- CSL has completed 12 LTS connection projects since the first.

Remote Compression Compound

Project: Euston

Client: Euston Biogas Ltd

Concept: Transport upgraded biomethane from the AD site to a remote compression compound next to the LTS network via a 7bar pipeline. Compress the gas to 42 bar and inject into the LTS network.

Completion: 2015



Project Outcomes:

- A 7 bar pipeline was installed to reduce capital expenditure. It was significantly cheaper and easier to build an intermediate pressure pipeline than a high pressure pipeline.
- The remote compound was built to house compressors and an ROV, where gas is compressed to 42 bar and injected into the network. This was the first use of this particular layout in the UK.
- It was decided to manage the risk of having out-of specification gas trapped in the pipeline in the event it was rejected at the GEU, negating the requirement for a remote reject line.

Type-4 CNG Trailer

Project: Various

Client: CNG Services

Concept: Procure the first Type-4 trailer (with fully composite cylinders) in the UK for the transportation of compressed natural gas and biomethane.

Completion: 2010



Project Outcomes:

- First use of Type-4 trailers in the UK.
- The benefits of using a Type-4, fully composite material vs. conventional steel cylinders include a 70% weight saving hence better efficiency in transporting gas and corrosion resistance.
- Ultimately lower lifecycle CO₂ emissions from mother-daughter station concept.
- 3 years of use transporting gas between Crewe and Scunthorpe.

HexelOne Pipeline

Project: Raynham

Client: Cadent

Concept: Demonstrate to Cadent the safe use of HexelOne pipe for 19 bar biomethane, to export to the Cadent LTS network.

Completion: June 2015



Project Outcomes:

- CSL successfully designed and installed a 1.4 km HexelOne pipeline for biomethane injection into the Cadent LTS network.
- Previously the only accepted material for high pressure pipelines was steel.
- By using polyethylene piping, costs and installation times were significantly reduced as well as introducing the possibility of alternate installation techniques such as directional drilling, which potentially have environmental benefits. Overall this grows the business potential of connecting biomethane sites to the gas grid.
- The equivalent steel pipeline would have taken 2 months to install, as opposed to the 1 week the Raynham project took.
- IGEM standard TD/19 put in place to allow use of Reinforced Thermoplastic Pipe.

CNG Daughter Station

Project: Scunthorpe

Client: Brit European

Concept: Design and build off-grid daughter station for private HGV fleet refuelling. Use trailer loading bays to fill station without disturbing HGV traffic flow.

Completion: Late 2015



Project Outcomes:

- A design for the daughter filling station was produced and site constructed - consisting of: trailer loading bays, buffer storage, hydraulic compression and dispensers.
- CNG is supplied from 'Mother' station sites at Crewe and Leyland.
- Scunthorpe site can supply 50 HGV's with CNG.
- Caters for an annual demand of 1,000,000 kg of CNG per year.
- Based on an equivalent diesel emissions saving of 80%, using CNG avoids 2,200 tonnes of CO₂ emissions annually.
- The first CSL Virtual Natural Gas Pipeline project.

Low Carbon Consultancy

Project: Various

Client: Various

Concept: Provide specialist consultancy in relation to gas and the transition to 2050.

Completion: 2015-2017



Project Outcomes:

- Energy Technologies Institute (ETI) Well to Motion Study.
- ETI Multi-Vector Study.
- Contributed towards Distributed Gas Schemes.
- Part of the Birmingham City Council Alternative Vehicle Strategy.

Bio-CNG Station on LTS Network

Project: Leyland

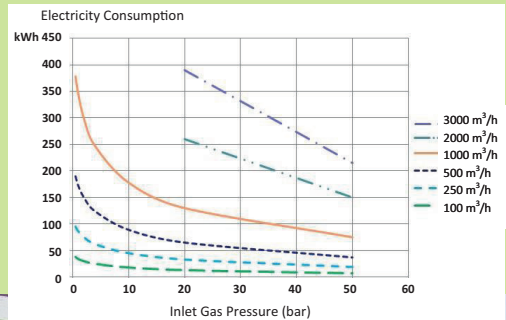
Client: CNG Fuels

Concept: 'Self-lay' into the LTS network. Meter gas offtake without the use of a pressure regulator. To make a case to the HSE to exempt a Bio-CNG station meter from the requirement of regulator. Compress and store Bio-CNG at 300 bar to fill trucks.

Completion: 2016

Project Outcomes:

- CSL identified significant compression cost savings by taking gas from the LTS network - as shown in the graph below.
- It was recognised there was no need to regulate pressure to protect downstream appliances since gas requires further compression. CSL presented the case to the HSE to gain exemption - causing industry rules to change.
- A detailed analysis and risk assessment was performed to eliminate the requirement of an ROV.
- Since the compressors are capable of processing 2000 kg/h of Bio-CNG to the truck pressure (250 bar), gas is stored in a buffer vessel at 300 bar, to avoid potentially damaging quick stop-starts if Bio-CNG was directly supplied into trucks.



Fuel Conversion

Project: Cantley

Client: British Sugar

Concept: Replace the heavy fuel oil required by the boilers and driers with natural gas. Design and project manage construction of intermediate pressure pipeline to supply the British Sugar factory at Cantley and meter outlet pipeline.

Completion: 2015



Project Outcomes:

- Managed design and build of new 9 km connection pipeline.
- Phased out the use of heavy fuel oil at the plant (a 14,000 tonne annual usage).
- Reduced the operating costs of the boilers and driers. At the time of construction, the estimated cost of heavy fuel oil per kWh of heat delivered was around 4.5p, versus the 2.5p/kWh delivered by natural gas.
- This equates to a £3.7 million per year saving.
- There is a 30% reduction in GHG emissions, with further reductions by reducing the number of fuel oil deliveries required.

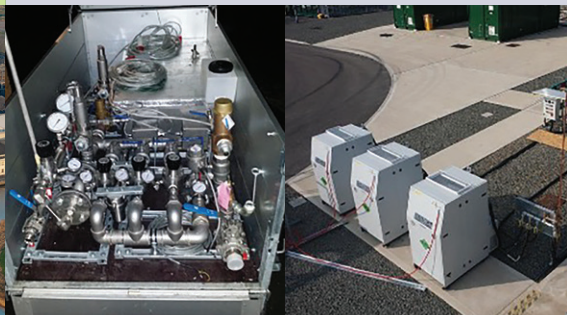
Compressed Biomethane for Commissioning

Project: Minworth - Stoke Bardolph

Client: Severn Trent

Concept: Install compressors to load compressed biomethane (CBM) onto trailers at 250 bar and transport to other sites to aid commissioning. Develop portable PRS system for offloading gas.

Completion: May 2016



Project Outcomes:

- CSL installed 3 compressors with pressure regulation on the inlet to compress 5 bar biomethane to 250 bar for loading onto CBM trailers.
- Successfully designed, built and tested 3 different portable PRS units to operate at a range of loads and inlet pressures, able to regulate the outlet pressure with heating. This allows for different applications of use.
- CSL have been able to deliver CBM to over 10 sites for gas injection into the grid in order to consolidate RHI tariff before depression periods.

First Use of Intelligent Pig in 4" Pipeline

Project: Fairfields Farm

Client: Fairfields Biogas Ltd

Concept: Insert an intelligent pig to inspect the integrity of a 900m section of 100mm steel pipeline ready for connection to the LTS network.

Completion: 2018



Project Outcomes:

- A new inspection method was successfully used for a 4" steel pipeline.
- Through the use of magnetic flux leakage technology, the pig was able to confirm there was no metal loss integrity impact from potential corrosion.
- Four manufacturing anomalies were detected, although they each fell within manufacturer's pipe thickness tolerance.
- This provided scope for future inspections of narrow metal pipelines to be performed using this method, to confirm the integrity of the metal.

Onsite CBM Station

Project: Emerald Biogas

Client: Emerald Biogas

Concept: Emerald was a CSL biomethane project completed in 2016. CSL installed an onsite compression system in 2018, raising pressure from 7 bar to 250 bar into CBM storage for delivery to a dispenser for CBM truck use.

Completion: February 2019



Project Outcomes:

- The design and installation of the first CBM to truck dispenser system, directly from the AD site.
- Tapped into the existing biomethane pipework to form a new connection and take gas to the compression system.
- Use to fill AD site owned trucks, allowing CO₂ savings compared to conventional diesel usage.

Hired PRS Unit

Project: Confidential

Client: Confidential

Concept: Take gas from a Cadent pig trap site, preheat and pass through PRS system, hired from GasUnie. Gas then transported through 7 bar pipeline for use in 50MW power generation site.

Completion: Ongoing



Project Outcomes:

- Connection to Cadent LTS network made - metering gas from pipeline before preheating and passing through PRS to reduce pressure from 37.2 bar to 7 bar.
- The PRS system was hired from GasUnie to reduce procurement time. A new PRS system would have taken 12 months to receive however it was required within 4 months - a project first.

First Biomethane Injection into NTS

Project: Somerset Farm

Client: BioCow

Concept: Design, build and assist customer with Application to Offer (A2O) process to connect to National Grid's National Transmission System (NTS). Inject biomethane directly into the NTS.

Completion: March 2020



Project Outcomes:

- The first connection to the NTS for biomethane injection.
- No capacity issues on NTS networks which can be associated with lower pressure tiers on distribution networks. The site processes 2,000 m³/h of biogas and injects 1,100 Sm³/h of biomethane into the grid.
- No requirement for odorant or propane injection into the biomethane, since it is not being injected into a local distribution zone.
- The site allows an annual emission saving 17,000 tonnes CO₂ by displacing natural gas.
- Use of SoluForce RTP for on-site 75 bar pipework (photo above).

First NTS 'Self-Lay' Offtake

Project: Fordoun

Client: Air Liquide

Concept: Work with National Grid to carry out first ever self-lay NTS connection including trialling processes and documentation. Prepare a Major Accident Prevention Document (MAPD) and Safety Case and gain acceptance from the HSE. Take gas from the NTS to supply the 'mother station'.

Completion: September 2019

Project Outcomes:

- First 'self-lay' connection to National Grid NTS network by a third party.
- National Grid Transmission completed a conceptual design study (CDS) at the NTS block valve site.
- CSL made the case to National Grid that an ROV was not required, hence neither was an RTU on the block valve site, saving £200k.
- The design of an off-take connection and private pipeline connecting to the 84 bar NTS network.
- Construction was completed in September 2019. The boundary between the National Grid owned connection and private pipeline will be delineated by an insulation joint.
- This will significantly reduce compression costs relative to typical CNG stations.



Scotland CNG Virtual Pipeline - Mother Station

Project: Fordoun

Client: Air Liquide

Concept: Obtain planning permission and consents. Design and build 'mother' station to compress and dispense natural gas from NTS block valve site. The gas is metered, odorised and compressed to 250 bar and dispensed into CNG trailers.

Completion: September 2019

Project Outcomes:

- Developed Europe's largest virtual natural gas pipeline, transporting gas to off-grid distilleries.
- Type-4 composite trailers will be used to transport CNG, maximising capacity to around 10 tonnes per trailer.
- The layout for a mother station was produced, including civil engineering, a meter and analyser kiosk, odorant injection, compressors, chillers and dispensers.
- Lower gas import cost since there are no local distribution zone charges.
- The construction was completed in September 2019 and the plant is now fully operational.
- This is Europe's largest CNG Mother station and is located in Fordoun (Aberdeenshire).



Compressor Delivery



CNG Trailer Bays



CNG Dispensers



Fordoun Construction

Daughter Stations

Scotland CNG Virtual Pipeline - Daughter Stations

Project: Glenmorangie, Dalwhinnie, Roseisle, Clynelish

Client: Air Liquide

Concept: Design and build CNG decanting system at distillery sites including ground CNG storage for continuity of supply. Support conversion from heavy fuel oil boiler systems to gas to reduce CO₂ emissions and improve fuel efficiency.

Completion: May-October 2019

Project Outcomes:

- CSL supplies CNG to 4 distilleries: Glenmorangie, Dalwhinnie, Roseisle and Clynelish.
- A conceptual design study was completed at Glenmorangie distillery.
- Design of an unloading system at each site produced, including trailer docking area, pressure reduction system (PRS), gas metering, heating and pipework.
- Bypassing the first pressure reduction stage in PRS once the trailer pressure falls below 60 bar allows a greater volume of CNG to be decanted from trailer before reaching the minimum required flowrate.
- The projects were completed May-October 2019.



Distillery CNG Daughter Station (above)
Offloading Cabinet & Trailer (above, right)

**30% reduction
in CO₂ emissions**



Clynelish Daughter Station

Celebrating over 16 years of innovation in gas

Dalwhinnie
Daughter Station



Glenmorangie
Daughter Station



Fordoun
Mother Station



cng services ltd



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