Reverse Compression Update

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Green Gas Day 2025

CNG Services Ltd

- 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 CNG Project
- Working on a number of Biomethane, H2 and CCUS innovation projects including:
  - Biomethane from manure with CCS
  - Biomethane direct into the NTS
  - Green H2 into the NTS and Hydrogen Business Model Projects
  - Reverse Compression to Create Capacity for Biomethane Injection
- 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 organisation for high pressure UK onshore natural gas works by DNVGL

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CNG Services Response to Ofgem RIIO-3 Draft Determination in relation to Reverse Compression

OFGEM
10 South Colonnade
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London
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Monday, 25 August 2025

RIIO-3 Draft Determinations – Gas Distribution

When the RHI was introduced in 2011 there was agreement that developers would fund specific biomethane costs including the biogas upgrading unit, grid entry unit, site compressors and grid connection pipeline. The RHI provides income support to provide a return on this investment and for around 100 GDN projects this has been the case. These projects use the capacity that already existed in the gas network and the GDNs have not funded capacity reinforcement projects - any required reinforcement would be 100% funded by the biomethane producer. In the absence of reinforcement, and with a minimum connection policy, there are minimal GDN connections costs.

Looking forward however, the lack of availability of network capacity is now critical with a large number of potential projects failing to progress (we have 25 recorded in our database). To achieve target levels of green gas injection, network reinforcement is needed to create capacity, with three technical solutions:

- Smarter pressure control to reduce natural gas flowing into a network and create more space for biomethane
- Reverse compression to export gas from one pipeline into a higher pressure one with available capacity
- New pipelines to connect two networks, allowing biomethane flows to access more demand

None of these investments were considered when RHI and GGSS were established and none were involved when all the existing biomethane plants were connected. Rather than double funding, therefore, an allowance towards these costs would be a step towards keeping funding provision in line with the historic position and putting new projects on an equal footing with the legacy ones.

What is Reverse Compression and How Does it Work?

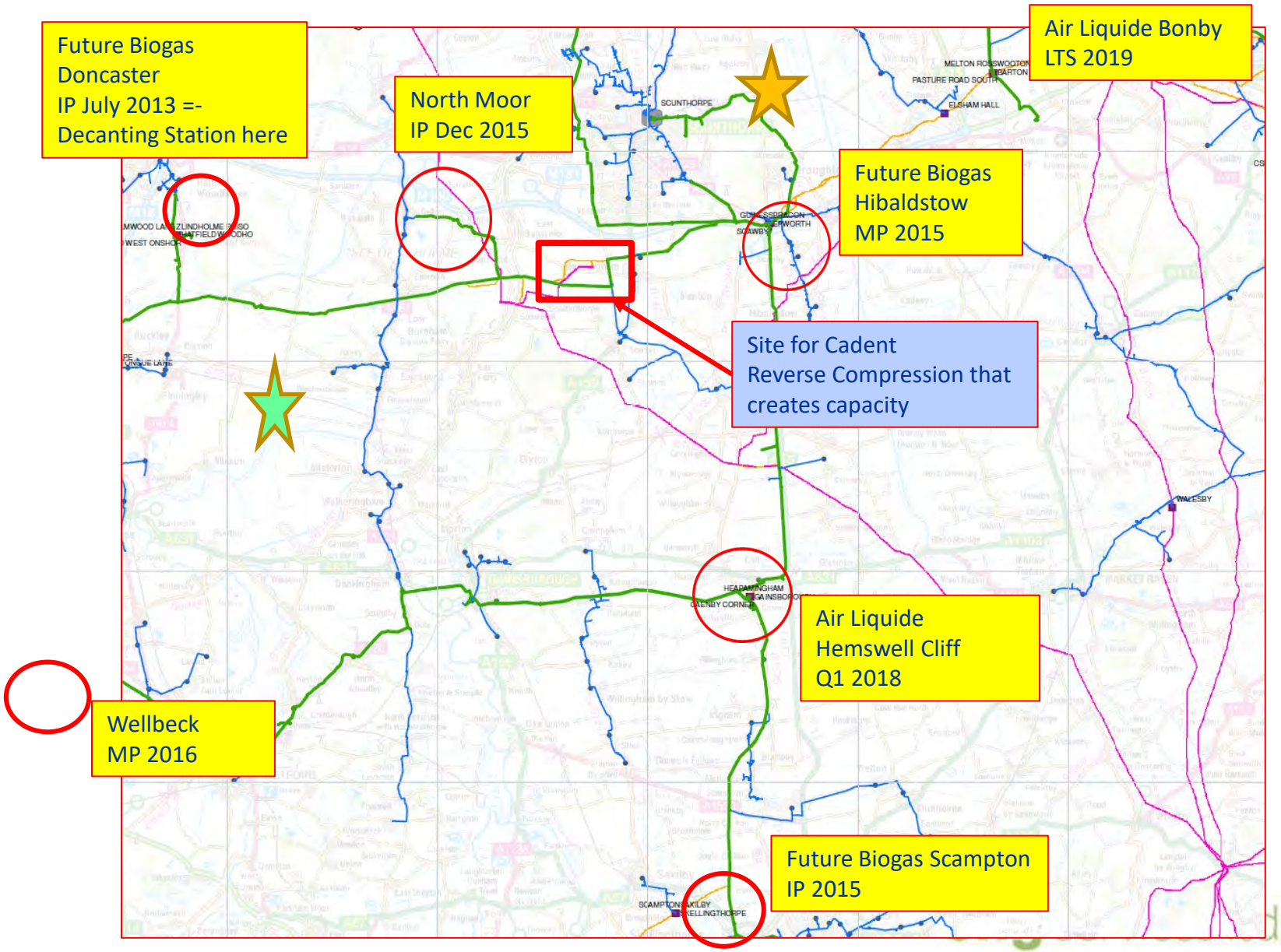
- Reverse Compression (RC) is important to create capacity lost in the period 2012 to 2025 due to biomethane projects going ahead (and using the capacity) and declining local gas demand caused by factory closures
- Typically a RC plant operates for around 10 – 15% of the hours in a year with very little running in the months October to March
- The operation of the RC is automatic (like a PRS) with no intervention from System Control. It has no effect on demand and no effect on security of supply, but it does allow a higher proportion of biomethane in the supply to local consumers
- There is one operational RC in GB, Cadent West Butterwick

Types of Reverse Compression Facilities

- There are 2 different types of RC:
  - Ones that provide capacity for multiple projects and that's typically in networks with a single Transmission Supply as common in France and Ireland:
    - In GB the gas grid has extensive interconnections and there are less locations to provide capacity for multiple projects
    - Cadent West Butterwick (next slide) is a great example of a single RC serving an extensive network, in this case IP. Potentially 6 projects can benefit now with other potential sites
    - *CSL has identified 6 multiple projects, 2 in Cadent area, 2 in WWU and 4 going from LDZ to NTS (one of these south of Cambridge can provide capacity for many AD plants on LTS, IP, MP)*
  - Ones that are for a single project such as High Bickington:
    - CSL has identified around 25 such projects from reviewing projects that have not progressed from 2012 onwards
    - In addition, around 10 existing biomethane production sites would benefit from RC (higher summer flows and/or possible expansion)
- The RC projects are fundamentally straightforward (as NaTrans in France) with key issues that impact cost and feasibility being:
  - Land
  - Electricity supply
  - Planning consent

West Butterwick RC – multiple Biomethane Projects Benefit

- The West Butterwick project was commissioned in 2024
- Funding by Ofgem NIC (“Optinet”)
- £6 million NIC Funding for Optinet, RC cost not known
- 6.5 bar inlet, 38 bar outlet
- Compressor sized for 5,000 scmh



Innovation Pathway to Reverse Compression in 2025

Innovation Pathway to Reverse Compression in 2025

- CNG Services Ltd (CSL) has extensive experience of small scale gas compression using reciprocating compressors based on projects in the compressed natural gas and biomethane markets (64 such compressors installed between 2014 and 2025)

- CSL has developed reverse compression technology since the first pilot project with NGN in 2012

- Notable projects since 2012 include:
  - Leyland Bio-CNG station (first Bio-CNG station connected to high pressure gas grid)
  - Euston biomethane into Cadent Local Transmission System
  - Fordoun NTS Mother station (for supplying Bio-CNG to off gas grid distilleries)

- In summary
  - Crewe led to Leyland which led to Fordoun and 16 public Bio-CNG stations
  - Crewe also led to Euston, Methwold and 10 other LTS injection projects and also Somerset Farm into NTS
  - There are 64 similar CE Marked compressors in operation in GB
  - The High Bickington project is the first commercial reverse compression plant in GB and takes advantage of learning from the previous 20 years as shown in the next slides
  - Going forward, for biomethane to be a significant contributor to 2050 NetZero targets there is likely to be requirement for >50 reverse compression projects by 2035

1. Crewe CNG Station Built in 2000-2001

- Haulier “Caratrans” based in Crewe, logistics for Vauxhall Ellesmere Port (2 x 400 mile return trips to Purfleet each day)
- Filling 40 dedicated CNG Trucks made by ERF in Middlewich

The station:

- 7 bar gas grid (Cadent)
- 3 compressors and significant storage

Lesson 1 – its very stressful being the owner of a single CNG Station filling 40 dedicated CNG Trucks twice a day. No plan B, only enough storage for 5 truck fills. So, No 1 task of a station owner is maintenance and standby cover

2. NGN RC Innovation Pilot 2012

- In 2012 there were biomethane projects that needed ‘within grid’ compression including GMT Biogas at Driffield (which went with Biogas CHP)
- CSL proposed an Innovation Project to NGN to prove the concept which was new for EU at that time
- A small screw compressor was installed at an NGN site near Skipton to extract gas out of a 2 bar pipeline and inject into a 7 bar one
- The trial was successful and proved the concept
- High Bickington, has the same concept as the NGN 2012 trial but with a compressor very similar to the ones at Crewe apart from only reaches 37 bar not 300 bar

Lesson 2 – the fundamentals of RC are established and widely used in Europe – similar to Skipton

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

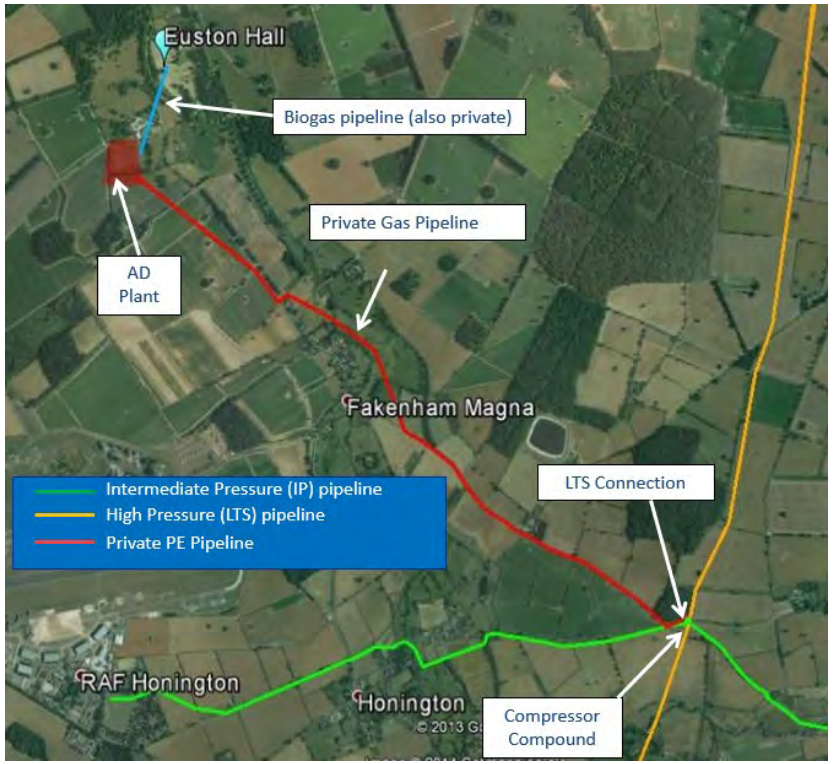
Project Outcomes:

- 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 CO_2 saving.
- Within grid compression was proven capable of providing capacity to otherwise uneconomic BtG projects and to avoid flaring biogas in summer.

3. Euston Biomethane Project – 2015

Client	**Euston Biogas Ltd**
Gas Network Operator	Cadent Gas
Location	**Euston Hall Farm Estate, Thetford, Suffolk**
Type of Project	Biomethane
Local or Remote Compressor	Remote
Entry/Exit	Entry – injection into existing LTS network

Pipeline Length, Material and Diameter	Private Pipeline – 6 km 125mm PE100 IP , 15m 100/50NB Steel LTS rated
Maximum Operating Pressure (MOP)	42 barg
Maximum Flowrate/LTS Diameter	1000 scmh/100NB
Compressor Type	SAFE reciprocating compressors
Completion Date	May 2015



Lesson 3 –having the compressors downstream of a 6 km pipeline was innovative but has become established and Cadent support to the concept and the SLO/1 process for LTS Connection was critical. As with Crewe and RC, >99% availability is critical as is support of the GDN

There have been many other similar plants with compressors remote from the AD plant. All are similar to Euston and have the same compressors (same as High Bickington RC)

4. Leyland Bio-CNG Truck Filling Station 2015

Connection to LTS

First Unregulated Gas Meter for Bio-CNG

Waitrose Bio-CNG Trucks

Lesson 4 - For Bio-CNG, the higher the pressure the better. First Bio-CNG station on the LTS with 26 bar inlet pressure and low unit operating cost

Lesson 5 – Justin Laney of Waitrose/John Lewis was first mover in Bio-CNG in GB (with Dave Landy of Argos) and was critical in persuading Scania to bring more dedicated Bio-CNG trucks to GB in 2015

Lesson 6 – Friends are always helpful. Cadent also key in allowing truck turning circle over the LTS and HSE agreed to change to Gas Safety Installation and Use Regs to have an unregulated gas meter

5. Somerset Farm – first Biomethane into NTS Project - 2020

10-75 bar Compressors

Biomethane Energy and Gas Quality Measurement

75 bar Soluforce Pipeline

75 bar Export Pipeline

Overall Plan

Lesson 7

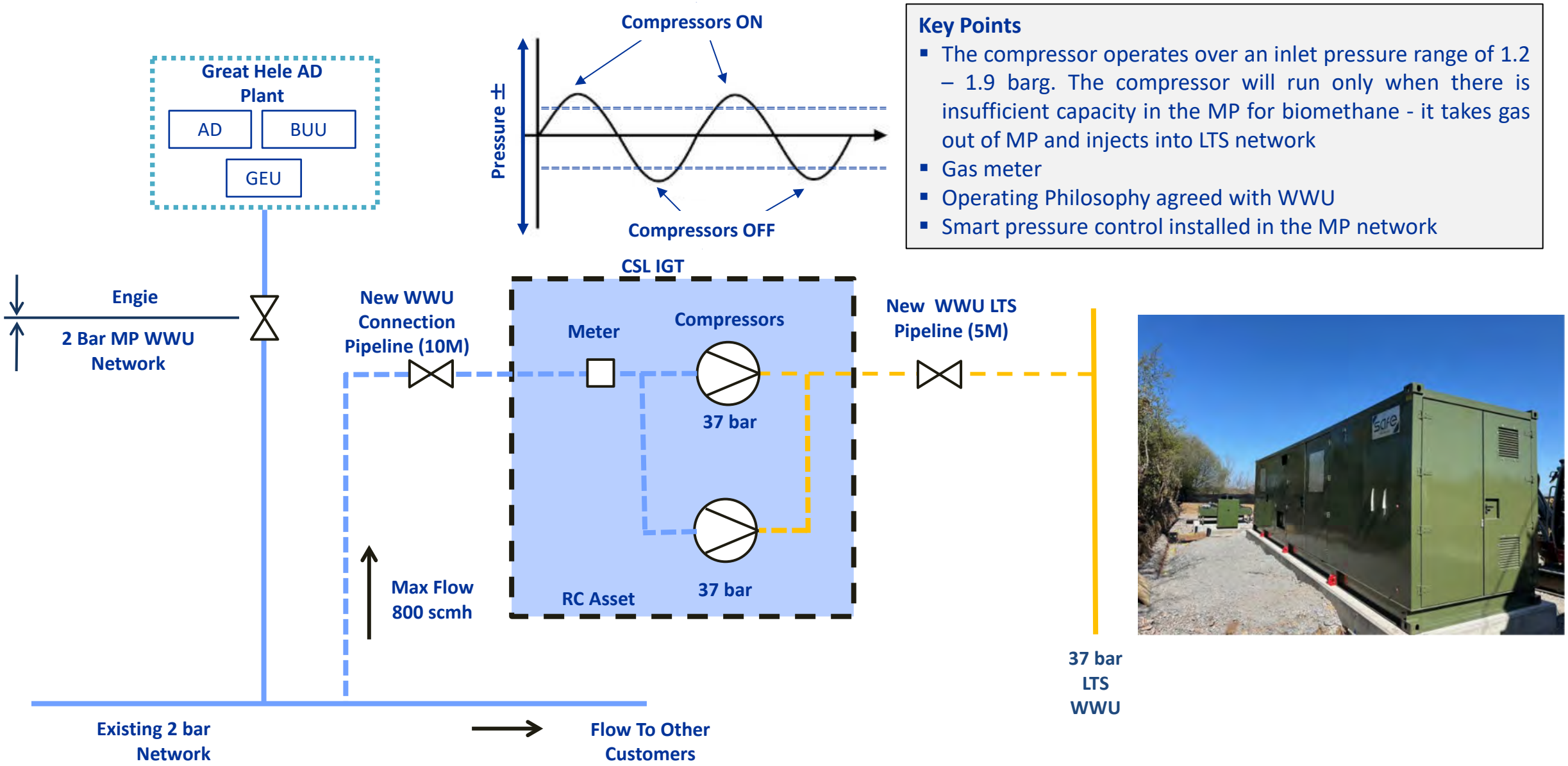
- First biomethane into NTS (Project CLoCC) and used oil free gas compressors for first time but other-wise similar to Euston/Leyland
- High Bickington RC is also oil free

6. NaTran France (formerly GRT Gaz)

- Built in 2018, 3.7 million Euros
  - Packaged plant built and factory tested at the manufacturer
  - 3,000 scmh, exports gas from 10 bar to 70 bar
- Compressor starts at 8.5 bar, stops at 7.5 bar, no manual intervention other than to have summer and winter settings
- Operates for around 50% of the hours in the year and allows 15 biomethane projects to inject into 10 bar grid
- The High Bickington specification is similar to Engie France with 2 main changes:
  - Oil free cylinder lubrication system
  - Small gas compressor to avoid any CH4 venting from the crank case (CNG Services design)

Lesson 8
- The basic NaTran system is similar to Euston and works well
- CE Marked

7.1 High Bickington MP To LTS Network – Reverse Compression Plant Schematic



Key Points

- The compressor operates over an inlet pressure range of 1.2 – 1.9 barg. The compressor will run only when there is insufficient capacity in the MP for biomethane - it takes gas out of MP and injects into LTS network
- Gas meter
- Operating Philosophy agreed with WWU
- Smart pressure control installed in the MP network

7.2 High Bickington Reverse Compression – 2025

Key Information:

- 2 x SAFE reciprocating compressors (1.5 to 37 barg)
- Aim to commission in October 2025

Reverse Compression Model Project

- Standard and proven compression package with CE Mark (64 GB compressors)
- Operating Philosophy
- Technical Specification
- Design Assurance
- Safety Case
- Emergency Procedures
- 24/7 O&M Arrangements
- HAZOP/LOPA, DSEAR, WSE
- Commissioning Procedures and NRO's

Lesson 9

- Do not take technical risks, the innovation is the RC Concept itself
- First commercial RC (ie not funded by Ofgem innovation funds)
- Similar spec to Engie business NaTran (formerly GRTF Gaz) in France
- CSL IGT Model

8. Conclusions

- For Biomethane and NetZero it is very important that RC becomes routine
- Some key RC projects are required to unlock large areas of the network in Cadent and WWU areas as per West Butterwick
- Many RC projects will be for a single biomethane project as per High Bickington
- The NaTran design from France is very good and provides a valuable template to allow GB to take advantage of learning
- CNG Services appreciates the support from WWU to the High Bickington project and looks forward to working with all the GDNS and NGT to facilitate more TWh/annum of biomethane by having widespread RC

Lesson 10

- When we work together we can achieve a lot
- WWU and Engie (owner of NaTran) have been great partners at High Bickington and WWU have provided feedback on learning related to the West Butterwick Project (of which WWU is a project partner, Optinet)
- An IGEM standard for RC Systems is under development and will allow learning from West Butterwick and High Bickington to be shared within the industry for the benefit of all