Reverse Compression UNC Mod Briefing

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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 CO_2 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
- 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 organisation for high pressure UK onshore natural gas works by DNVGL
- Working on a number of H_2 and CCUS innovation projects

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Summary

- Reverse Flow options was presented at the Entry Customer Forum on 7th September
- WWU & Cadent are currently carrying out an innovation project with compression at a site near Doncaster
- Based on that project, the GDNs have produced a specification for GDN owned and operated compressors
- This briefing is to support a UNC Mod to facilitate biomethane producer owned compressors with a number of changes:
  - No LDX exit Charges
  - No LDZ Entry Charges/Rebate
  - No impact on CV or odorisation
- Slides in Appendix attached by way of background
  a) GasUnie Within Grid Compressor 6 bar pipeline to 40 bar
  b) GRTgaz Safe reverse flow compression projects in France
  c) LTS/NTS – Direct Compression 19/38/42/70 bar LTS
  d) LTS –Private 6.9 bar pipeline to LTS (19 – 42 bar)/NTS

Within Grid Operating Principles

- The operating principle underpinning within-grid-compression is that during the summer the gas network will be able to reduce the regulator set points at the AGIs that feed the localised network a biomethane site is connected to
- This will give a compressor a pressure band to operate in and ensure that the compressor is not moving gas from low pressure to high pressure networks for the regulators on an AGI to then flow the gas back from high to low pressure
- For example, the IP distribution networks in GB operate at a nominal pressure of 7 barg and as such, the maximum operating pressure that the AGI regulators will be set at is 6.9 barg. If this is reduced to 6.5 barg during times of low network capacity (i.e. summer) it will give the compressor a band to operate in from 6.5 bar to 6.9 barg
- The pressure cannot rise above 6.9 barg as the compressor will be switched on to move gas out of the network
- If the pressure falls and approaches 6.5 barg then compressor will turn off
- If the network pressure falls even further below 6.5 barg then the AGI regulators will start to open and move gas from the high pressure network to low pressure
- Maintaining 6.5 barg for summer demand will generally be acceptable in terms of gas security of supply due to absence of 1 in 20 peak day demand

Within Grid Ownership Options – the UNC Mod is to allow Option 2

Option 1 – GDN Owned	Option 2 – Biomethane Producer Owned
Compressor is owned operated and maintained by the GDN and forms part of the network	Compressor is owned, operated and maintained by the biomethane producer and does not form part of the network
Comprises an Exit to the lower pressure grid (2 bar or 7 bar) and an Entry into the high pressure grid (7 bar or 19/40/70 bar LTS)	Comprises an Exit to the lower pressure grid (2 bar or 7 bar) and an Entry into the high pressure grid (7 bar or 19/40/70 bar LTS)
Exit meter for management information	Exit meter for management information
No charges as gas does not leave network	At present the gas shipper would pay an Exit Charge to leave the MP/IP and receive Entry Rebate to enter IP/LTS (the UNC mod aims to exempt from these charges/payments)
Funding may be from the biomethane producer in the form of up front CAPEX or a tariff	Funding from the biomethane producer
Ongoing charge for maintenance and compression levied by the GDN	Ongoing charge for maintenance and compression paid for by the biomethane producer
Compressor design approved by the GDN – common specification across all GDNs	Compressor design set by the Biomethane Producer but the GDN can set out specific requirements eg Process Safety and Oil related – common requirements from all GDNs
Self-lay may be an option	Responsibility for design, build and maintenance with the biomethane producer
Land and planning likely to be arranged by the biomethane producer	Land and planning to be arranged by the biomethane producer
Pressure in lower pressure grid reduced in summer months to facilitate compressor operation and ensure there is no circular flow	Pressure in lower pressure grid reduced in summer months to facilitate compressor operation and ensure there is no circular flow

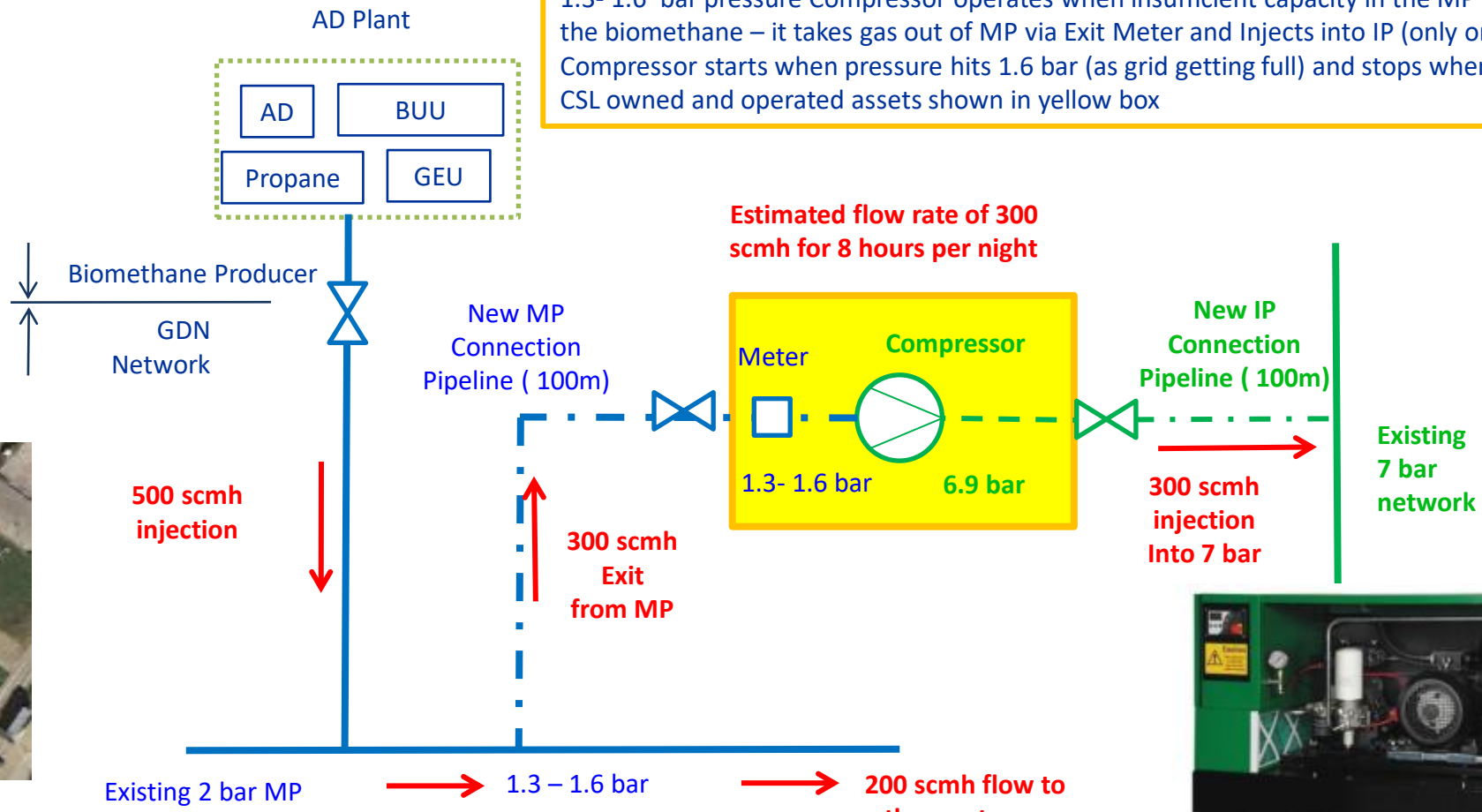
Within Grid Compressor Fundamental Principles

These are based on CSL work in this area and research in EU

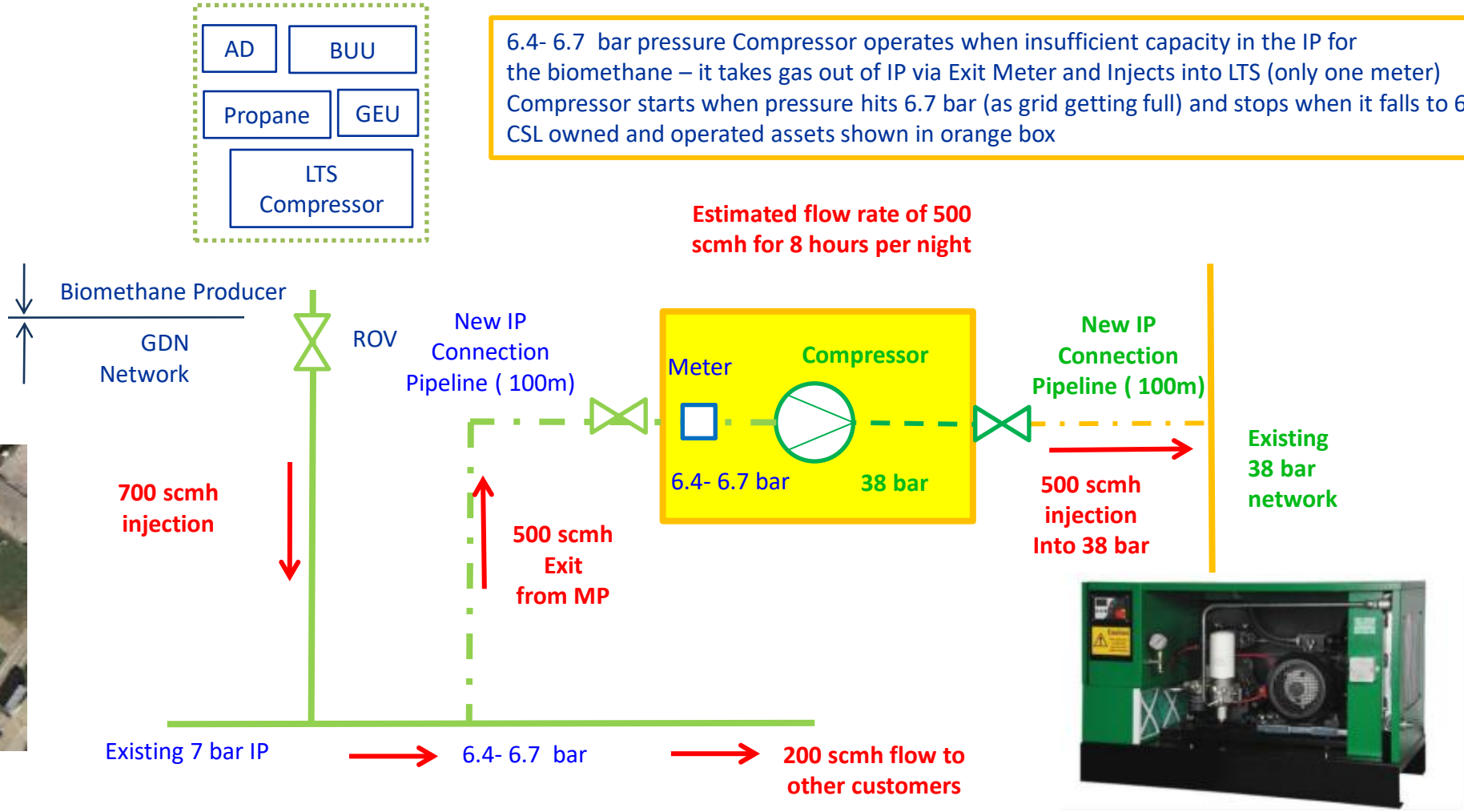
1. For LTS and NTS >40 bar pressure, gas reciprocating compressors should normally be used
2. For LTS <40 bar pressure, screw compressors can also be used
3. Oil free compressors should be used or ones with a system to capture any oil that passes through the compressor (as used on membrane upgrading plants which ensure nom oil passes to the membranes)
4. There should be no risk to security of supply by design - key is to reduce grid pressure in summer and have simple Operating Philosophy with no scenario possible to impact security of supply to existing customers
5. Usually only one compressor will be required due to low running hours
6. To reduce cost and increase reliability, ideally use standard compressors from CNG/Biomethane/Biogas upgrading
   - Already comply with ATEX, PED and are CE marked
   - Minimal changes (if any)
7. Similar examples as the 6 bar to 19/38/42 bar remote compressors installed by CNG Services at Euston, Methwold, Bay Farm, Bonby
8. 2 bar to 7 bar is very simple, should be <9 months project
9. Aim to keep it simple, keep costs down to ensure more biomethane projects are economic
10. Operating philosophy is very simple – for IP to LTS, switch on at 6.7 bar in the IP, switch off at 6.4 bar
11. No need for gas recycle, but have Variable Speed Drive to go down to 50% flow
12. Probably no need for chiller as the gas temperature at inlet to the compressors will generally be <15 deg C
13. Have a gas meter (on the low pressure Exit) to provide useful management information (alongside electricity meter)
14. Aim not to install projects which will never operate – small is best, can add 2nd compressor later if needed

MP to IP Compression plant

1.3- 1.6 bar pressure Compressor operates when insufficient capacity in the MP for the biomethane – it takes gas out of MP via Exit Meter and Injects into IP (only one meter)
Compressor starts when pressure hits 1.6 bar (as grid getting full) and stops when it falls to 1.3 bar
CSL owned and operated assets shown in yellow box



IP to LTS Compression plant



Background Briefing a)

GasUnie Within Grid Compressor 6 *bar pipeline to 40 bar*

Site Visit
4rd June 2019

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INTRODUCTION

The following sheets are about the pilot plant of Gasunie for green gas boosters.

This pilot plant has been the starting point for the ongoing European tender for these boosters.

The tender consists of 3 models.

model A 1000m3/h

model B 2000m3/h

model C 3000m3/h

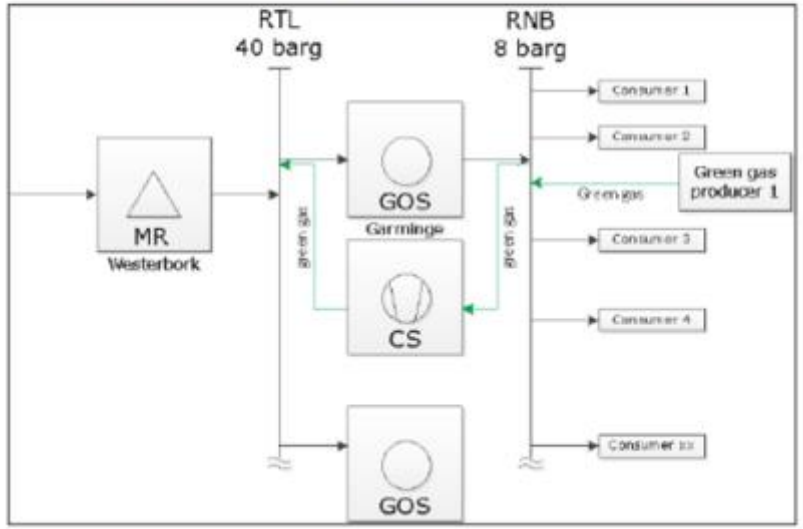
The presented booster can be used as indication for model A 1000 m3/h.

Table 1.Operating conditions and other parameters in relation tot the design of the systems.

Parameter	unit	RNB	RTL
P_{min}	barg	5,4	30
P_{max}	barg	8	40*
DP	barg	10	40
MOP	barg	8	40
MIP	barg	13	46
T_{min}	°C	5	5
T_{max}	°C	20	35

Normally the natural gas flows from the Gasunie's Regional Transmission Pipeline (in Dutch: RTL, 40 barg) into a local distribution company (in Dutch: RNB, 8 barg) via the Gasunie's gas delivery station (in Dutch: GOS).

At the green gas feeding station CS Garminge, which is placed parallel to the GOS Garminge, green gas (bio-methane) will be fed from the local distribution network; Enexis, into the RTL with the help of compression. Attero, as the producer of green gas, feeds the green gas into the Enexis network. In Figure 1 is shown what the relation is between the parties.



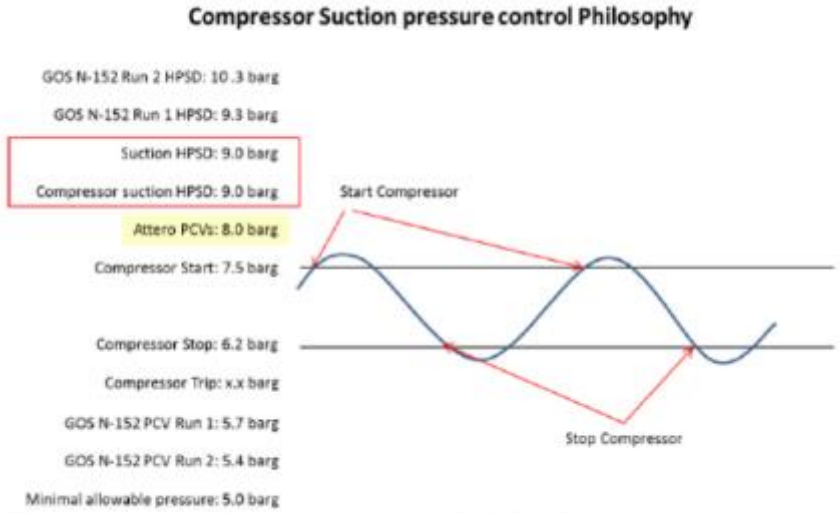
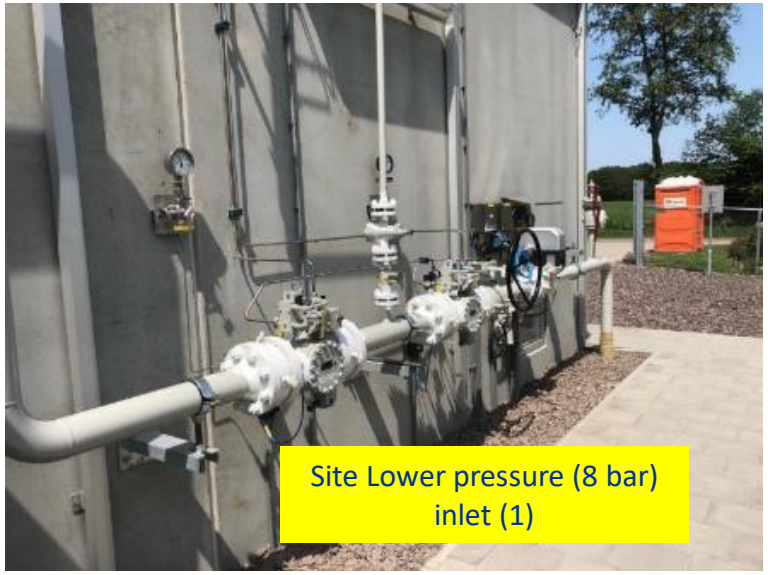


Figure 2. Compressor's suction pressure control philosophy



Site Lower pressure (8 bar) inlet (1)

Site High Pressure (40 bar) Outlet

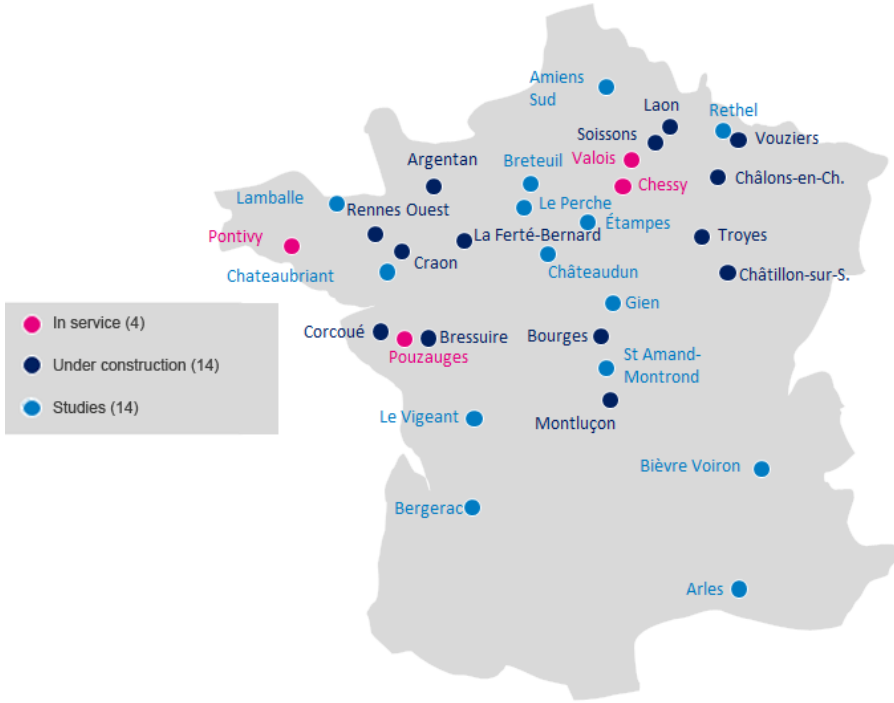
Reciprocating Compressor

Background Briefing b)
GRTgaz France

Reverse Flow – 32 Projects on French Network

- Using Safe Compression

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8
Suction pressure (barG)	3,9	4	7,5	4	8	7	8	4
Discharge pressure (barG)	55	67,7	60	67,7	67,7	67,7	67,7	67,7
Capacity (Nm3/h)	540	1,450 x2	820	1,000	1,500	1,000	3,000	1,500
Suction Temp. (°C)	15	15	15	15	15	15	15	15
EM power (kW)	110	250 x2	110	200	250	200	450	315



Background Briefing c)

LTS/NTS – Direct Compression 19/38/42/70 bar LTS

The key issue for these projects is managing the start up of the compressor and Biogas Upgrading Unit to ensure that the Grid Entry Unit doers not trip due to propane issues (too high or too low CV for a minute which trips the plant)

Following is a typical project

Note – load factor for each reciprocating compressor is typically 50% which is high. For screw, normally only one and so 100%

Barnes Farm Biomethane Project

Client	**Air Liquide**
Gas Network Operator	Cadent Gas
Location	Barnes Farm, Rowton, Telford, Shropshire
Type of Project	Biomethane
Local or Remote Compressor	Local
Entry/Exit	Entry

Project Scope:

- Design and construction of a 70 bar steel biomethane injection LTS pipeline under Cadent Self Lay process
- Design and construction of the customer facilities including twin reciprocating compressors & customer HP steel outlet, GEU, ROV and RTU
- Special crossing required under field drain
- G17 & GL5 Mechanical. Civil, CP Detailed Design with Appraisal and Approval

Pipeline Length, Material and Diameter	600m 100NB/50NB steel LTS adopted pipeline, 40m 50NB steel HP compressor outlet
Maximum Operating Pressure (MOP)	70 barg
Maximum Flowrate/LTS Diameter	950 scmh/600NB
Compressor Type	SAFE reciprocating compressors
Completion Date	December 2019

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Background Briefing d)

LTS –Private 6.9 bar pipeline to LTS (19 – 42 bar)/NTS

Cadent projects (Cadent allow self-lay of LTS connection which is critical for these projects)

The propane is added at 6.9 bar and so there are no issues with compressor/BUU/GEU issues that happen at sites with Direct Compression

Following shows typical LTS and NTS projects

Methwold Biomethane Project

Client	**Warren Energy (Future Biogas Operator)**
Gas Network Operator	Cadent Gas
Location	Methwold, Thetford, Norfolk
Type of Project	Biomethane
Local or Remote Compressor	Remote
Entry/Exit	Entry

Project Scope:

- Design and construction of an IP gas pipeline between the AD Plant and remote compressor, including HV supply and fibre optic communications, owned and operated by Warren Energy
- Design and construction of a customer compressor compound incl twin reciprocating compressors and HP steel outlet pipework
- Design and construction under Self Lay process of Cadent MEC facilities including Remote Operated Valve, HP inlet and outlet pipework, RTU, compound & final connection to Cadent LTS
- GL5 & G17 Mechanical Detailed Design with Appraisal and Approval.

Pipeline Length, Material and Diameter	3.5km 90mm PE IP pipeline to remote compressor, 20m 100/50NB steel LTS rated compressor outlet/ROV Inlet & outlet connections
Maximum Operating Pressure (MOP)	42 barg
Maximum Flowrate/LTS Diameter	600 scmh/200NB
Compressor Type	SAFE reciprocating compressors
Completion Date	November 2015

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Somerset Farm Biomethane to NTS Project

Client	**BioCow**
Gas Network Operator	National Grid Gas
Location	Somerset Farm, Cants Drove, Murrow, Wisbech, Cambridgeshire, PE13 4HN
Type of Project	Biomethane
Local or Remote Anaerobic Digester	Remote
Entry/Exit	Entry

Project Scope:

- Design and construction of a 75 bar 100NB steel 1Km private gas pipeline & fibre optic communications from the AD plant boundary to a new NGG NTS MEC at an existing block valve, CSL Duty Holder operator under full Safety Case
- Design and construction of HP customer compressor outlets from twin reciprocating compressors to HP meter and 150NB HP Soluforce RTP meter outlet pipework to boundary ROV compound
- GL5 Mechanical. Civil, CP Detailed Design with Appraisal and Approval.
- **This was the first NTS Biomethane Injection project**

Pipeline Length, Material and Diameter	1Km 80NB steel private pipeline, 140m 150NB Soluforce RTP, 80m 80NB & 50NB Steel HP compressor outlet connecting pipework
Maximum Operating Pressure (MOP)	75 barg
Maximum Flowrate/NTS Diameter	4000 scmh/100NB
Compressor Type	SAFE reciprocating compressors
Completion Date	August 2020

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