GETTING BIOMETHANE INTO THE GRID

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Biogas plants are widespread in the UK but are mainly used in electricity production schemes. Due to the transmission losses associated with electricity production, a better alternative is to clean the biogas to make biomethane and inject it into the existing gas network. However, until now, only three plants are successfully injecting biomethane back into the grid.

Northern Gas Networks (NGN) is being approached more frequently with enquiries from potential biomethane producers who would like to inject biomethane into the network, within excess of 50 enquiries having already been received.

The location of potential biomethane plants is often pre-determined, as often the enquiries are received from existing farms or household waste plants that are located in rural locations with medium or intermediate pressure connections.

Demand issue

The anaerobic digestion process is continuous, meaning that biomethane plants often request to input gas into the grid at a continuous rate. Varying the rate of biomethane is difficult because the reaction that makes biogas from waste cannot be practically turned up or down in less than a few days.

A typical farm enquiry will anticipate a biomethane production of around 300-500 standard cubic metres/hour (scmh), with larger scale enquiries of around 2000scmh being received from producers such as waste water facilities.

The domestic use of gas creates a diurnal demand profile. This means that each day, less gas is used on a night time and annually, less gas is used in the summer than the winter. Hence, summer evenings will create periods of very low demand - so low that the rate of production of biomethane may exceed the demand.

This will mean there is "no space" within the medium and low pressure networks for the biomethane to be absorbed.

The industry estimates that around 40 per cent of initial enquiries for biomethane plants are constrained by the lack of demand-related capacity on the medium or intermediate pressure network and the cost of constructing a new pipeline to allow the biomethane to be transported from the plant to a larger network with sufficient capacity.

NGN have completed studies in relation to proposed projects which have indicated a shortfall in capacity to accept gas in summer with varying requirements of compression; for example, eight hours duration up to 100 days per year depending upon weather and demand conditions.

Each enquiry is different based on the size of network and the proposed size of the biomethane plant.

Expected Minimum Hourly Demand Expected in an Example MP System Based on Standard Load Duration Curves

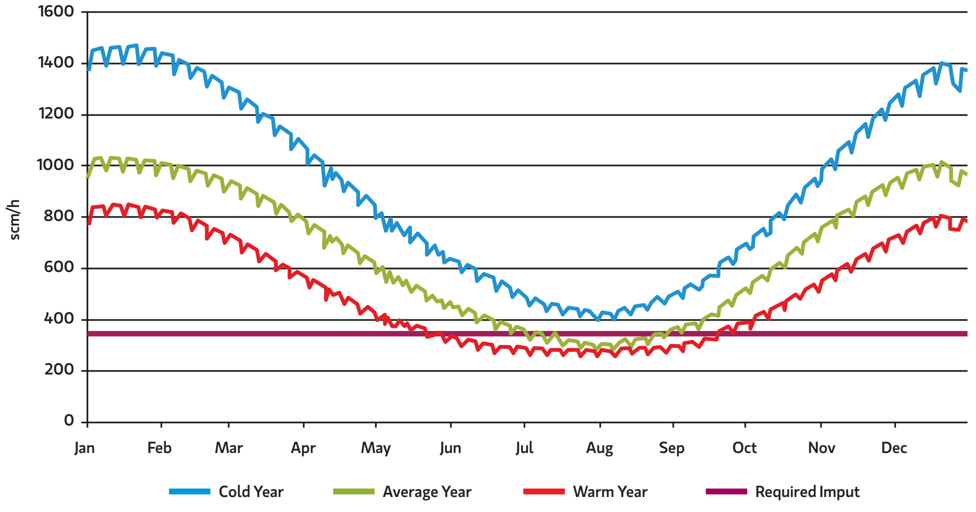


Figure 1 (above) is an extract from analysis carried out in relation to a biomethane enquiry.

Proposed solution

To overcome the problem, it was proposed that capacity could be "created" by compressing gas from a medium pressure (MP) system and reversing the flow uphill into an intermediate pressure (IP) system. The compressor would only be required to operate when the demand on the MP network is insufficient to consume the amount of gas being injected into the network at a constant rate from a biomethane source.

NGN worked together with National Grid (NG) and CNG Services Limited (CSL) to carry out a field trial and test this theory in a pilot study. The objective of the pilot was to:

1. Prove the principle of increasing the "effective" capacity of a medium pressure network to support biomethane plants that would otherwise be constrained and hence uneconomic.
2. Provide a working and accurate simulation tool.
3. To design, build and test safe systems of operation to ensure a safe and secure gas supply at all times.

Network selection

In order to carry out a successful trial, a suitable site needed to be found. It was preferable that the site fulfilled the following requirements:

1. A medium pressure network with a seasonal demand profile and very low demand at the bottom end of the diurnal.
2. An intermediate pressure to medium pressure, preferably 7-2bar where the IP had enough capacity to accept the gas.
3. At least two IP to MP injection points: one to be utilised for the compressor installation and one to be utilised as the simulated biomethane injection point. (Should the network have more than two injection points, these will be required to be "backed off" by reducing their pressure during any trial period.)
4. A non-complex network

Site selection

Once we had narrowed the selection of suitable IP/MP networks, I carried out site surveys of three pressure reduction installations (PRIs) to identify which site would be the most suitable to locate a compressor based on the following criteria:

1. Existing valved connections on the IP and MP side of the PRI to connect test equipment
2. Space for the compressor to be installed
3. Power supply and/or space for a generator
4. Good access.

Skipton 7/2bar PRI offered the best match to the requirements and was selected as the preferred field trial site.

Design

NGN and NG then worked closely with CSL who selected a compressor that was suitable for the chosen network and the proposed trial conditions. The pilot was designed so that:

1. The medium pressure system cannot be drawn down below a safe minimum
2. The intermediate pressure system cannot be pressurised above a safe maximum
3. The compressor is effective in moving excess gas production over demand
4. A fault in the compressor, its control system or interfaces to the existing site plant led to automatic and intermediate restoration of the original pressure reduction system functions. »

A transient computer-based model of a pipeline network was produced by TSC Simulation to create a theoretical model of the pilot. This could then be used to measure if the trial was successful or not.

HAZOP study

A hazard and operability (HAZOP) workshop was carried out in order to identify and evaluate problems that may represent risks to personnel or equipment, or prevent efficient operation during the trial. This included determining minimum pressures which should be monitored closely throughout the trial. Parameters were determined such that if any of the following occurrences happened, the compressor would be electrically isolated:

1. If any system extremity pressures fell below the specified minimum
2. If the injection rates fell below a specified minimum
3. If the source pressure fell below the specified minimum
4. If the intermediate pressure increased above the specified maximum.

These scenarios were simulated and tested during the trial. In all cases mechanical devices were included as a backup to the electronic controls.

The settings adopted for the pilot were as follows:

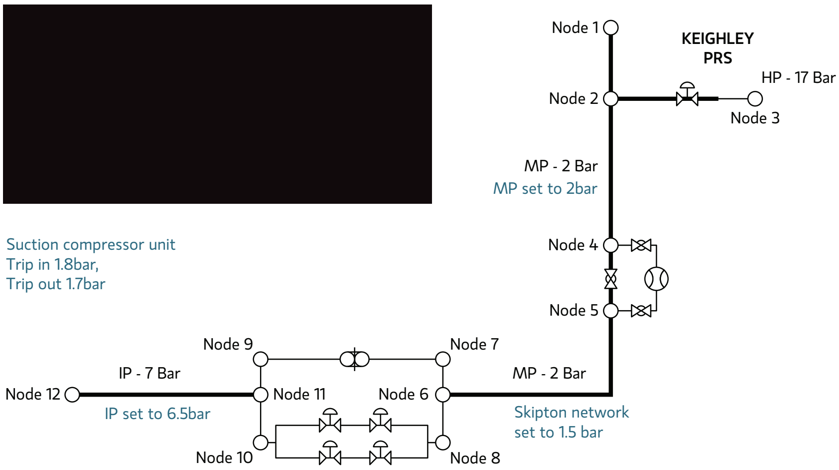
1. IP network – 6bar
2. MP network (Keighley) 2 Bar
3. MP regulator Skipton 1.6 bar
4. Suction compressor trip in pressure 1.8 Bar
5. Suction compressor trip out pressure 1.7 Bar
6. Suction slam shut 1.6 Bar
7. Discharge compressor trip out 6.9 bar
8. Discharge slam shut 7.0 bar

These parameters allowed the trial to take place effectively, but without compromising the existing network integrity or security of supply. An onsite programmable logic controller (PLC) captured, monitored and controlled all of the on-site activity in line with the above pressures.

Figure 2 (above) is a schematic of the trial set up.

There is a block valve at Snaygill, between Keighley and Skipton. This valve was closed in order to section off the Keighley side of the network from the Skipton side and allow the Keighley network to be set up at 2bar and the Skipton regulator to be set up at 1.6bar. This allowed for a more efficient trial, as the reduced pressure at Skipton simulated demand on the network without the need to wait for a "peak" period of gas consumption.

A bypass was designed and fitted over the valve at Snaygill. This bypass allowed gas to circumvent the block valve at a steady, governed rate, thus simulating a constant biomethane feed. When the 1.6bar (Skipton side) network rose to 1.8bar, the compressor began to work and fill the IP network until either the MP network reduced to 1.7bar, or the IP network (set at 6bar for the trial) increased to 6.9bar. Once either of those limits was reached, the compressor ceased operation and normal operation resumed. The PLC was set so that should any unexpected occurrences transpire, the compressor would be slammed off and Skipton PRI would return to normal operation.



Results

The trial proved to be successful. The simulated biomethane source flowed at the pre-set 250scmh. This did reduce somewhat during the trial and was primarily due to reduction in demand which could not be controlled any further. However, this was not detrimental to the outcome of the trial. The compressor turned on and off automatically, in line with the pre-determined values. The MP network pressures remained within acceptable limits during the trial and the IP pressure was not significantly impacted by the injection of gas from the MP network.

Conclusion

The trial has fulfilled the objectives outlined and gone on to confirm that a compressor within the grid can be designed and controlled to enable rates of biomethane injection that exceed minimum consumer demands in a discrete network. Therefore, within-grid compression can be a solution to the issue of network capacity and dispel the issue of biomethane production being constrained by a lack of demand-related capacity on the medium or intermediate pressure network. As has been proved with the careful selection of networks and sites for this trial, the solution of compression is subject to the biomethane plant being within reasonable distance of a suitable MP network.

Northern Gas Networks, in partnership with IGEM, is hosting an event for potential producers of biomethane in the NGN area. The event will help potential producers understand the commercial opportunities in biomethane and how they can make money from their current operations by producing biomethane and selling it for injection into the local gas network. The event is on 26th September at FERA, in York.

For more information visit ***www.igem.org.uk/gastocash***