Biomethane injection in the UK

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Overview

- Introduction - Dave Lander
- UK experience of Grid Injection of biomethane
  - Timeline
  - Numbers of projects to date
  - Technologies generally employed
- Parties involved...
  - ...and their commercial and regulatory drivers
- Measurement Risk assessment
  - Requirement of Gas Distribution Networks for all connections (conventional or non-conventional)
Overview

- Analytical challenges
  - Producer v Gas transporter
    - Cost v Accuracy
  - “Bulk” properties and contaminants

- Conclusions and discussion
Introductions

- Dave Lander
- Joined gas industry in 1974
  - British Gas Corporation: R&D: substitute natural gas
  - British gas plc: R&D: alternative uses of natural gas
  - Lattice / Advantica: R&D: gas quality
  - National Grid - Transco: Policy: gas quality
  - National Grid: Policy: gas quality
- Left National Grid in 2008
  - Independent consultant in natural gas quality
Introductions

- Experience
  - Natural gas quality (technical, policy, strategy)
  - Biomethane (technical, policy, strategy)
- UK representative for groups developing a number of ISO and CEN standards
  - ISO6974 - analysis of natural gas
  - ISO6976 - calculation of properties from composition
  - EN16726 - Gas Quality
  - EN16723 - Biomethane
UK experience of non-conventional gas injection

- Timelines
  - 2000
    - Preliminary discussions between Ofgem and Transco regarding injection of waste-derived gases, coal-bed methane and coal-associated gases;
    - Transco Ten Year Statement amended to include organohalides limit and radioactivity limits
UK experience of non-conventional gas injection

- Timelines
  - 2010
    - Didcot: first injection of biomethane into a UK gas distribution network
    - SGN’s distribution network
    - Demonstration project - aimed at assessment of issues and monitoring requirements
    - Cautious view on technology and monitoring requirements
    - Not commercially viable - demonstrated technical feasibility and where savings might be made
UK experience of non-conventional gas injection

- Timelines
  - September 2011
    - EMIB (Energy Market Issues for Biomethane) Review Group
    - Identified technical and commercial barriers to biomethane injection
    - GDN connection policies
    - GDN capacity availability
    - Technical standards for calorific value measurement (relaxation of accuracy requirements)
    - Gas quality regulation (water dew temperature, oxygen content)
UK experience of non-conventional gas injection

- Timelines
  - March 2013
    - ENA (Energy Networks Association) biomethane roundtable
    - Continued addressing issues identified by EMIB
    - Functional Specification for entry facilities (later to become IGEM/TD/16)
    - Gas quality monitoring according to risk assessment (GQ/8)
    - Enrichment of biomethane or blending to avoid consumer billing issues
    - Class exemption on oxygen limit within Gas Safety (Management) Regulations
    - Siloxanes projects sponsored by GDNs
UK experience of non-conventional gas injection

- Timelines
  - May 2014
    - Commercial Renewable Heat Incentive (RHI) (originally started in 2011) extended to additional technologies, including biomethane
    - Available for 20 years; income from RHI is not taxed
Biomethane injection projects

Biomethane projects per year 2010-2015

Source: CNG Services Ltd
Biomethane injection projects

Biomethane projects per year 2010-2015

5-18% UK gas demand
15-48% residential gas demand
(source: National Grid)

Source: CNG Services Ltd
Process routes to biomethane

- **Production**
  - Anaerobic digestion
    - Variety of feedstocks
      - Agricultural - (energy) crops
      - Agricultural - waste
      - Water treatment
      - Municipal waste
      - Landfill?
    - Biogas: $\text{CH}_4$, $\text{CO}_2$, inerts, contaminants
  - Gasification with steam/oxygen
    - Bio-syngas: $\text{CO}$, $\text{H}_2$, inerts, contaminants

- **Production** ➔ **Upgrading and purification** ➔ **Grid Entry**
Process routes to biomethane

- **Upgrading and purification**
  - Anaerobic digestion
    - Upgrading - removal of CO₂
    - Purification - removal of contaminants
  - Gasification with steam/oxygen
    - Purification - removal of contaminants
    - Upgrading - (water gas shift +) methanation

Production → Upgrading and purification → Grid Entry
Process routes to biomethane

- Grid Entry
  - Pressure and flow management
  - Metering
  - Enrichment of calorific value
    - Commercial propane
  - Gas Quality monitoring
    - Measurement risk assessment
  - Odorant addition
    - Imparts odour
Biogas upgrading technologies

- Removal of carbon dioxide
  - Water wash - used initially
  - Solvent wash
  - Membranes
  - Pressure-swing adsorption (PSA)

- Removal of hydrogen sulphide
  - Within AD process to suppress H2S content of biogas (O2/air injection; ferric chloride)
  - Absorption systems for final H2S removal (active carbon bed)

- Removal of contaminants
  - Absorption systems (active carbon bed)
Biogas upgrading technologies

- All technologies appear to have been employed
- Each technology has advantages and disadvantages
- Competitive market is now established, so price is significant factor

![Gas upgrading technologies](chart.png)

Based on DLC GQ/8 workshops
Parties involved

Producer
- Production

Delivery Facility Operator
- Upgrading and purification
- Grid Entry

Gas Transporter
- Grid
Parties involved

Delivery = Facility Operator

Production → Upgrading and purification → Grid Entry

Gas Transporter may own equipment

Grid
Regulatory drivers

Producer
Production

Delivery Facility Operator
Upgrading and purification
Grid Entry

Gas Transporter
Grid

EP(EW) Regulations Environmental Permitting (EA)

GCOTE CV billing (OFGEM)

GSMR Gas quality (HSE)
Commercial drivers

Network Entry Agreement

Producer
- Production

Delivery Facility Operator
- Upgrading and purification
- Grid Entry

Gas Transporter
- Grid

Gas Shipper/Supplier

Consumer

£
Commercial drivers

Network Entry Agreement - where Gas Quality (and CV) is specified

Producer
- Production

Delivery Facility Operator
- Upgrading and purification
- Grid Entry

Gas Transporter
- Grid
Measurement risk assessment

- Based on National Grid’s Management Procedure T/PM/GQ/8
- Made available to and adopted by other GDNs as part of ENA biomethane roundtable
- Structured workshop to make semi-quantitative assessment of measurement risks to GDN
- Recommends gas quality monitoring regime
Analytical challenges

- Biomethane projects are small scale
  - gas quality monitoring is relatively expensive
- Measurement risk assessment
  - Minimum monitoring (commensurate with legislative and commercial risk to gas transporter)
Analytical challenges

- Biomethane projects are small scale
  - gas quality monitoring is relatively expensive
- Measurement risk assessment
  - Minimum monitoring (commensurate with legislative and commercial risk to gas transporter)
- Balance of process instrumentation and off-line analysis
  - Technology, cost and accuracy
Analytical challenges

Parameter
- Calorific value, interchangeability parameters (Wobbe index, ICF, SI)

Challenge
- Cost reduction
  - Existing technology is online GC
  - Scope for inferential devices
  - Ofgem have relaxed CV accuracy requirements
Analytical challenges

Parameter
- Calorific value, interchangeability
- Contaminants (except H2S)

Challenge
- Cost reduction
- Risk assessment - offline analysis
  - Agree and manage sampling regime
  - Online monitoring preferred by gas transporter
- Complexity - range of species
  - Sulfur species
  - VOCs, higher hydrocarbons
  - Siloxanes
Siloxanes

- DNVGL (Netherlands) report is available in the public domain
- Limits based on three appliance impact considerations were suggested:
  - 0.135 mg.m\(^{-3}\) (as Si) to avoid failure of ionization probe of domestic gas appliances after 15 years operation.
  - 0.015 - 0.077 mg.m\(^{-3}\) (as Si) leading to 2-10% loss of thermal output from domestic gas boiler after 15 years operation.
  - 10.6 mg.m\(^{-3}\) (as Si) leading to 1000 ppm mol/mol of CO in flue gas of domestic gas boiler after 15 years operation.
- Loss of thermal output impacts at the lowest level:
  - 7% loss corresponds to around 0.05 mg.m\(^{-3}\) (as Si).
  - However, this presents problems regarding detection...
Siloxanes

- Impacts would be seen at 0.08 mg.m\(^{-3}\) (as Si)
- Typical NEAs currently specify 0.4 mg.m\(^{-3}\) (as Si)
  - Compromise, because of typical detection limits of laboratory GC-MS systems
  - Demands that there is some mitigation by dilution with natural gas
- Online systems being assessed by NPL
  - Quoted LDLs suggest the technology may offer a promising online solution...
  - ...provided cost is acceptable
## Analytical challenges

<table>
<thead>
<tr>
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<tbody>
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<td>Agree best practice for sensor-based technology to ensure traceability</td>
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Summary of UK experience

- Financial incentives have stimulated rapid growth of biomethane projects
  - Appearance of competition for supply of key equipment and services
  - Financial viability as subsidies decrease?

- Gas quality issues are being managed...
  - Gas upgrading technologies are now readily available
  - IGEM standard for network entry facility (IGEM/TD/16)
  - Low calorific value of biomethane requires enrichment or blending
    - Enrichment cost and feasibility of blending influence viability
  - Some requirements can be mitigated by risk assessment (e.g. total sulphur, hydrocarbon dew temperature)

- Producer - Gas Transporter “tension”