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

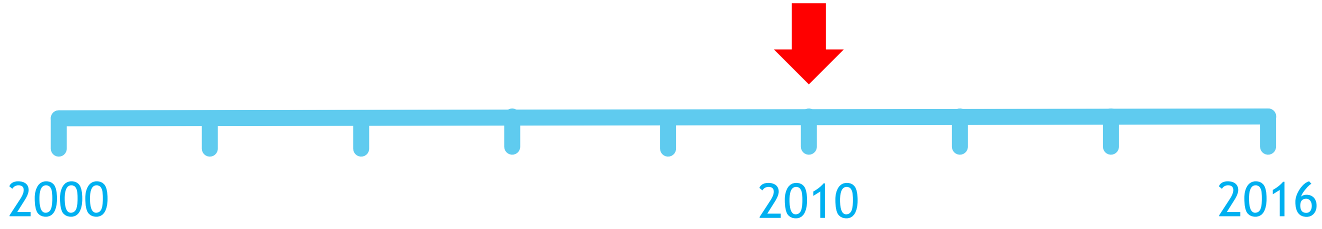
- Experience
  - Natural gas quality (technical, policy, strategy)
  - Biomethane (technical, policy, strategy)
- UK representative for groups developing a number of ISO and CEN standards
  - ISO6974 – analysis of natural gas
  - ISO6976 – calculation of properties from composition
  - EN16726 – Gas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

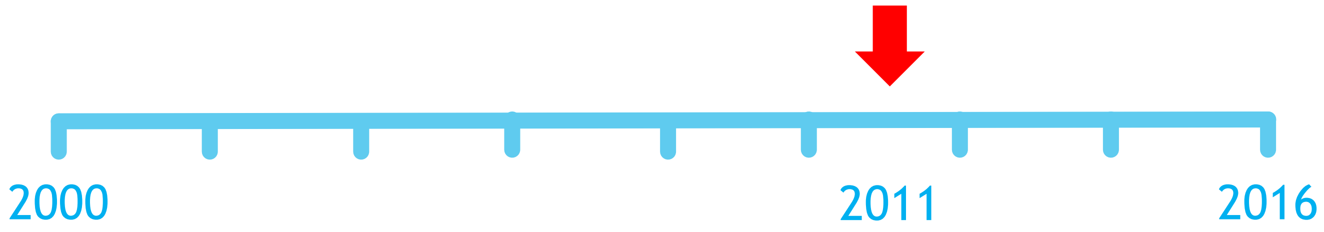
UK experience of non-conventional gas injection

- 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



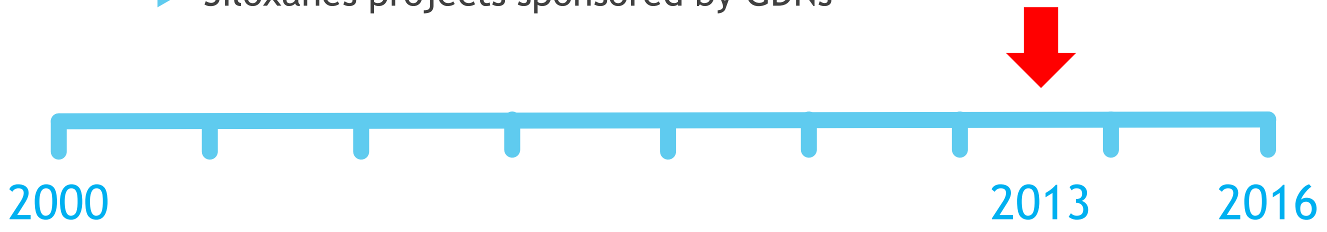
UK experience of non-conventional gas injection

- 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)



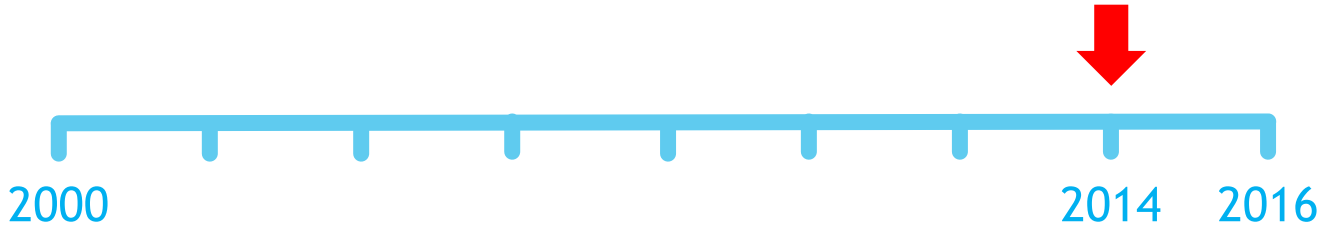
UK experience of non-conventional gas injection

- 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

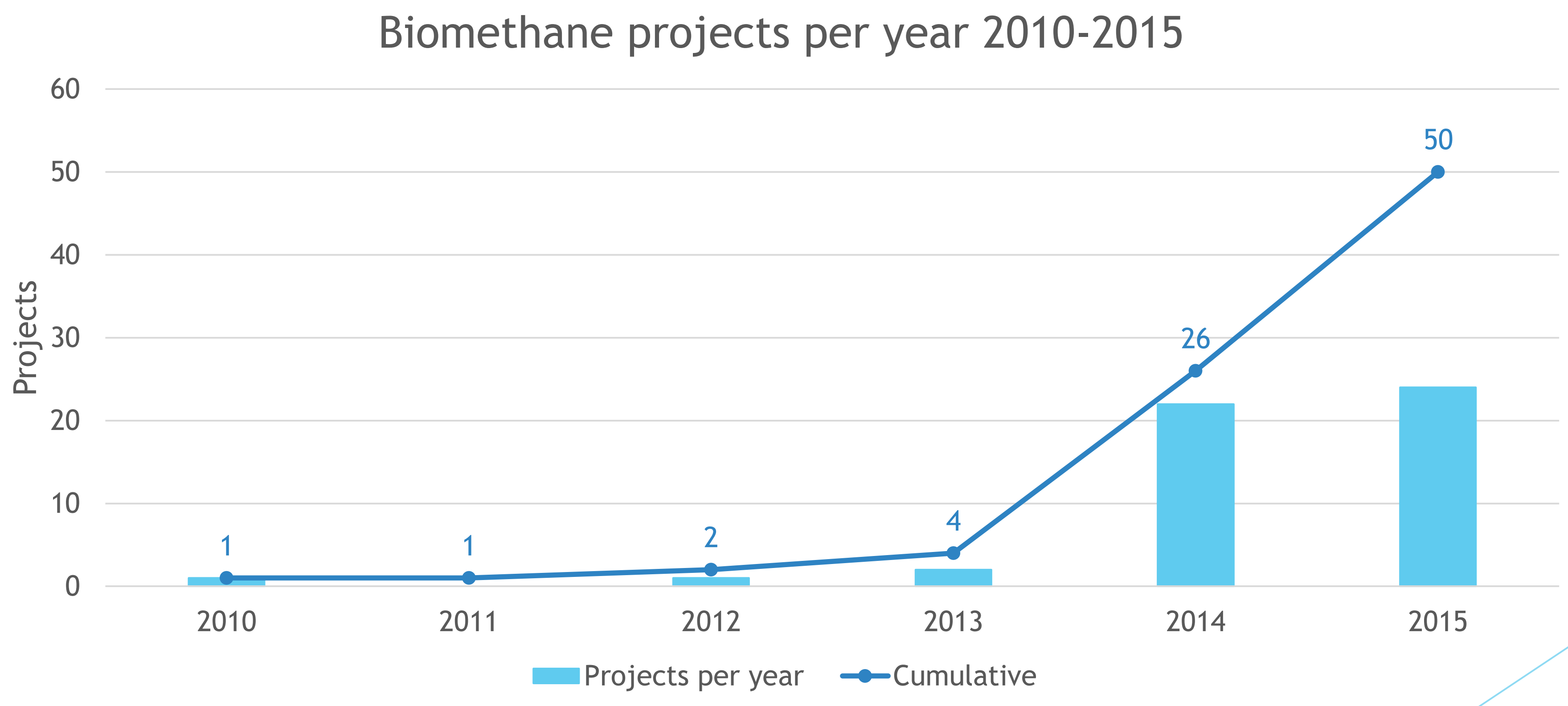


UK experience of non-conventional gas injection

- 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



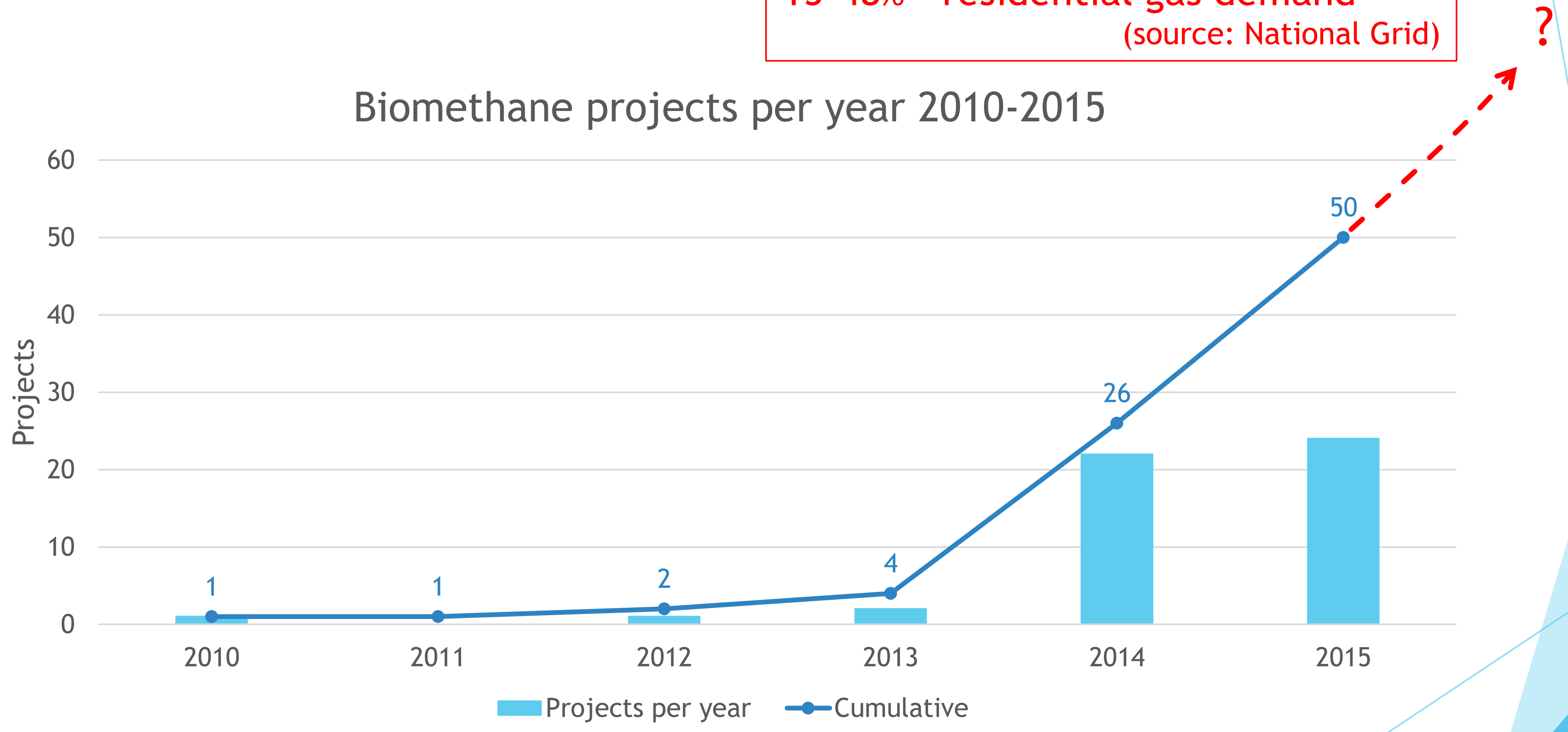
Biomethane injection projects



Source: CNG Services Ltd

Biomethane injection projects

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: CH_4, CO_2, inerts, contaminants
  - Gasification with steam/oxygen
    - Bio-syngas: CO, H_2, inerts, contaminants

Process routes to biomethane

- Upgrading and purification
  - Anaerobic digestion
    - Upgrading – removal of CO_2
    - Purification – removal of contaminants
  - Gasification with steam/oxygen
    - Purification – removal of contaminants
    - Upgrading – (water gas shift +) methanation

Process routes to biomethane

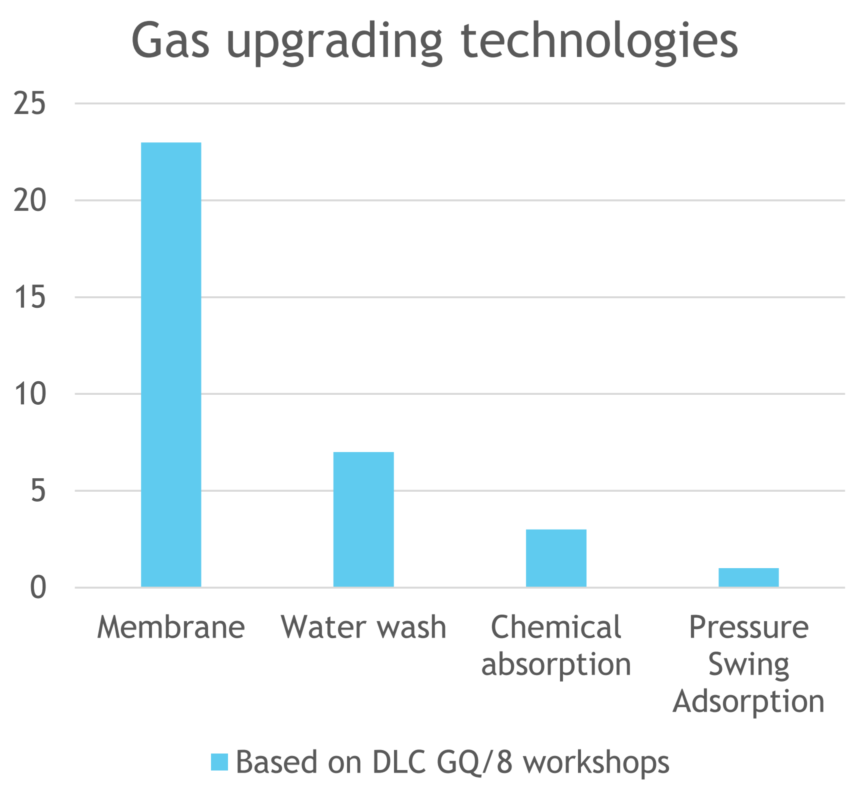
- Grid Entry
  - Pressure and flow management
  - Metering
  - Enrichment of calorific value
    - Commercial propane
  - Gas Quality monitoring
    - Measurement risk assessment
  - Odorant addition
    - Imparts odour

Biogas upgrading technologies

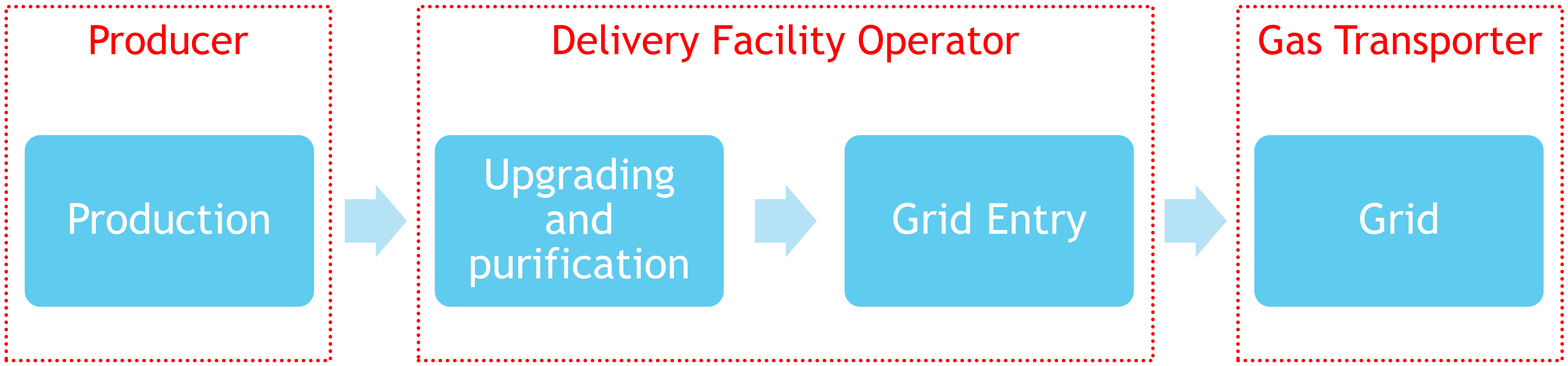
- Removal of carbon dioxide
  - Water wash – used initially
  - Solvent wash
  - Membranes
  - Pressure-swing adsorption (PSA)
- Removal of hydrogen sulphide
  - Within AD process to suppress H_2S content of biogas (O_2/air injection; ferric chloride)
  - Absorption systems for final H_2S removal (active carbon bed)
- Removal of contaminants
  - Absorption systems (active carbon bed)

Biogas upgrading technologies

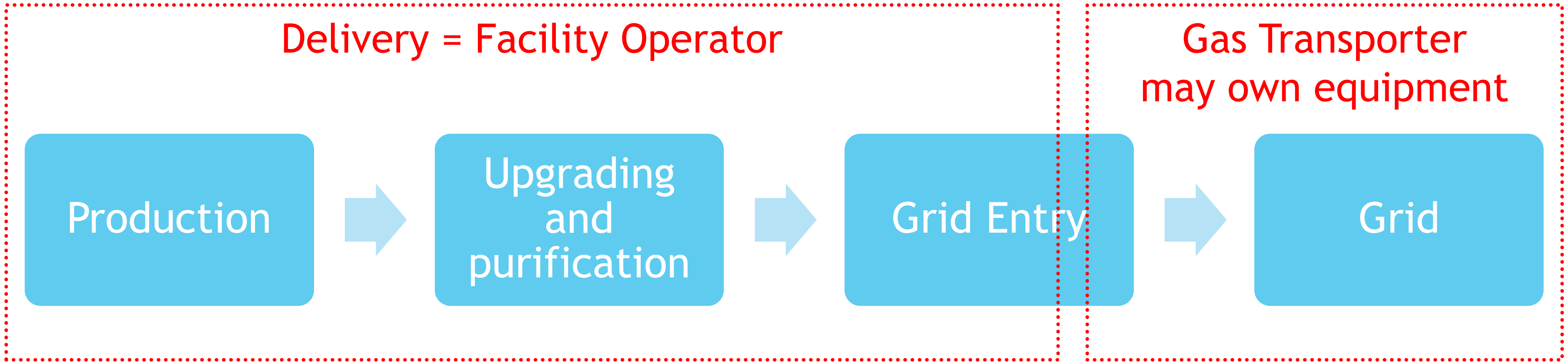
- All technologies appear to have been employed
- Each technology has advantages and disadvantages
- Competitive market is now established, so price is significant factor



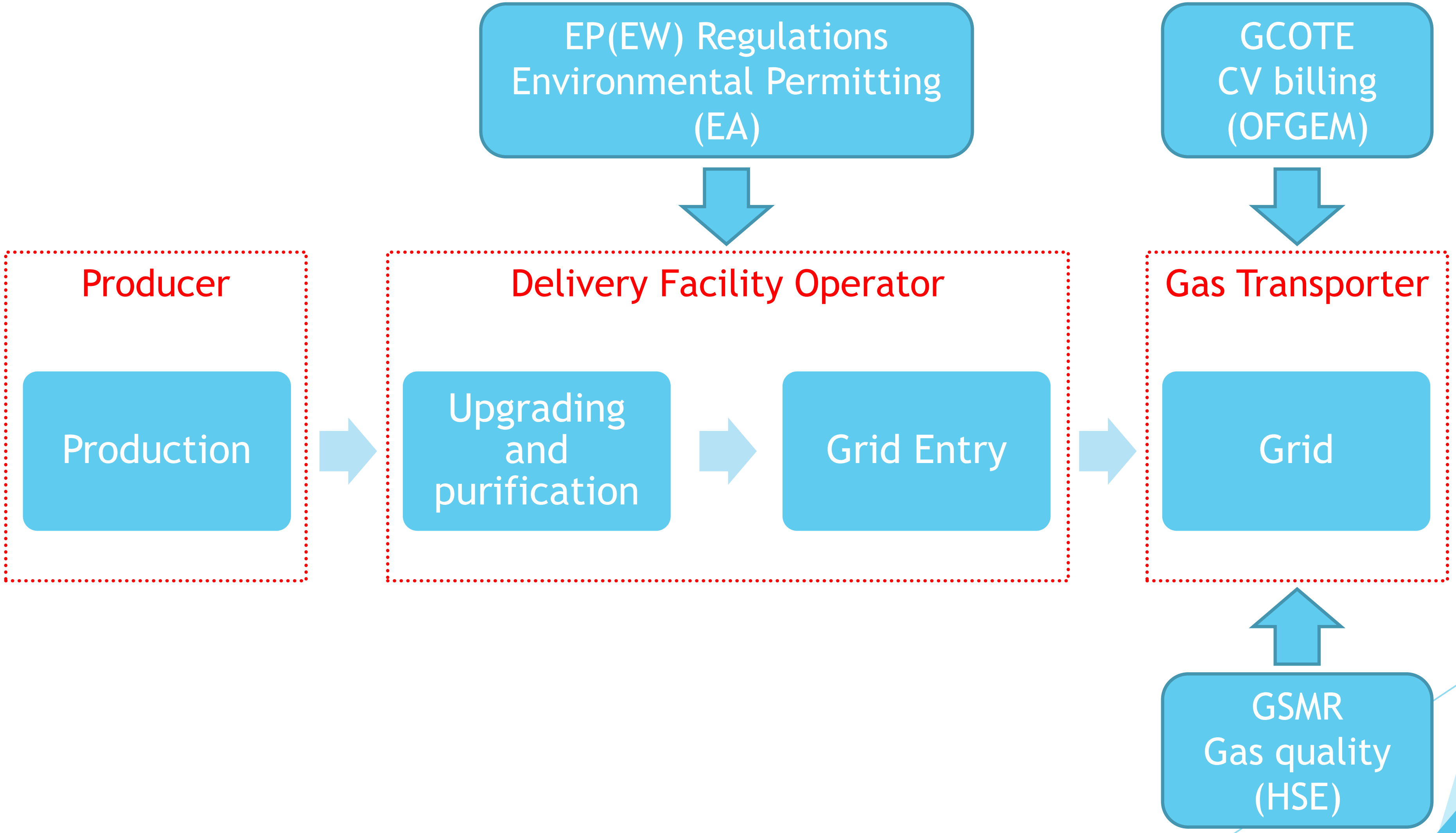
Parties involved



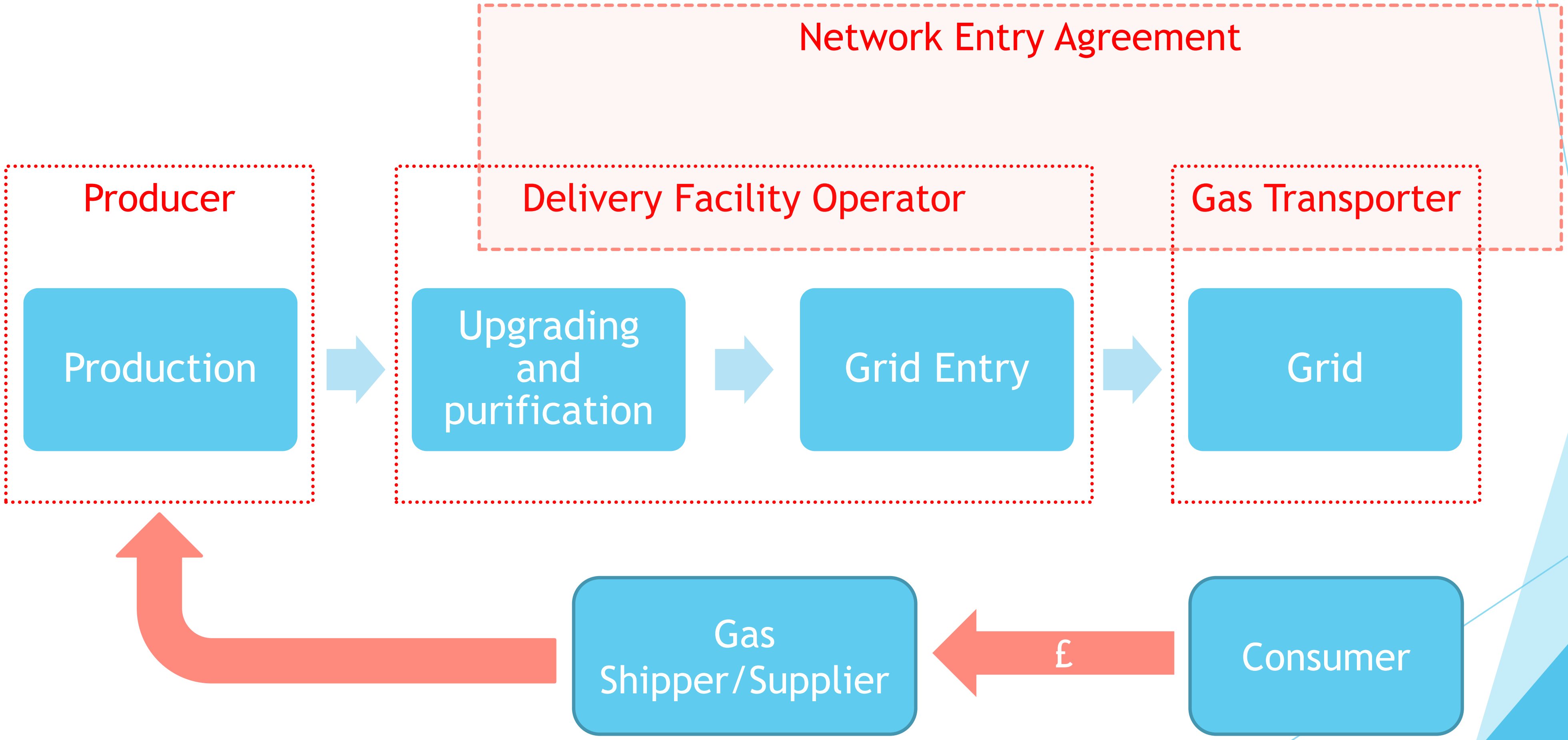
Parties involved



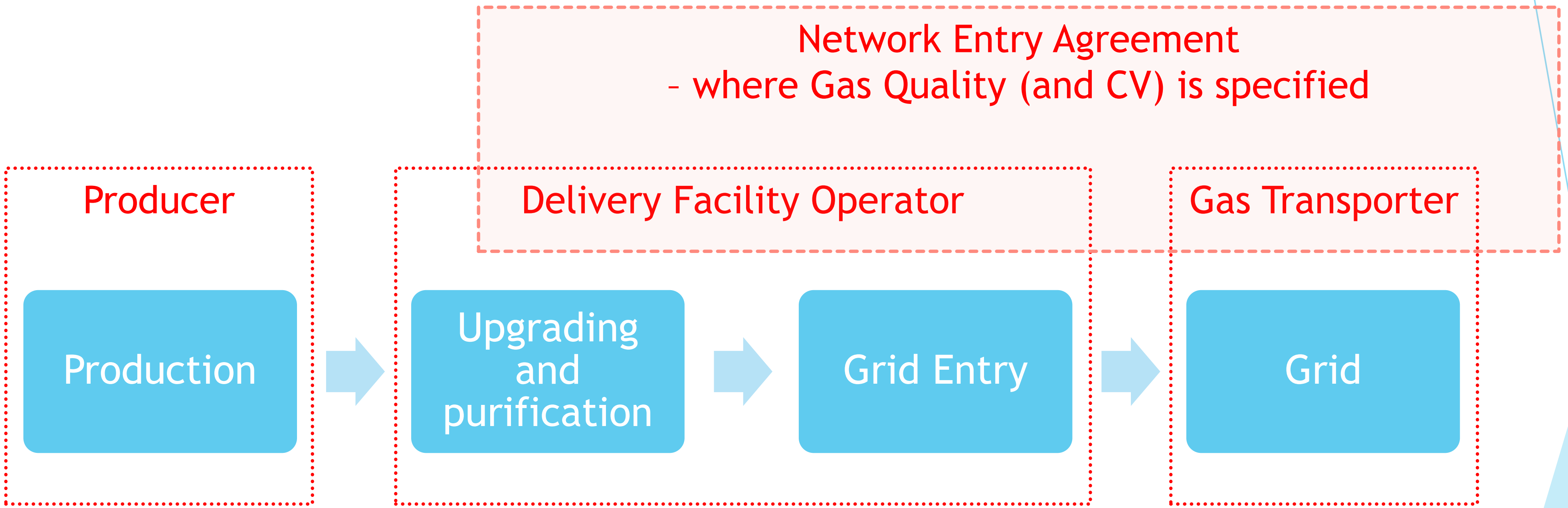
Regulatory drivers



Commercial drivers



Commercial drivers



Measurement risk assessment

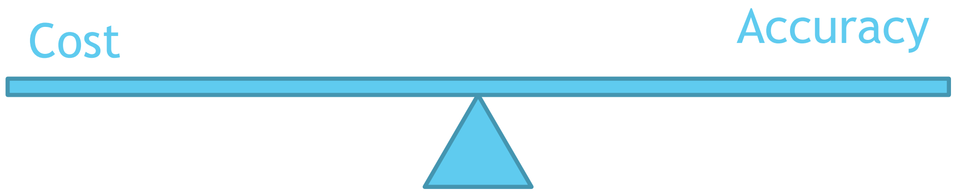
- Based on National Grid's Management Procedure T/PM/GQ/8
- Made available to and adopted by other GDNs as part of ENA biomethane roundtable
- Structured workshop to make semi-quantitative assessment of measurement risks to GDN
- Recommends gas quality monitoring regime

Impact

likelihood	1	2	3
1			
2			
3			
4			

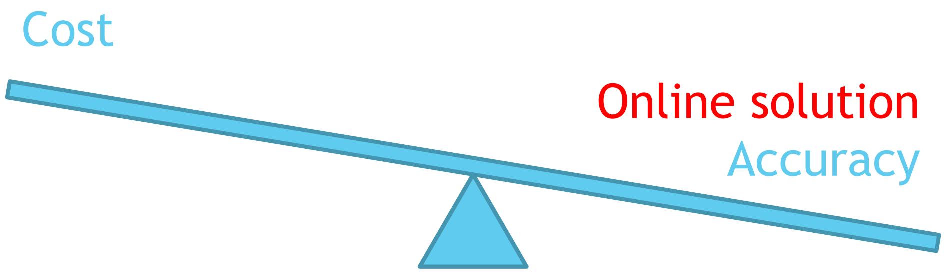
Analytical challenges

- 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

Parameter

- Calorific value, interchangeability
- Contaminants(except H2S)

- Water dew temperature

Challenge

- Cost reduction
- Risk assessment – offline analysis
- Complexity – range of species
- Agree best practice for sensor-based technology to ensure traceability

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”