Past and Prospective Developments in Gas Networks in Britain

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Low carbon pathways to 80% GHG cuts by 2050 suggest need to go from gas as heating fuel, to:
- Electric heat pumps, biomass boilers, etc; and
- Gas decarbonisation (CCS; biogas; inject/convert to H2)
- Low-pressure gas mains networks might need decommissioning by 2050

But shale gas offers pressures to maintain/expand role

So how has the industry changed in the past?

What insights for the future from past transition experiences?

Five main transitions in UK gas industry since its origin in early 1800s

And a sixth low carbon transition…
Outline: origins and transitions

- Originating the British Gas regime (1792-1812)
- 1st Transition: 1812-1877 – essentially market-led
- 2nd Transition: 1877–1914 - broaden services, expand customer base, cut costs & raise quality
- 3rd Transition: 1915-1945 – growth, fragmentation & ‘incoherence’
- 5th transition: 1978 – 2008 – return to the market
- 6th Transition: 2008-2050 – low carbon…
- The future for natural gas?
Originating the British Gas regime (1792-1812)

- Tomory: coal gas lighting industry developed as offshoot of existing technological tradition: distillation
  - charcoal, tar, coke, gases obtained from heating wood/coal in closed ovens with limited oxygen
- Gaslight inventors used knowledge, techniques, instruments borrowed from ‘pneumatic chemistry’ (Beddoes/Watt)
- UK gaslight take off helped by British scientific knowledge, mechanical skills & growing coal-based economy
- 1790s experiments: Lebon; Murdoch (Boulton & Watt)
  - Paris, 1801: Lebon shows *Thermolamp*; B & W respond
  - 1805: B & W installs at large industrial scale in Phillips & Lee’s textile mill, replacing 3,000 candles
- B & W built numerous stand-alone plants 1807-12
  - Also Clegg & others; B & W lost interest after 1812
Originating the regime: B & W’s achievement

- Transformed an idea into a working *industrial scale* technology, deployed in many big mills
- Drawing on wealth of technical skills & experience, own & from supply chain, in iron working & pneumatic apparatus
- Much help from Phillips & Lee - development partners, spent much - enabled full-scale plant testing
- B & W could access large resource pool, allowing them to
  - Experiment & scale up (£5000 of R &D)
  - Promote technology via network of big industrial customers
  - Publicise as trustworthy, economically attractive innovation (Murdoch’s 1808 Royal Society medal), as with steam
- Trained many craftsmen & engineers across the industry, including Clegg (key role in 1st Transition)
The Market-Led 1st Transition: 1812-1877 (i)

- From distributed standalone model to urban *piped network*
  - Led by German merchant Frederick Winsor – visited Lebon
  - 1806: launched National Light and Heat Co.; Parliamentary Bill opposed by B & W 1908 (Murdoch Royal Society Paper)
  - 1809: joint stock company sought & failed to get Act of Parliament
- Gas Light & Coke Company (Act passed 1810, chartered 1812)
  - World’s first public gas supply company, focused on *gas sales*
  - Built path-breaking, integrated, tightly-coupled *network* in London, before railways
  - Drew on experience, legal forms & models of existing networks (water supply & canals)
  - Led to networked urban infrastructure
  - By big company, making gas in a few big gasworks
  - Distributed through a network of mains
  - Not fully integrated until after 1814 restructuring (Clegg)
Rapid spread of gas supply networks in Britain
- London: 30 miles of mains by 1815, 120 miles by 1820
- 1826: networks in almost all towns of >10,000 people
- 1829: 200 companies

Private and Public Ownership
- Increasing moves towards municipal ownership from 1840s
- Chamberlain’s municipal socialism reforms 1873-75

Gas produced one of the first modern MNCs
- 1826: Imperial Continental Gas Association
- Set up operation in several European cities (Berlin, Ghent…)
The Market-Led 1\textsuperscript{st} Transition (iii)

- Market-led transition
  - But the state enabled environment where inventors (patents), manufacturers & entrepreneurs (finance) flourished (Mokyr)

- Growing concerns about
  - Quality & reliability; disruption of streets & pavements; exercise of local monopoly power; regulatory tension: shareholder earnings versus consumer prices (Daunton)

- \(\Rightarrow\) Regulation: Gasworks Clauses Acts
  - 1847: dividend control
  - 1871: obligation to supply all consumers on demand

- Professionalisation: Gas Institute founded 1881

- By 1882, 490 private or municipally-owned firms
  - Seeking profits or net revenue for local treasuries
2nd Transition: 1877–1914: broaden services, expand customer base, cut costs & raise quality

- The creation of new markets, in a market-led transition
  - Pressures: low load factors; poor customer perceptions; monopoly power concerns; new competition from incandescent electric light from 1880 (Swan & Edison)

- Responses:
  - Extend & promote services to heating & cooking (exhibitions & ‘lady demons’)
  - Broaden customer base (hire purchase & pre-pay slot meters)
  - Cut costs/raised quality by eventual use of efficient Welsbach incandescent mantles (4-6X illumination)

- Outcomes
  - By 1914: wider services; growing working class users; customers tripled to 7 million
Transition Pathways & Branching Points

- **Transition Pathways**
  - reflect decisions by interacting actors along them, as well as the dominant *logic* (e.g. market or state logic) & technology

- **Branching Point**
  - Key decision point where actors’ choices, in response to internal or external pressures, affect whether pathway is reinforced or branches

- Pathways & branching points are emergent properties
  - Actors may not consciously pursue a pathway but address particular challenges as they arise

- **Path dependence literature**
  - Suggests earlier choices may constrain later choices

- Branching points for two phases of the gas regime
  - To be extended to the other transitions
## Branching Points in the 2\textsuperscript{nd} Transition, 1877–1914

<table>
<thead>
<tr>
<th><strong>Choices made at branching points</strong></th>
<th><strong>Outcome for Transition Pathway</strong></th>
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<tbody>
<tr>
<td><strong>Branching point 1: Perceived need to promote and increase the range of energy services supplied by gas</strong></td>
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<tr>
<td>To organise trade exhibitions to promote gas appliances (ca. late 1870s)</td>
<td>Start of increased emphasis on advertising &amp; promotion of appliances – shift towards supplying more varied services</td>
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<tr>
<td>To organise the 1882-3 gas exhibition</td>
<td>Increased emphasis on advertising amongst undertakings</td>
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<tr>
<td>To introduce hiring of appliances (widely taken up in 1880s)</td>
<td>Continued the shift towards more varied services</td>
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<td><strong>Branching point 2: Perceived need to broaden the customer base</strong></td>
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<tr>
<td>To introduce prepayment meters (from 1889)</td>
<td>Shifted regime to broaden customer base; continued shift to more varied services</td>
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<tr>
<td><strong>Branching point 3: Perceived need to compete on price and quality</strong></td>
<td></td>
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<tr>
<td>To introduce incandescent gas mantles (from 1898)</td>
<td>Strengthened competitive position of gas light, so regime continued to supply this service</td>
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<tr>
<td>Jointly mounting a legal fight against the holder of the British Welsbach mantle patent (1901)</td>
<td>Strengthened competitive position of gas light, so stayed in lighting market</td>
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**Source:** Arapostathis et al. 2013; Foxon et al. 2013, Transition Pathways Project.
3rd Transition: 1915-1945 – growth, fragmentation & ‘incoherence’

- By late 1930s: largest European gas industry (11 million customers) but precariously competitive
- Industry fragmented: uncoordinated relative to electricity & with many small scale firms; no national gas grid
- By World War II, 800 private & municipal firms
  - Supplying town gas from coal in > 1000 gas works
- 1941: senior industry figure called it ‘incoherent’; must
  - With an increasingly expensive feedstock (coal)
  - Struggling to compete with electricity in the home & with coal, coke & oil in commerce & industry
  - Must expand or be left with ‘limited & costly supply of gas’ to sell

This set the scene for the 4th transition

- 1945: post World War II Labour Government
- 1948: nationalisation, reorganisation & new processes
- State-owned company, led by Gas Council, rationalised industry structure with 8 Area Boards & vertical integration
- Accepted need to respond to competition & cost challenges
  - Promoted central & space heating services
  - Experimented with three niche technologies
    » Lurgi coal gasification (2 plants built)
    » Reforming oil fractions: ‘oil gas’ cut costs of gas by half (gas became cheapest domestic heating fuel);
    » Imported LNG from 1963 (new pipeline to deliver re-gasified Algerian LNG at high pressure to Area Boards)
  - 1960-65: sales grew by one third
  - 1965: coal gas 50%, oil gas 42%, LNG 8%
4th Transition (ii)

- **1965**: major North Sea gas discoveries
  - British Gas had right to buy all British sector gas
- **1966**: bold move to new-found North Sea natural gas
  - Reorganised industry & its actors
  - Built LNG terminals & national gas grid from the LNG ‘backbone’ pipeline
  - **1967-77**: challenging national conversion programme
    - 2X higher calorific value of natural gas
    - Modified appliances in 13 million homes & 440,000 commercial & industrial premises by 1977
  - Halved cost of gas once more
  - **1966-77**: sales rose nearly 400%; price per therm down 16% in nominal terms
## 4th Transition: Branching Points in the State-led Transition to Natural Gas, 1948–1977

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<th><strong>Choices made at BP</strong></th>
<th><strong>Outcome for the Transition Pathway</strong></th>
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<tr>
<td><strong>Branching Point 1: Perceived need to cut cost in response to pressures from coal costs &amp; competition from electricity, coal &amp; oil</strong></td>
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<tr>
<td>Promotion of central &amp; space heating (1960s)</td>
<td>Reinforcement of incumbent regime, creation of new markets; increase pressures on production side, esp. for Metropolitan Boards</td>
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<tr>
<td>Introduction of Lurgi process (1960s)</td>
<td>Niche technology for local problems. Internal adaptation, renewal &amp; reconfiguration</td>
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<tr>
<td>Introduction of oil gasification processes (1960-1970)</td>
<td>Re-alignment of the regime/dominant technology in the late 1960s</td>
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<td>Early experimental LNG transportation (1957-1960)</td>
<td>Experimental phase important for enrolment of key actors to wider scale use of LNG</td>
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<tr>
<td>LNG pipeline (1961)</td>
<td>Niche technology for local problem &amp; critical infrastructure. Pathway reconfiguration through hybridisation</td>
</tr>
<tr>
<td>North Sea Exploration and search for natural gas (mid 1960s and 1970s)</td>
<td>Landscape pressure on the incumbent regime. Technological substitution</td>
</tr>
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| **Branching Point 2: Perceived opportunity to respond to the discovery of North Sea gas** |  |
| Gas Council monopsony in UK nat. gas regime (mid 1960s) | Reinforced the centralisation of the regime & the state-led transition |
| Conversion designed as single operation without intermediate phase or period (1966) | Conversion to natural gas (1967-1977). Facilitated & provided a fast pace to the ‘technological substitution’ |
| Pilot Schemes for local conversion (1967-1977) | Facilitated ‘technological substitution’: developing expertise & enrolling new actors; persuading general public to support new regime. |
| ‘Guaranteed Warmth’ campaign (1969) | Important for the enrolment to the new regime |
| Commissioning of the Morton Report (1970) | Important for the enrolment of new actors (the general public) |
| Gas Act 1972 | Reinforced centralisation of the regime & the state-led transition |

*Source: Arapostathis et al. 2013, Foxon et al. 2013, Transition Pathways Project*

- State-led nature of transition to natural gas enabled
  - Close co-ordination of actors
  - To achieve transition that govt. & industry actors agreed to be socially beneficial
  - Imposed change on initially reluctant consumers, e.g. householders

- At key earlier points, system
  - Recognised challenges
  - Resourced & undertook reorganisation & R & D
  - Encouraged niche experimentation – explored options
  - Worked effectively with government & were supported
  - Took & managed risks of natural gas conversion
  - Stranded costly town gas production assets
5th transition: 1978 – 2008 – return to the market

- **Landscape pressures: geopolitics & ideology**
  - 1970s oil price shocks
  - Free market economics & liberalisation (Hayek; Friedman)

- **1979: Thatcher Conservative government – free market ideology; privatisation agenda**

- **1987: UK’s 1st major energy privatisation**
  - British Gas sold as vertically integrated *monopoly* in transmission, distribution & supply of gas
  - New regulator appointed
  - Gradual unbundling & competition: British Gas ‘demerged’ 1997 (Centrica/ Transco)

- **From 1998: internationalisation**
  - Interconnectors to Belgium, Netherlands & Norwegian fields

* For more on this transition, see Arapostathis et al. (2014)
6th Transition: 2008-2050 – low carbon?

- Landscape pressure: climate change mitigation
- UK pathways to meet 80% GHG targets suggest need to go from gas as heating fuel to
  - Electric heat pumps, biomass boilers, etc.,
  - &/or gas decarbonisation (e.g. biogas injection; injection or conversion to hydrogen)
  - Low-pressure gas mains networks likely to need decommissioning before 2050
- And limited remaining gas capacity is with CCS (Figure)
- Much depends on speed/ nature of moves to renewable heat & success of CCS – neither in hands of gas industry
- But pressure from UK & international (shale) gas interests to enhance gas presence
UK Generation Capacity 2050

Figure 9.4 Total UK generation capacity in 2050 under DECC scenarios and Transition Pathways (source: Davies et al. 2013)
Gas: decline or prosper?

- From its origins, the gas industry proved remarkably resilient, able to experiment & adapt, sometimes rapidly.
- Does it – & will government & regulators - recognise & act on how it might respond to the challenge of decarbonisation?
- Much will depend on government & governance:
  - What might happen to decarbonisation pathways & signals, policies & to pursue them & CCS?
  - What forms of governance & what roles for state, market, civil society & international actors?
  - What key branching points on future pathways?
- Do we need a ‘managed’ & supported decline of the low pressure networks?
Some thoughts from the 4th transition

- 4th transition achieved radical change via centralisation & coordination of power
  - something to consider in context of strong de-carbonisation & shale gas pressures

- In a little over 30 years gas was transformed from an ‘incoherent’, inefficient industry with 800 firms, a costly feedstock & a distributed system, to
  - An integrated system with a national gas grid
  - A new feedstock, natural gas
  - A broader range of cheaper services, especially heat, & booming sales

- Not suggesting a return to old-style nationalisation
  - But experience worth reflecting on for low carbon transition, although context very different today
A ‘Master Narrative’ for Natural Gas?

- Important role & agency of visions ascribed to innovations
  - As B & W managed for steam engine & gas lighting
  - And Gas Council for move to ‘High Speed’ natural gas & national network

- Past transitions show visions helped innovators set ‘master narrative’ & meaning that mobilised more actors, influenced social practices & public policies

- If it is to adapt, the industry would need to re-invent a master narrative for natural gas in era of climate change, fossil fuel challenge & decarbonisation visions

- And what role might be played by shale gas, with the risk of path dependence & lock-in?
Thank You!
Acknowledgement & Some Sources

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