Policy Exchange

The Heat Summit

How can we decarbonise heating?

14th December 2016

Richard Howard, @RichardHowardPX

Event supported by:

EUA energy&utilities alliance

Imperial College London

#HeatSummit

Key Questions

- How can we decarbonise heat at the lowest cost and hassle to consumers?
- What are the main technology options?
- Do they differ for domestic/commercial/industrial properties?
- How do these compare in terms of: decarbonisation potential, cost, consumer acceptability, infrastructure/system requirements?
- What are the 'no/low regrets' options?
- Which options still need to be investigated further?
- What are the barriers to deployment, and how can they be overcome?
- What new policies/regulations are required?
- What should the Government say in the forthcoming Carbon Plan?
- How should the decarbonisation of heat be governed?
- Who are the key actors and what is their role?

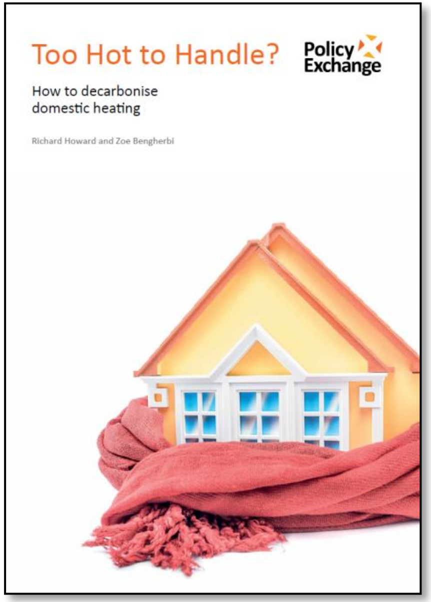
Agenda

Session 1

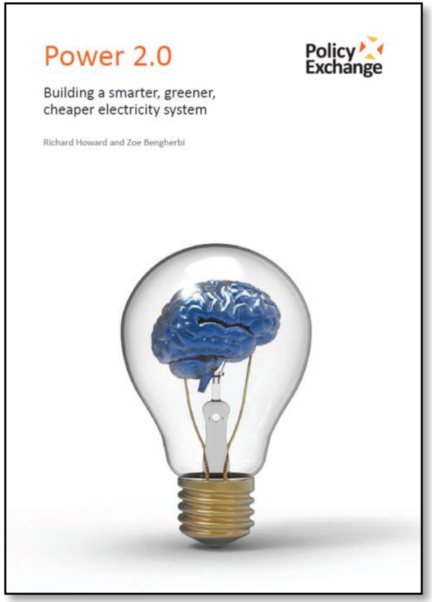
- **09:00:** Introduction by Richard Howard (Policy Exchange)
- **09:20:** Presentation by Keith MacLean & Robert Gross (Imperial College London)
- **09:40:** Presentation by Tony Glover (Energy Networks Association)
- **09:55:** Panel discussion involving the above plus Matthew Bell (CCC)
- **10:25:** Break for refreshments

Session 2

- **10:45:** Keynote speech by Baroness Neville-Rolfe
- **11:05:** Panel discussion including Alan Whitehead MP, Mike Foster (EUA), Joanne Wade (ACE), and Dan Osgood (BEIS)
- **12:00:** Event ends



https://policyexchange.org.uk/publication/too-hot-to-handle/



https://policyexchange.org.uk/publication/power-2-0

Context

- £32 billion pa spent on heat
- 48% total energy use
- 1/3 GHG emissions
- Gas heating in 23m homes

Figure 1.1: Energy consumption by end use and sector, 2013[11]

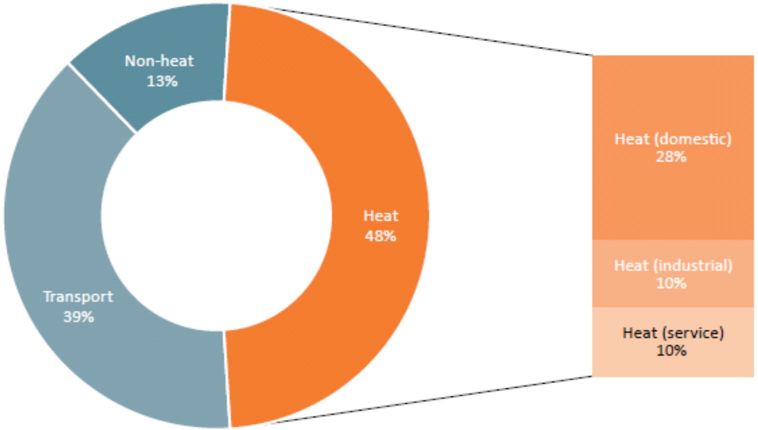
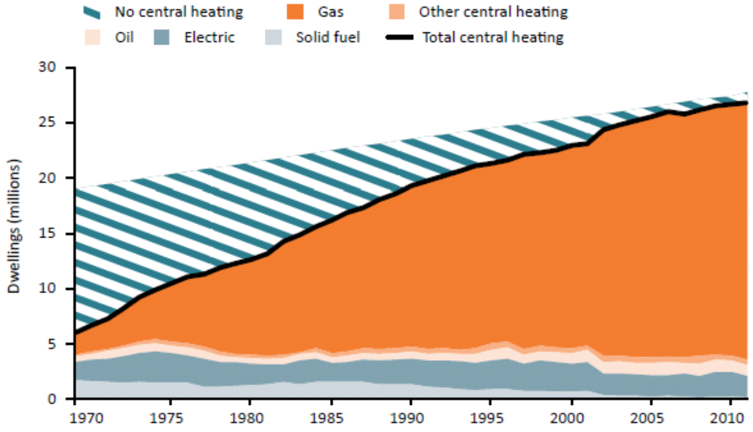


Figure 1.3: Installed central heating by type, 1970–2012



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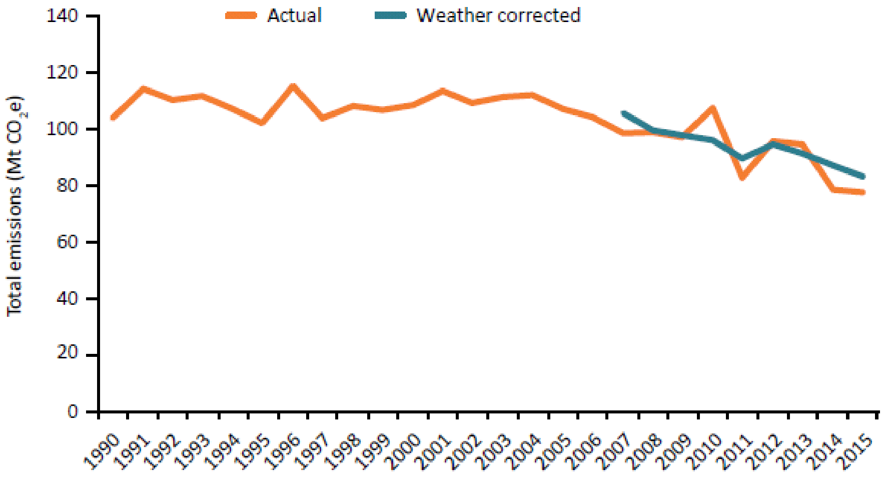
Context

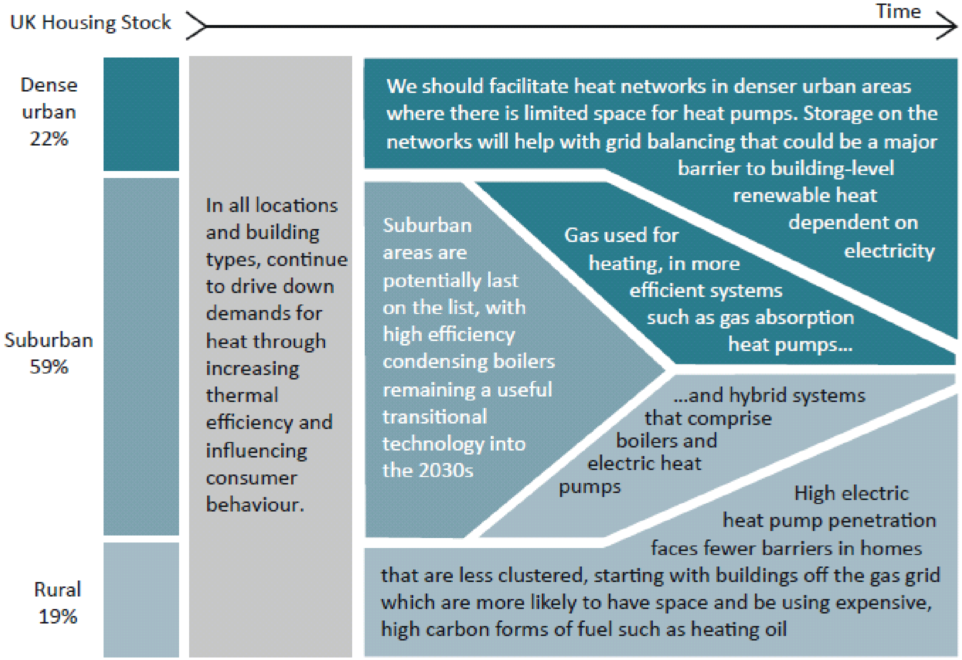
- Climate Change Act = ↓80% GHG emissions by 2050
- ↓25% domestic heat emissions 1990-2015 (↓20% weather corrected)
- ↑ # households
- ↓ heat use / household
- ↓ carbon intensity of heating fuels

Figure 1.7: Change in emissions from domestic heating (including cooking), 1990–2015



DECC Roadmaps (2012/13)

Figure 2.2: 2013 DECC Heat Strategy[67]



- 2050 mix = 85% heat pump, 10% heat networks, gas <5%
- Issues:
  - Picking winners
  - Peak demand
  - Network challenge
  - Cost/consumer
  - Supply chain

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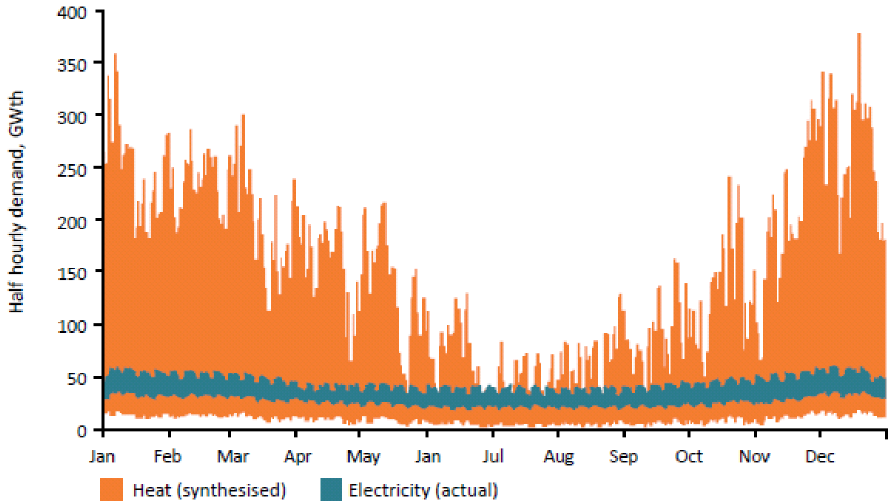
Key challenge: meeting peak demand

- Peak heat = 300GWs+
- Peak elec = c.60GW

➢ Supply challenge
➢ Network challenge

Figure 2.4: Annual heat and electricity demand profile for 2010[71]



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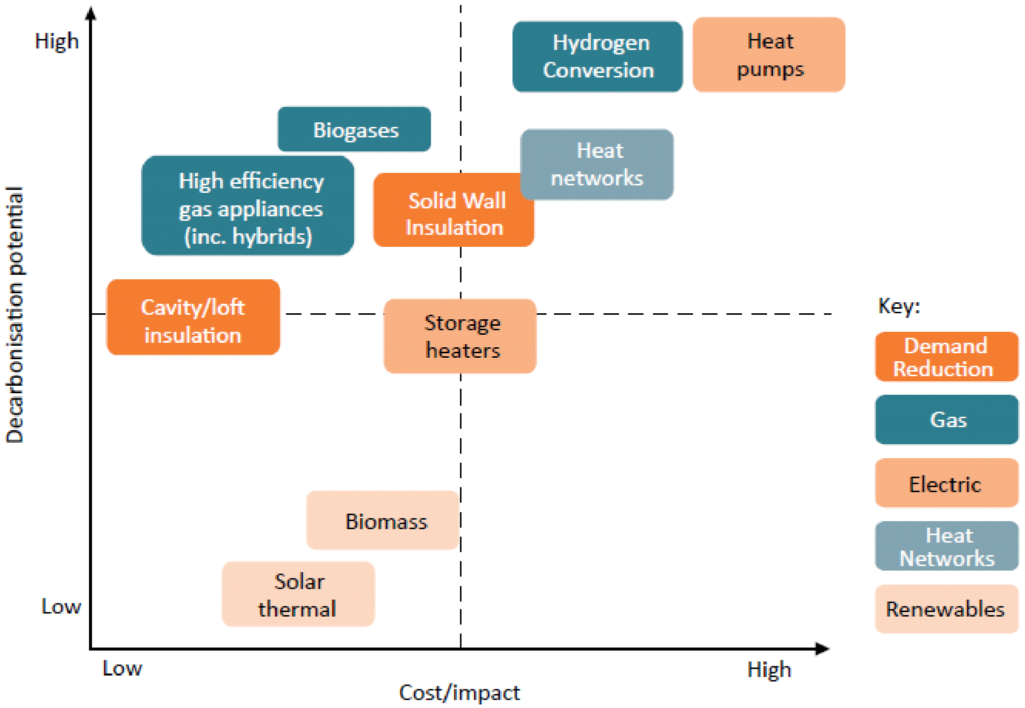
Assessment of options

- Decarbonisation potential
- Network impact
- Supply impact
- Consumer impact



Energy efficiency

Pros/potential	Cons/cost	Recommendations
• Reduce heat demand by 20% by 2050? • Low-cost measures: insulation/controls • Co-benefits: reduce fuel poverty, health benefits • No/low regret option	• Solid Wall: costly and disruptive • ↓Installation rates • Policy uncertainty • Behavioural and financial barriers	• Infrastructure priority • Efficiency standards • Link Stamp Duty to EPCs • Green mortgages • Expand fuel poverty schemes

Green gas

Pros/potential	Cons/cost	Recommendations

• High consumer acceptance
• High efficiency gas appliances (Boiler+, mCHP, GDHP, hybrid)
• Biogases
• Hydrogen conversion = ↓73% emissions
	• Limits to efficiency gains possible
	• Bioenergy availability
	• Hydrogen conversion
	  • Cost
	  • CCS requirement
	  • Disruption to home
		• Efficiency standards
		• Boiler scrappage
		• RHI: include GDHP
		• Bio feedstock - food / waste
		• Gas standards
		• Investigate hydrogen conversion

Electrification / heat pumps

Pros/potential

- Route to (near) zero carbon heat

Cons/cost

- High capital cost
- Disruption to home
- Performance issues?
- Consumer acceptance?
- Generation capacity
- Network investment
- 80% hholds = £300bn?

Recommendations

- Important role but < suggested by DECC
- Role in new builds / off gas grid
- Cap RHI tariffs (10p/kWh)
- Use carbon prices (gas vs electricity)

Heat networks

Pros/potential

- Potential 10-20% domestic heat by 2050?
- Can be as cheap as gas boiler
- Multiple heat sources. Reduce carbon over time.
- Heat storage

Cons/cost

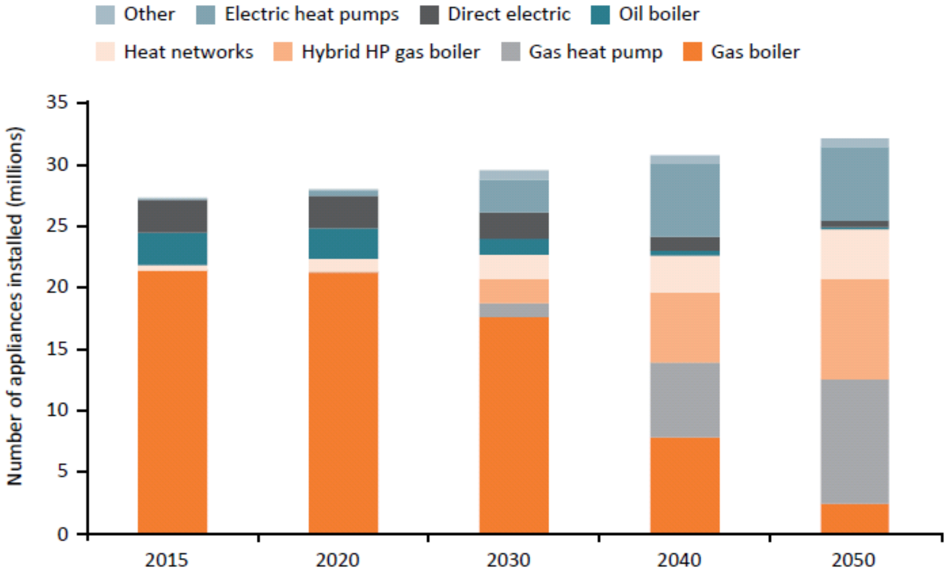
- Consumer knowledge /acceptance?
- Consumer protection?
- Cost
- How to decarbonise heat networks?

Recommendations

- Bespoke regulatory regime (Ofgem)
- Extend HNDU remit to financial close
- Use HNIP to de-risk/ future proof projects
- Wayleave / access rights

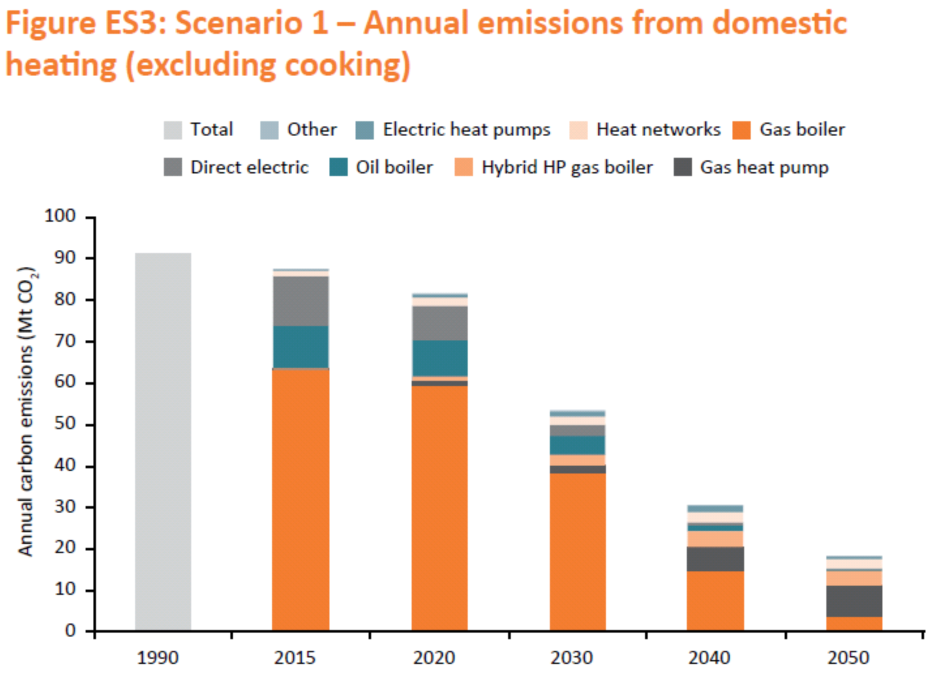
80% scenario: ‘path of least resistance’

Figure ES2: Scenario 1 – Mix of heating appliances



	2015	2030	2050
Gas boiler	21,350,000	17,600,000	2,410,000
Gas heat pump	–	1,160,000	10,150,000
Hybrid HP gas boiler	10,000	1,950,000	8,170,000
Heat networks	500,000	2,000,000	4,000,000
Oil boiler	2,600,000	1,270,000	150,000
Direct electric	2,710,000	2,110,000	550,000
Electric heat pumps	90,000	2,690,000	6,010,000
Other	50,000	790,000	680,000
Total	27,310,000	29,570,000	32,120,000

80% scenario: 'path of least resistance'



- ↓80% cut in emissions by 2050 (↓42% by 2030)
- Residual emissions mainly gas
- 90%+ cut possible but requires different tech mix – elec / hydrogen

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Govt needs a new heat strategy…

1. Long term commitment to decarbonise heat
2. Balanced approach
3. Consumer-focused
4. Avoid picking winners
5. Use carbon pricing / market signals
6. Integrate heat, efficiency, fuel poverty
7. National & localist approach
8. Tackle technology & system challenges

Heat decarbonisation - the options

Dr Keith MacLean

14th December 2016

Imperial College London

Mix of carbon reduction solutions

- Lower consumption through
  - building efficiency improvements
  - operational efficiency through e.g. district heating
- Decarbonisation of heat generation
  - repurpose gas grids with hydrogen
  - electrification (as grid carbon intensity reduces)
  - others? (bio-sources, solar thermal, geo-thermal)
- All major infrastructure investments

Study objectives

- Retrofit (20,000 properties/week over 20-25 years)
- Assess cost, impact and practicality of
  - Hydrogen in repurposed gas grid
  - Electricity
  - District heating
- For different housing types
  - Urban
  - Suburban
  - Rural
  - Flats

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Impact and cost assessment

Urban and suburban properties	Repurposed gas grids (hydrogen)	Electrification (heat pump)	District heating
Cost/impact of decarbonised heat supply			
Cost/impact of network activities			
Cost/impact of activities in customer premises			
Need for new regulation			

Urban property - networks

	Network type				
	Gas grid			Electricity	District heating
	Natural gas	Hydrogen		Heat pumps	Large heat pump
Evaluation criteria		SMR+CCS	Electrolysis		
Network investment cost (£k/home)		0.3		2	9
Homes converted per year (thousand)		1,000		400	100
Trench size (m)		N/A		1	3
Traffic and access disruption					

Urban property – consumer + regulation

	Network type				
	Gas grid			Electricity	District heating
	Natural gas	Hydrogen		Heat pumps	Large heat pump
Evaluation criteria		SMR+CCS	Electrolysis		
Criticality of energy efficiency					
Appliance costs per household (£k)		0 - 1		5 - 15	0 - 1
Household disruption					
Customer acceptance					
Visual and noise impact					
Regulation issues					

Urban property - heat supply

	Network type				
	Gas grid			Electricity	District heating
	Natural gas	Hydrogen		Heat pumps	Large heat pump
Evaluation criteria		SMR+CCS	Electrolysis		
Heat production efficiency (%)	85%	85%	85%	270%	340%
Energy supply cost (£/MWh in 2016)	50	>75	>125	130	100
Heat supply cost (£/MWh in 2016)	60	>90	>150	50	45
CCS criticality					
Seasonal storage cost (£/MWh)	30 - 80	100 - 250		> 50,000	80 - 8,000

Conclusions - hydrogen

- Feasible thanks to the ongoing programme to install new pipework in the local gas mains
- Could be used in 85% of buildings connected to the gas network
- Little additional impact on roadworks or in consumer homes
- Relies heavily on the development of new large scale, low cost hydrogen production facilities (potentially CCS)

Conclusions - electrification

- Heat pumps, can be suitable for less densely populated environments where disruption and cost can be
  - minimised for electricity system upgrades
  - kept to acceptable levels for building installation work
- Direct electric heating is suited to properties like flats in high rise buildings where
  - gas-fired boilers cannot be used
  - space heating requirements are low

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Conclusions – district heating

- Can supply heat efficiently and at low cost
- Well suited to
  - areas of mixed use with strong anchor clients
  - new developments
- Retrofit can be suitable
  - in less densely populated areas,
  - for flats in multi-storey buildings
- Suitable low carbon heat sources needed
- Benefit from regulation

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Conclusions - general

- Each solution has a role to play, but none is a silver bullet
- Big task, more manageable with
  - energy efficiency investment to reduce consumption and cost
  - an early start, good planning and preparation
  - Long-term infrastructure investment programmes
- New governance arrangements should be introduced
  - strong city and local authority level involvement
  - skills knowledge and resource will be needed
- Choice and/or the rate of deployment depend on
  - the non-cost impacts, not just simple economics
  - customer acceptance
- Coordinated pilot developments should be initiated quickly

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Links

Main report

http://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/Heat-infrastructure-paper.pdf

Annexes

http://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/icept/Heat-infrastructure-annexes.pdf

Any questions

keith.maclean@provpol.com

What works?: A systematic review of heat policy options relevant to the UK context

Dr Robert Gross
Imperial College and UKERC

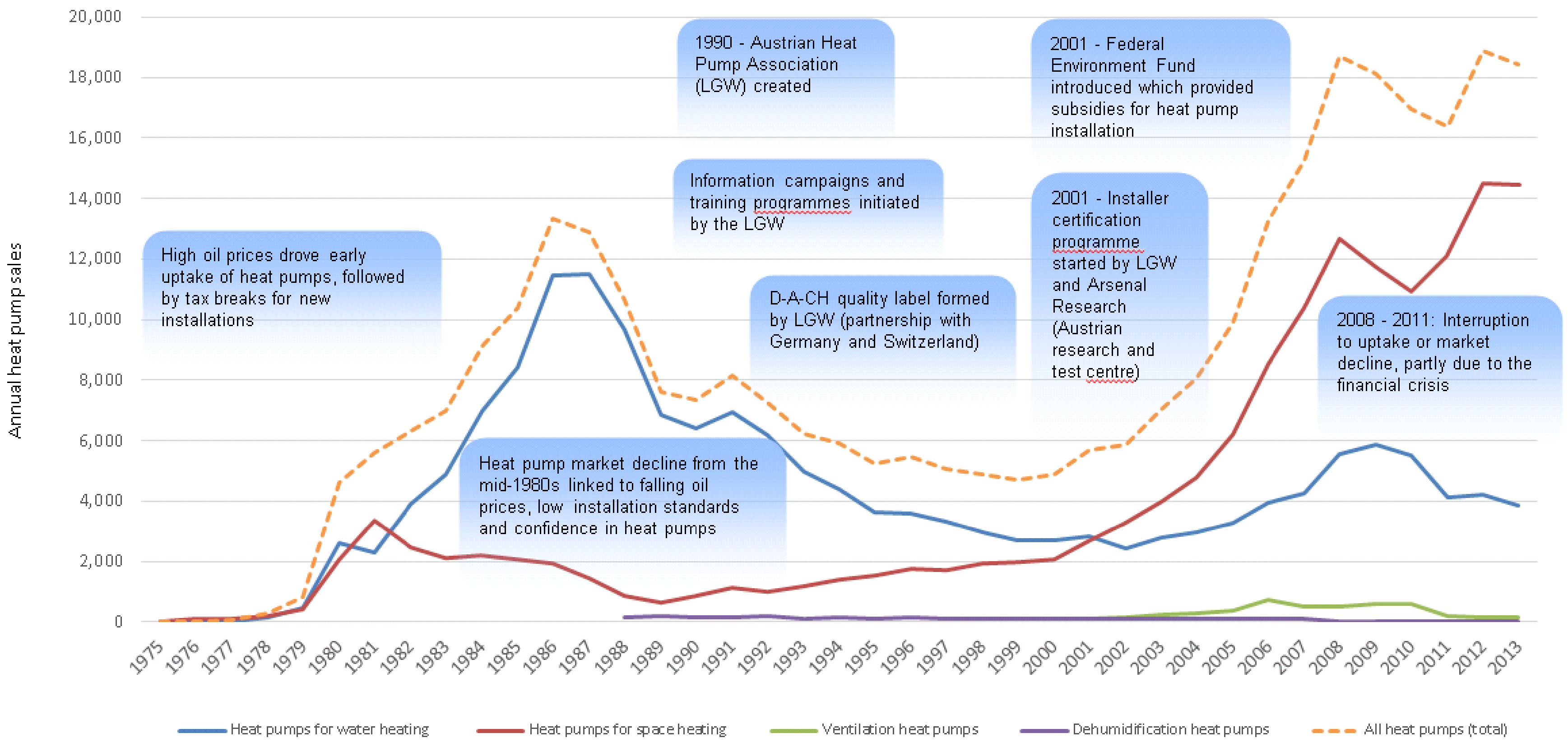
Overarching research question:

What policies/other factors have driven change/transformation in heat delivery technologies, fuels and infrastructure?

- What factors determine the success of the policy (barriers, other regulatory issues, market structure and historical factors)?
- What is the impact of external factors (fossil fuel prices, heat density, resources)?
- Who are the agents of change (local/national govt, utilities, consumers, others)?
- Would this policy (or aspects of the policy) work within the contemporary UK energy market context?
- What are the lessons for UK policy?

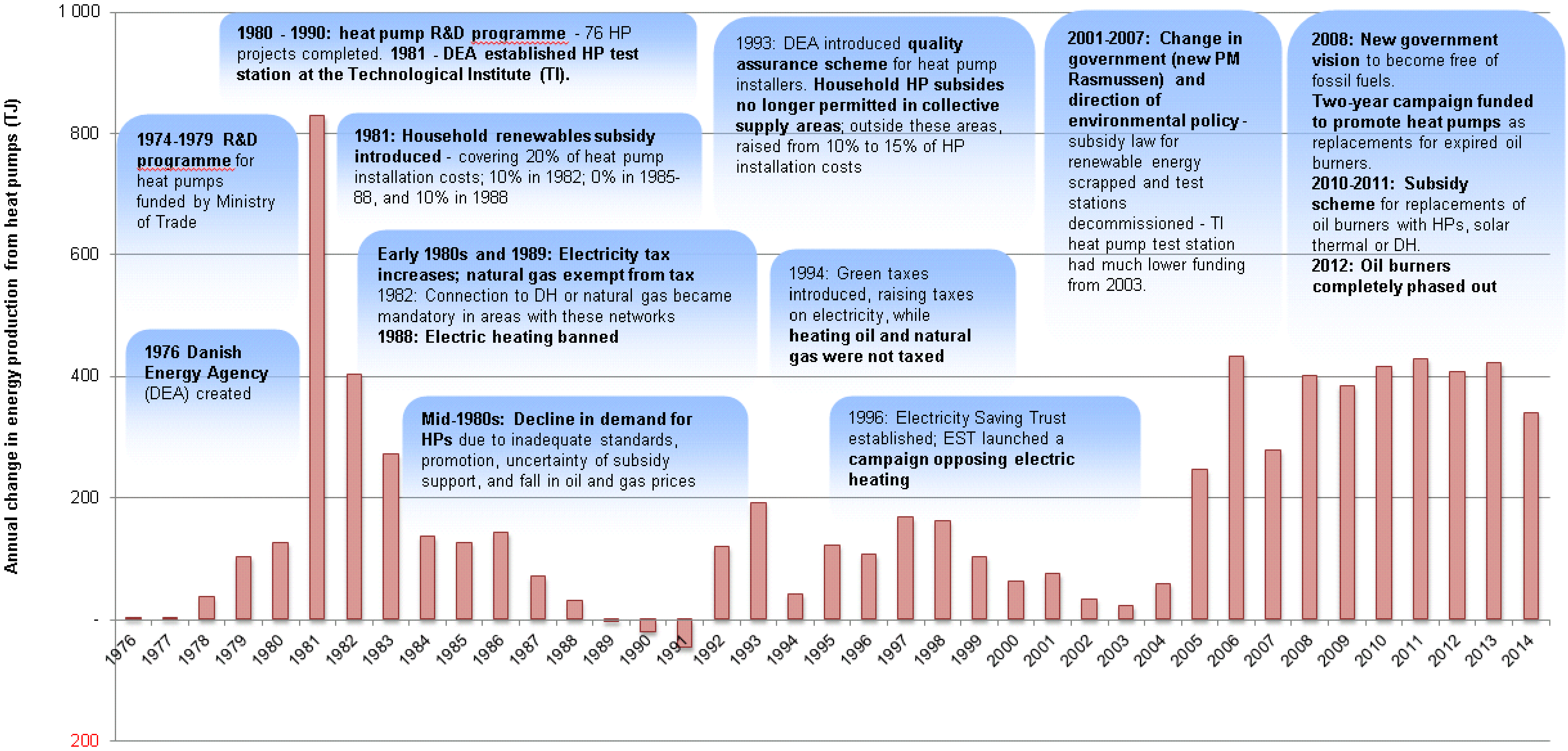
Heat pump case study: Austria 1975-2013:

Oil prices, tax breaks and subsidies, information campaigns, standards and quality assurance



DH case study: Denmark 1976-2014:

R&D, HP test station, household subsidies, electricity taxes, shifting policy support, phasing out of heating oil



Detailed comparisons…

Country	European climate zone (s)	Indigenous production of natural gas, 2013 (TWh, gross calorific value)	natural gas customers, 2013 (1000s)	private households, 2013 (1000s)	Average annual heat pump sales, 2010-2013 (Absolute numbers)	Average annual heat pump sales, 2010-2013, per 1000 households
Finland	Colder	0.0	34	2,571	64,885	25.2
Sweden	Colder	0.0	40	4,632	106,502	23.0
Estonia	Colder	0.0	52	556	12,607	22.7
Denmark	Average	56.0	420	2,339	27,364	11.7
France	Warmer / average / colder	3.7	11,301	27,804	136,831	4.9
Italy	Warmer / average / colder	81.9	22, 941	25,518	119,658	4.7
Austria	Colder	14.5	1,351	3,722	17,405	4.7
Spain	Warmer / average	0.5	7,473	18,212	62,014	3.4
Portugal	Warmer / average	0.0	1,354	4,007	12,805	3.2
Switzerland	Average / colder	0.0	423	7,970	21,248	2.7
Germany	Average / colder	115.8	21,179	39,411	67,755	1.7
Netherlands	Average	796.4	7,152	7,549	8,616	1.1
United Kingdom	Average / warmer	424.2	23,003	27,611	18,185	0.7
Lithuania	Colder	0.0	559	1,310	620	0.5
Slovakia	Colder	1.0	1,503	1,811	738	0.4
Hungary	Colder	19.2	3,468	4,106	813	0.2
Column data source(s)	EC (2013); Zimny et al. (2015)	Eurogas (2014)	Eurogas (2014)	Eurostat (2016)	EHPA (2014)	EHPA (2014); Eurostat (2016)

Conclusions

- **Heat provision <u>can</u> be transformed -** In Denmark, Sweden and Finland, 50-60% of buildings are supplied by district heating. In France, Italy and Sweden over 1 million heat pumps were sold between 2005 and 2013

- **Policy stability, continuity and support is a key success factor for both technologies**

- **Technical standards, quality of installation are key to heat pump progress – boom, bust and recovery…** subsidies, information, tax breaks won't work if the consumer experience is poor

- **Investment grants appear to be particularly important for heat networks where energy markets have been liberalised**

- **Fossil fuel or carbon taxation has been successful in building stable low-carbon heat markets in Sweden and Denmark.** Subsidies for replacing oil and electric heating can also be effective in stimulating demand both for heat pumps and heat networks

- **Strong planning policy is a feature of most large-scale heat network.** Planning and regulatory frameworks need to give heat network developers confidence. Choice may need to be constrained

- **Contextual factors <u>are</u> important (energy prices, power sources, gas resource/coverage, ownership structures and liberalisation) <u>but the UK could do far more with the right policies</u>**

The Voice of the Networks

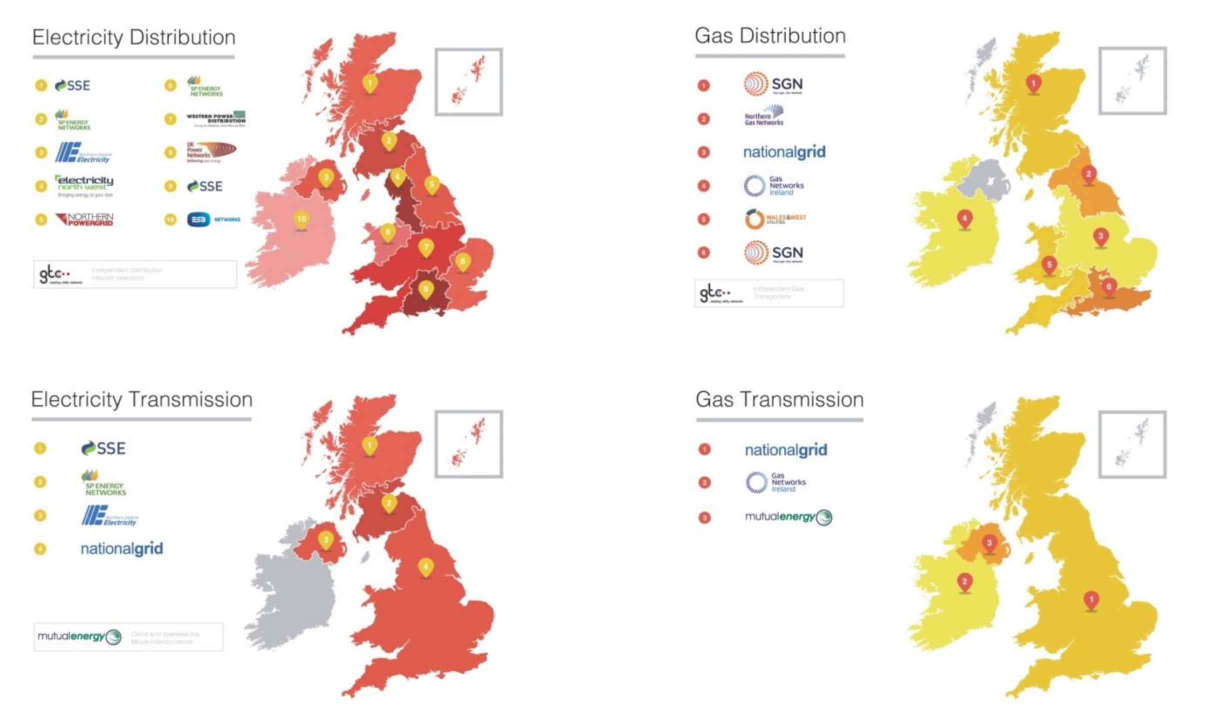
Energy Networks Association

The Heat Summit – How can we decarbonise heating?

14th December 2016

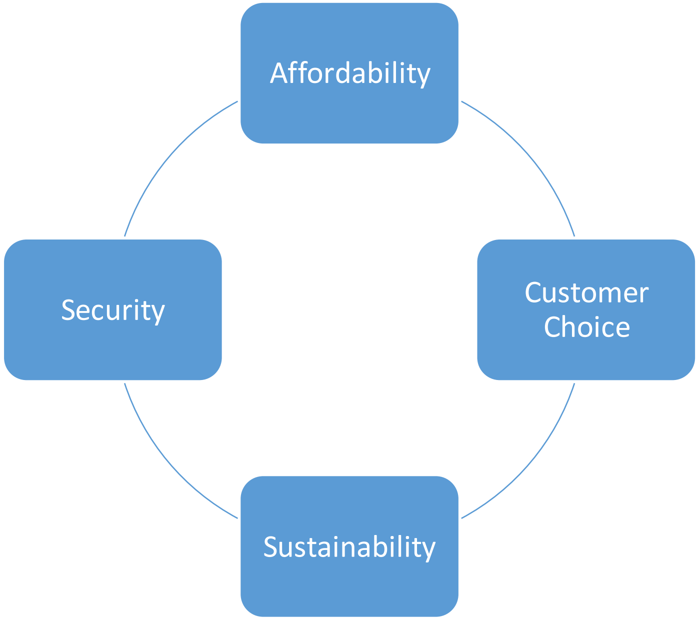
Tony Glover
Director of Policy and Gas, ENA

Energy Networks Association



Energy Networks Association

- As the representative body for the UK's gas and electricity networks, Energy Networks Association is well placed to analyse the whole energy system without bias towards any energy source.
- Any holistic consideration demonstrates clearly that our gas networks will have a vital role to play in the coming years; not just in an affordable progression to a low carbon economy, but also as a long term part of a sustainable energy mix through the injection of green gas into the grid.

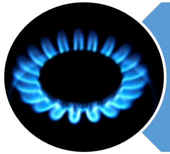


Gas in Our Culture and History

The Gas Networks

- The challenges of the low carbon transition will also require an approach, which recognises the vital role of gas and the gas networks in affordable and secure energy future. Currently over 80% of energy usage at peak time is derived from gas. The gas network will provide vital support to electricity infrastructure during peak usage both during the low carbon transition and as part of a lower carbon future. If the use of electric heating becomes more prevalent, the electricity network will also need to cope with greater seasonal peaks in winter.

Customer Choice - Gas is the fuel choice for UK consumers, meeting the heating needs of almost 85% of domestic properties and the cooking needs of around 50% residential and service sector buildings.



Security – Over 80% of peak energy usage is currently derived from gas. Without gas and the gas networks there is simply not enough energy for the UK to function or the means to transport that energy at peak periods.

Sustainability – Peak gas and electricity demand is 25 times higher than existing low carbon capacity.

Affordability - Heating your home by gas is around 3 times cheaper than using electricity and saves consumers over £400 per annum compared to alternatives.

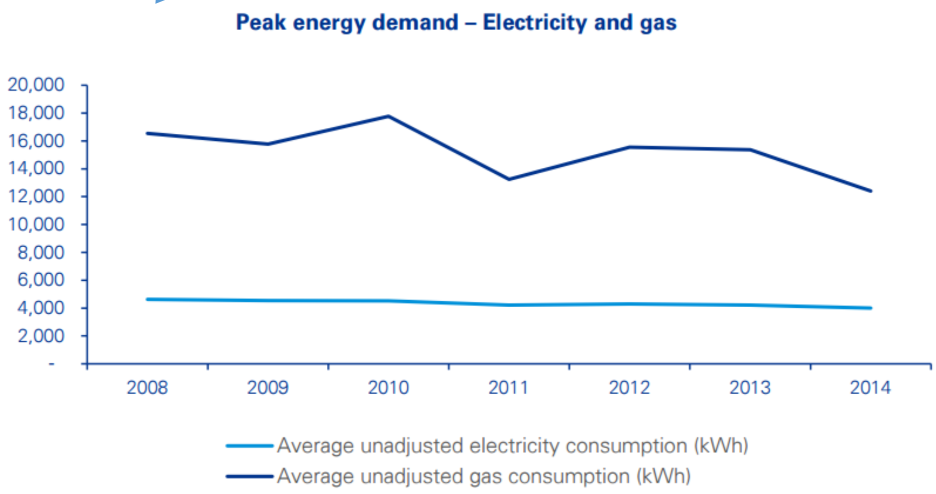
Future Heat Challenges

The energy trilemma is a challenge now, but will become more difficult by 2050 as interventions (with associated costs) will be needed to achieve decarbonisation policy aims. The trilemma is:

- **Security of supply:** The need to ensure we have enough energy to sustain our economy is a vitally important consideration for policy makers. This is particular important for supply energy at peak times.

- **Delivering energy efficiently:** As increased energy efficiency takes hold, there will still be a critical need to maintain the security of energy supplies. Gas remains a readily available source of energy for the GB market and this looks set to continue to be the case in the longer term.

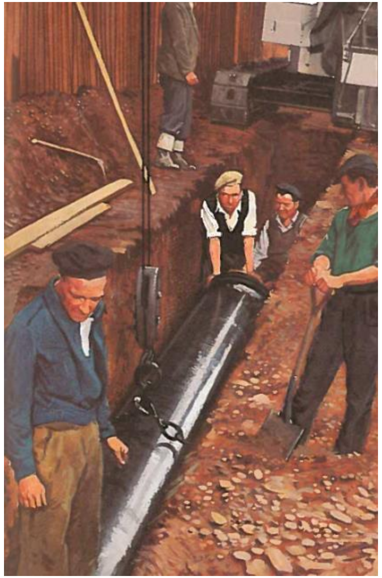
- **Decarbonisation of heat:** The Climate Change Act 2008 commits the UK to reducing carbon emissions by at least 80% in 2050 from 1990 levels. The biggest driver of change across the energy sector is the reduction of carbon emissions across power, heat and transport. Decarbonisation of power is already well advanced but heat and transport are lagging significantly behind. Gas, as the major source of heat, will need to be decarbonised in some way.



Source: DECC, ECUK 2015 Tables 3.07

Repurposing the Gas Network

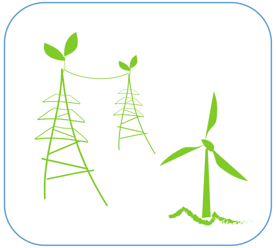
Changing applications, changing sources



Greening the Gas

Green Gas Advantages

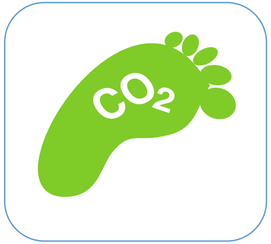
- There are a number of sources of green gas, such as biomethane and hydrogen, which can be used in our networks to provide heat and fuel for transport, and offer a range of benefits alongside their contribution to reduced carbon emissions.



ENERGY SYSTEMS

DIVERSIFICATION

SUSTAINABLE TRANSPORT



CARBON REDUCTION

SERVING CUSTOMERS

CIRCULAR ECONOMY

Green Gas Innovation

GDNs are leading innovation projects which are providing technical understanding of green gas injection into the grid, as well as demonstrating commercial potential and highlighting necessary regulatory changes to encourage growth in the sector.

BIOMETHANE
60 Biomethane to Grid injection plants capable of producing 4.65 million Megawatts of renewable gas.

BIO-SNG
National Grid demonstration plant in Swindon looking at turning domestic household waste into green gas for injection into the network and for use in Heavy Goods Vehicles

HYDROGEN
Northern Gas Networks H21 Leeds Citygate, which aims to investigate the challenges, benefits, risks and opportunities of converting the existing gas network in Leeds, to a hydrogen network.

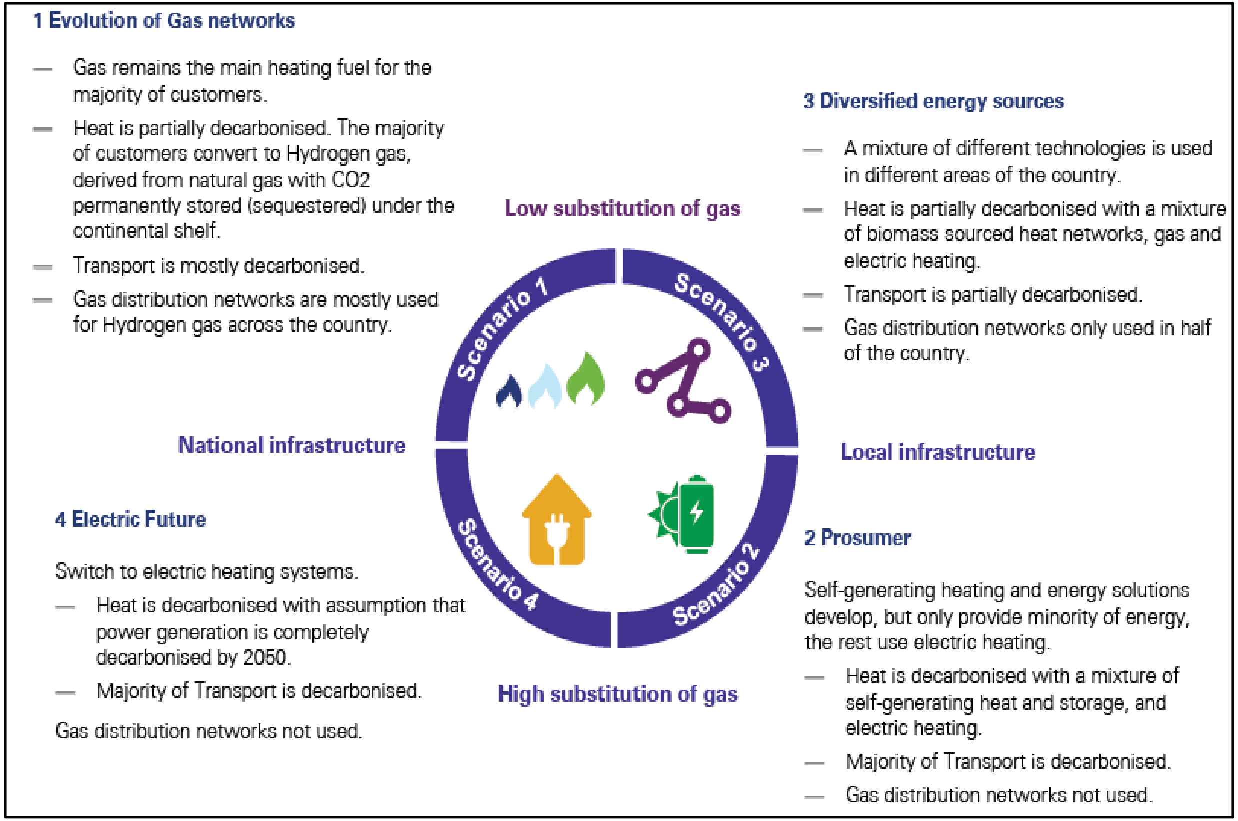
HyDeploy project will demonstrate on Keele University's private network that natural gas containing levels of hydrogen (10% to 20%) beyond those permitted by the current safety standards (0.1%) can be distributed and utilised safely.

A Growing Body of Evidence

A growing body of evidence demonstrates the importance of the gas network including **Delta EE report, WWU Bridgend Study and Imperial College work.**

A recent KPMG report commissioned by ENA has demonstrated the vital role the gas network will play in supporting and mitigating the increasing demands on our electricity network from decarbonisation.

<u>'The UK Gas Networks role in a 2050 whole energy system'</u> looked at four scenarios which show potential ways that energy demand, particularly heat demand, could be met in 2050.



Conclusions from the Report

	Practical obstacles	Incremental cost	Incremental cost per consumer up to 2050
Evolution of Gas	Low/Medium	£104-122bn	£4,500-5,000
Prosumer	Very high	£251-289bn	£11,000-12,500
Diversified energy	Medium/High	£156-188bn	£6,800-8,000
Electric Future	High	£274-318bn	£12,000-14,000

Cost of Change

- Large investment will be needed to decarbonise the heat sector which ever option is chosen; meeting winter peak heating demand is a critical cost driver.
- Large investment will be needed to convert homes and businesses to new energy sources.
- Continuing to use the gas network offers significant savings versus alternative heating sources.

Practicality of change

- Decarbonisation of heat will require a major fuel source change.
- Customers value the convenience and reliability of the current heat system, which presents a barrier to change
- Practical issues for customers such as space, affordability and changed performance present a barrier to change
- Major changes to energy systems and installation of new networks will face practical planning and installation challenges.

Policy implications and recommendations

- Policy and regulatory decisions are needed on the future for gas and heat. Without such decisions, there is a risk that families and businesses will pay more than they need to and decarbonisation targets will not be met.
- But long term energy regulatory and market frameworks need to retain flexibility so as to deliver the best 'whole energy' solution for 2050.
- Transport decarbonisation policy needs to be integrated with power and heat decarbonisation policy and planned over the same timescales.
- Due to the long term nature of network investments, gas and electricity policy decisions need to be firmed up ahead of the next RIIO network price controls.
- Major investment is needed to decarbonise gas and heat in the home. Funding and delivery decisions e.g. via energy supply or network companies, probably need to be taken by Government.
- More detailed assessment on the acceptance of major change by consumers and society is needed, with regard to both policy and practicality aspects.
- Gas and heat innovation funding and piloting needs to continue, especially in areas that help to firm up the understanding of options for 2050.

How can we decarbonise heating?

Tony Glover, Director of Policy and Gas

Energy Networks Association

Tony.glover@energynetworks.org

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