WALES&WEST UTILITIES

On the road to a green energy UK

consumer willingness and ability to pay for decarbonised heat

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Contents

Disclaimer

This report was first written in 2015, when the Department of Energy and Climate Change (DECC) had responsibility for energy policy. It became part of the Department for Business, Energy and Industrial Strategy (BEIS) in 2016.

For consistency, it is referred to as DECC throughout this report.

1 Context

The Department of Energy & Climate Change (DECC) 2013 Heat Pathway suggested two solutions to decarbonise heat: heat pumps would replace gas central heating in suburban areas and communal heating networks could replace individual central heating systems in urban dwellings currently served by the UK gas network.

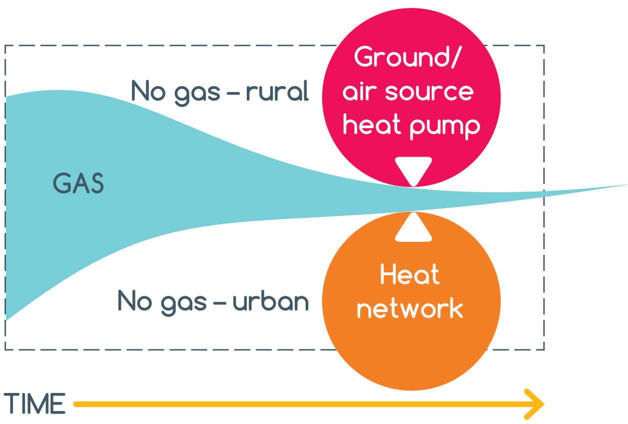


Figure 1: UK Heat Pathway (DECC 2013) [1]

DECC's subsequent study (MJM September 2015) into the impact of heat networks on investment into the gas iron mains replacement programme identified no case for change. The results showed:

- In the case study areas examined – none of the existing gas network was decommissioned
  - Heat networks only served specific buildings
  - Gas was still required for other end users and for cooking
  - In some cases, gas demand increased for combined heat and power (CHP) or fuel for the heat network
- It was difficult to conceive an entire area switching their heating source without major incentives
- The cost to the consumer and nation would be very expensive indeed, with the Energy Technologies Institute estimating a cost of £100 billion and the need to convert 20,000 homes per week to achieve the change
- The study quotes: "Little will be gained by DECC seeking to displace expenditure by the Gas Distribution Networks on iron mains in order to fund the development of heat networks."

This study was a narrow assessment of heat networks rather than the whole of DECC policy, so Wales & West Utilities decided to commission research to extend this work from a consumer perspective, to assist with understanding the investment requirements in gas networks during the 2020s and 2030s.

[1] Department of Energy & Climate Change, 2013. *The Future of Heating: Meeting the Challenge*

2 Background

2.1 Bridgend – a typical town in south Wales

Bridgend is a ‘bottom up’ case study of a real gas network, focusing on a discrete geographic area. It comprises more than 10,000 gas consumers, featuring domestic, commercial and industrial consumers, including some areas of social housing and a number of civic buildings. The area chosen mirrored the DECC commissioned study. The research uniquely segmented different classifications and clusters of consumers, to consider specifically what may be needed to influence each classification of consumers respectively to change their heating source. Bridgend is recognised as typical of many towns and cities in the UK, so therefore the findings and conclusions are highly likely to be applicable throughout the UK.

Bridgend was also chosen as the local authority has advanced plans to install heat networks and has received government funding to do this via ETI. It was initially noted that:

- Gas networks are highly integrated, with a very diverse consumer base
- The costs of operating the gas distribution network in the area are reducing rapidly due to the programme to replace iron gas mains, which is 80 per cent complete.

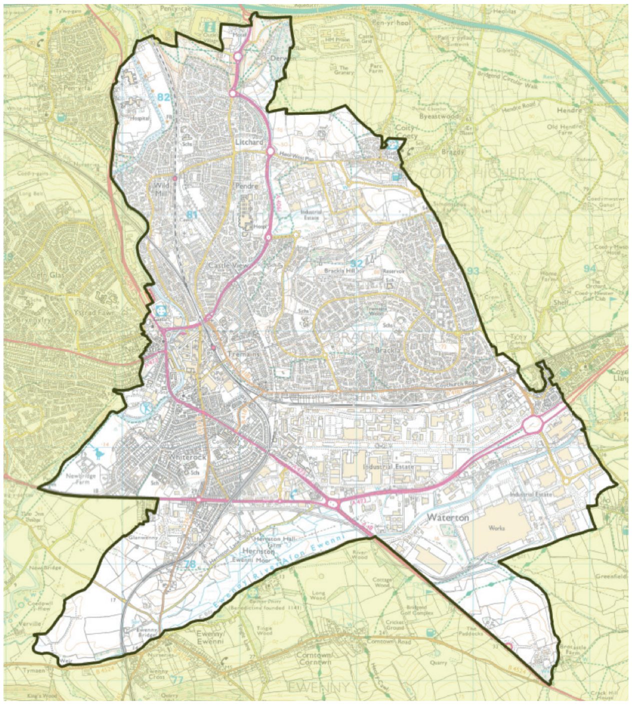


Figure 2: Map of Bridgend research area

2.2 Wales & West Utilities sponsored research – economic model

The first phase of the research involved building a detailed model to enable a review of the impact of the proposed heat networks and also that of heat pumps proposed by DECC as their pathway to reduce the carbon impact of heat.

ECONOMIC ANALYSIS

The cost benefit analysis was conducted across a 35-year period and shows that the most cost effective heating source is via a gas fired heat network. The 35-year period shows how the up-front investment for equipment (£10,000) is offset throughout the period, resulting in an annual £28 consumer credit – which amounts to a £950 consumer credit over the 35-year period.

Total additional costs per annum, discounted over a 35-year period, for a detached high user property.

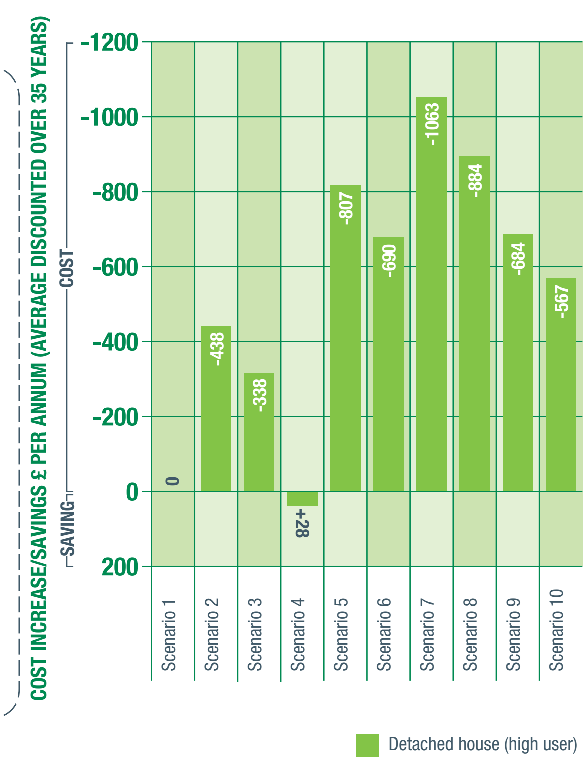
KEY

The x axis is set at zero £s and represents the current scenario of using gas and electricity as is. Prices are as at 2015, when the research was first instigated, and the scenarios for each column are described below:

1. No change – use of gas and electricity as usual, with gas central heating
2. No change use of gas and electricity as usual, with gas central heating, with insulation
3. Heat network fired by gas, gas for cooking, joint gas and electricity for energy, with insulation
4. Heat network fired by gas, gas for cooking, joint gas and electricity for energy, without insulation
5. Air source heat pump with insulation
6. Air source heat pump without insulation
7. Ground source heat pump with insulation
8. Ground source heat pump without insulation
9. Heat network, electricity as energy source, no gas, with insulation
10. Heat network, electricity as energy source, no gas, without insulation

Differential savings £-per annum from Gas Central Heating System (GCHS) (discounted over 35 years) – (example used detached house – high user)

NOTE: Heating network, using gas as energy source, lower cost than air source heat pump (ASHP), ground source heat pump (GSHP), options



Localised scenarios (with and without insulation)

3 Results of research and their impact on DECC 2013 policy

3.1 Heating networks

Four areas were identified with potential for heat networks within the DECC study area, with area 3 – as shown on the map – being the most financially attractive area. This was for a CHP unit for a hospital and surrounding buildings. A CHP unit is essentially a highly efficient micro power station, which uses waste heat for local buildings, as well as avoiding electricity transmission losses because it generates power onsite.

Due to the switch to local power generation, it was evident that gas usage for the hospital would nearly double rather than reduce, which would potentially require an upgrade to the local gas network. However, annual fuel savings of around 30 per cent would ultimately cover the high initial capital costs on a payback period of 35 years, based on enabling access for consumers to a community loan scheme with zero per cent interest.

For domestic consumers in the scheme, assuming they paid the up-front cost for the installation of circa £10,000 per dwelling, this could offer a small annual saving of £28. These figures include baseline fuel costs and, in addition, there would be carbon savings of approximately 30 per cent due to the efficiency of CHP.

It was also noted that there was no proposal to change fuels for cooking purposes within any of the commercial or residential properties, which is a small but important amenity. The risk of incurring excessive costs for utilising the gas network for such low usage for cooking, was mitigated by both the ongoing use of gas

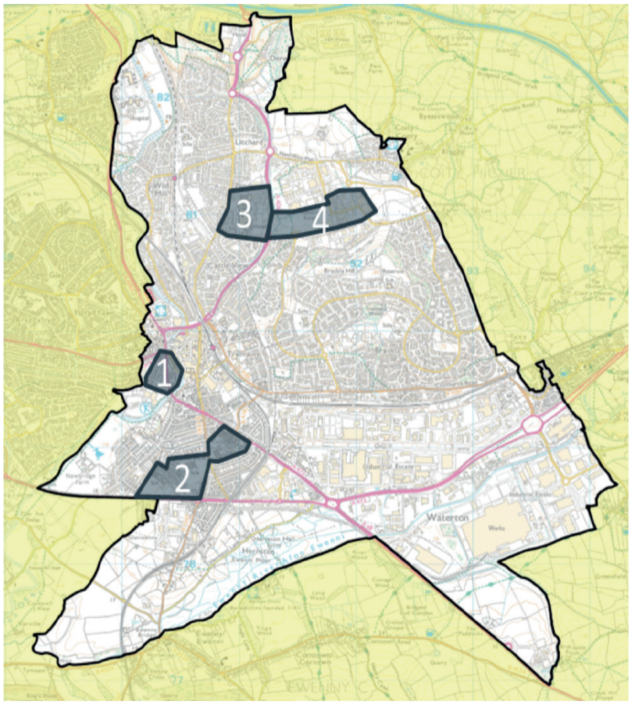


Figure 3: Proposed heat networks

for the CHP and the low operating costs of the local network, which is mostly maintenance-free polyethylene gas pipes.

The results showed that cost effective heating networks, developed for new-build domestic housing and business construction programmes, could be part of the longer-term solution for domestic and commercial heating in the UK.

3.2 Air source heat pumps

The research evaluated the use of air source heat pumps in areas outside those that were proposed for heat networks. These comprised the majority of the residential properties in Bridgend.

As with most towns and cities in the UK, it is estimated that 80 per cent of the Bridgend properties that will exist in 2050 are already built. Mature properties need investment to insulate them – in addition to the cost of installing heat pumps. Generally, the older the property, the more investment is needed to bring its insulation standard up to a level that is compatible with using a heat pump. It was noted that Bridgend properties were in the main generally mature.

The economics of a heat pump were evaluated noting a number of variables:

- The efficiency of the performance of the heat pump in winter, when heat is required
- The relative cost of gas and electricity (electricity being circa 3-4 times that of gas in 2015)
- The installation costs of the heat pump and home insulation
- The level of subsidy available, in the form of the Government's Renewable Heat Incentive.

The study identified that due to the initial high level of capital outlay required, costs could increase by more than £1,000 a year for a detached dwelling.

Also, heat pumps do not reduce carbon emissions, due to the marginal carbon intensity of the additional demand for electricity in the winter months:

- Heat pump winter marginal carbon intensity is **937g/kWh**, but reduces by its 3:1 efficiency to **312g/kWh**
- Carbon intensity of a gas boiler of **185g/kWh.**

It was also observed that heat pumps would be unlikely to meet the peak seasonal demand for heat without significant investment in the electricity network infrastructure, generation capacity or energy storage – or all three. Demands on the gas network would still remain for cooking, for water heating and for commercial properties not suitable for a heat pump.

4 Consumer willingness to pay

The subsequent research aimed to understand if financial constraints were a major issue. It looked at whether people were willing to pay for low carbon heating and, indeed, if they had the ability to pay. If they lacked ability, the research looked at the potential government policies that would be required for consumers to change to low carbon heat.

4.1 Financial constraints

Empirical evidence available in the UK was used, covering more than 30 years from the 1980s to 2015, of consumers considering whether to change to alternative energy sources, utilising consumer practice to switching to gas in gas infill scheme areas[2]. This is where the gas network is extended, enabling new gas connections in previously off-gas areas.

This revealed that the initial capital cost is the key factor influencing whether consumers will, or will not, change to an alternative heating source. The tipping point was estimated at around £3,000 (at 2015 prices) per dwelling, above which they wouldn't pay. It further revealed that take up rates for successful schemes start with 30 per cent of consumers switching and that this levels off at 75 per cent of the area switching to gas after 25 years (Chew Valley, Bristol case study).

4.2 Willingness and ability to pay

By uniquely segmenting different classifications of consumers, the research identified that consumers fit into six cohorts:

- Civic organisations with access to long term, low interest capital
- Social housing, owned by organisations with similar access to long term capital
- Savvy domestic consumers who have money to invest
- The business community, with competing short and medium term demands for investment along with uncertainty of their future
- Domestic consumers with limited access to finance and competing needs for funds
- Domestic consumers with no access to credit or funds of any type.

By use of socio-economic analysis of these cohorts, their ability to fund the investment required to change to low carbon heating alongside their likely payback expectations, Bridgend consumers were allocated proportionately into each of the cohort groups.

Where there was a requirement for an initial capital cost (for example for a heat network and/or a heat pump) it was identified that more than 80 per cent of consumers

Cohort	Payback period	Population
End user	Consumers with minimal resources and who cannot borrow money – will not change because they have no financial means to change	33%
Consumer/investor	Consumer/investors who will need significantly high incentives to encourage them to change – **3-year breakeven**	48%
Business consumer	Business consumer eg retail outlet – **5-year breakeven**	8%
Shrewd investor	Comparator – with the current Renewable Heating Incentive (RHI) period Shrewd investor – with cash-stable business – **7-year breakeven**	3%
Social housing	Social housing/housing association landlord(s) – **10-year breakeven**	8%
Long-term investor	Long-term investors – public sector buildings eg library, doctors' surgery for public consumers – **15-year breakeven**	1%

Table 1: Bridgend consumer segmentation

would not or could not afford to change to such an alternative lower carbon heat provision.

A spacial analysis of the study area also identified the approximate locations of the respective cohorts, summarised in figures 4 and 5, into those who are able and/or willing to pay – and those who are not.

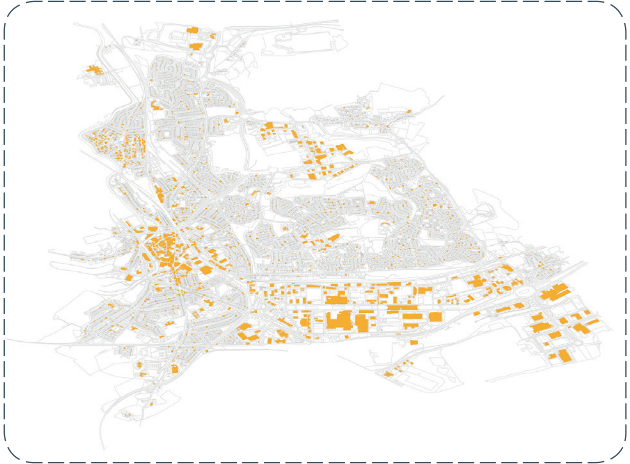


Figure 4: Consumers able/willing to pay

Figure 5: Consumers unable/unwilling to pay

[2] Clarke C, Winnan N, 2015. *An analysis of fuel switching and consumer willingness to pay for a new energy source – impact on heat network utilisation.*

5 Policy requirements

The key government policy areas that would require change to enable decarbonisation of heat are:

- Access to low cost/zero interest up-front grants
- Subsidies for low carbon heat
- Carbon taxation
- Legislative standards.

5.1 Subsidies

Using the different consumer cohorts identified, financial modelling was carried out to look at the incentives that would be needed to provide acceptable payback periods, to encourage investment in alternative heating sources. For example, investing £10,000 in heat networks for each consumer cohort, respectively, is illustrated below:

Heating networks – 'breakeven' scenarios

Possible incentives to influence different types of energy.

Consumers to invest £10,000 in a new heating system eg heating network (£0 upfront subsidy)

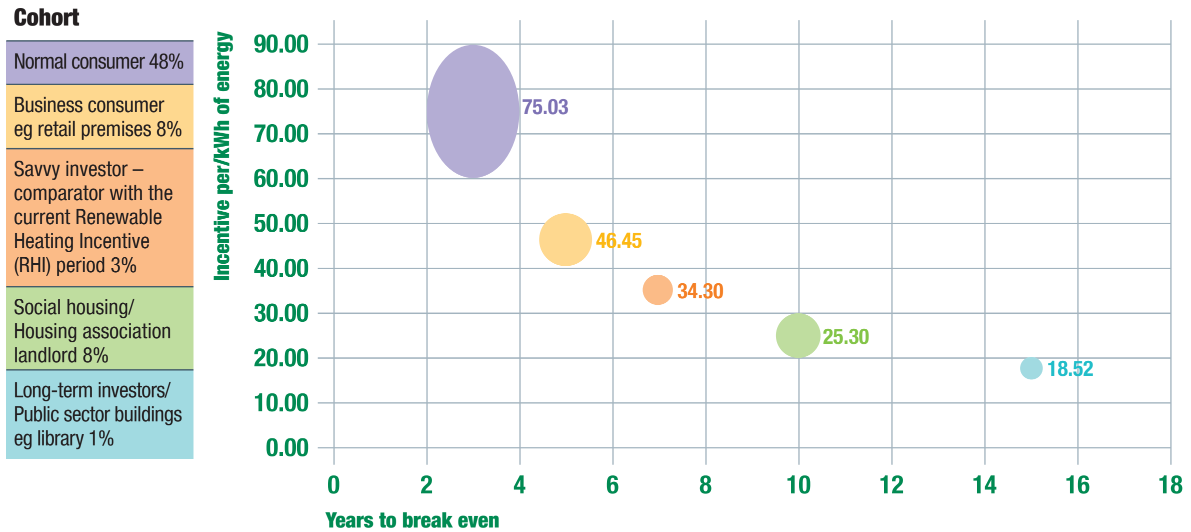


Figure 6: Breakeven analysis – heating networks – subsidies

The majority of consumers who could pay would require a higher subsidy level of 75p/kWh, which is well in excess of previous rates. The 33 per cent of end users, with no access to credit and no financial means, could not afford to change no matter the level of subsidy.

5.2 Up-front grants

As a substitute for subsidies, a simple up-front grant to cover the costs could be provided, eg £10,000 per dwelling to procure a low carbon heating system. With an estimated 25 million dwellings on the gas network in the UK, that would require an estimated total investment of £250 billion for the UK. This was considered a major challenge unlike anything previously attempted and which would result in significantly increased costs of energy for all consumers – and/or taxation for all.

5.3 Carbon taxation

The Committee on Climate Change forecasts a carbon tax rate of £70/tonne in 2030, this being an approximate annual charge of £210 for the typical residential consumer in Bridgend. Against an investment of, say, £10,000 to avoid that change, even with the existing subsidy, this would not balance the investment case nor change payback periods to a point where consumers would make a different decision.

6 Conclusions

The research shed new light on the complex business of decarbonising heat and has revealed a number of surprising results:

- Real examples of UK energy switching revealed that initial capital cost is the key factor that influences consumer switching behaviour.
- Heat network proposals are not displacing gas networks – most installations are gas fired boilers or CHP, increasing gas demand (displacing central electricity generation).
- Electric heat pumps currently increase emissions and cost compared to gas boilers.
- 80 per cent of consumers would not/could not afford to change to lower carbon heat provision.
- Very large subsidies would be needed to change consumer preferences.
- Carbon taxation would have to be higher than the Committee on Climate Change forecast which would have impacts on vulnerable customers and business.
- Current government policy (Electric Heat Pumps & Heat Networks) would have minimal effect on consumer behaviour and hence gas network usage.
- Biomethane gas injection subsidies of 6.77p/kWh (October 2015) offer a much more cost effective route to decarbonisation than electrification.

7 Recommendations

The research commissioned by Wales & West Utilities has revealed that the proposed 2013 DECC pathways for heat decarbonisation are far more expensive than anticipated. At the time, it was suggested that the policies would save consumers money, but the economic analysis has revealed that large up-front investment is needed and that the savings may never pay back that investment.

It was also observed that some pathways did not address the issues surrounding peak energy demand, noting that domestic premises can consume up to 10 times the daily energy for heat compared to power.

It was evident that some level of compromise is required to keep the energy trilemma balanced, i.e. decarbonising heat while maintaining security of supply at the lowest cost. In 2015, the following actions were recommended:

- Biomethane is only one form of 'green gas' – there are other potential 'green gas' options including producing lower carbon synthetic gas and gas mixed with other lower carbon gases eg hydrogen. It is recommended that further work establish the potential for green gases.
- It was observed that seasonal demand for heat swings significantly and this does not align with some forms of renewable generation. It is recommended that the compatibility of different renewable energy options, including how seasonal peak demand could be met, should be analysed in more detail.

Four key projects have been progressed since 2015, which address these actions:

- H21 Hydrogen Cities – innovation work led by Northern Gas Networks, supported by Wales & West Utilities, has completed a feasibility study that proposes the conversion of the existing gas distribution system for certain identified cities to pure hydrogen, with Bristol and Cardiff being highlighted in the Wales & West Utilities area. It has been estimated 30 per cent of UK heat demand could be met by hydrogen in the 17 cities identified by the project.
- Bio-SNG – turning waste into gas. The first plant worldwide to convert non-recyclable waste into a methane/hydrogen blend, solving the problem of dealing with waste and provides a green gas supply on to the distribution network. The plant is due for commissioning in 2018, being connected to the Wales & West Utilities system in Swindon. It has been estimated by National Grid Distribution (now Cadent Gas) that 30 per cent of domestic heat could be supplied via bio gases.
- Project Freedom – a smart switching technology that enables hybrid heating systems to switch between renewable electricity heating when available, and green gas when not.
- 2050 Energy Pathfinder – an integrated energy simulator that models future demand scenarios including heat, power and transport. This is matched by supply options, such as renewable electricity, green gases and nuclear power. Storage can be input to balance against interconnection and supply interruptions.

It is concluded that using the above technology, an integrated, multi vector approach is emerging that uses each technology to its best and hence provides a lowest cost pathway to heat decarbonisation.

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