Incumbency in the UK heat sector and implications for the transformation towards low-carbon heating

Richard Lowes, Bridget Woodman, Matthew Clark

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Executive summary and implications for policy

This is the final working paper from the UKERC Heat, Incumbency and Transformations project. The project which has been running since June 2016 is investigating the idea of incumbency with a specific focus on the UK's heat sector. The project is primarily interested in what the implications of incumbency are for the UK's move towards low carbon heating.

Our first working paper, released in January 2017, considered what the word incumbency actually means in relation to the UK heat sector (Lowes *et al.*, 2017). Our second working paper released in January 2018 considered what incumbency is in the UK's heat sector and mapped companies currently active within the UK's heat market (Lowes *et al.*, 2018). The paper then included a risk and opportunity analysis which considered how each sector identified may be affected by the decarbonisation of heat.

This paper is based around results from a large number of interviews with experts from across the UK's heat sector considering the idea and importance of incumbency linked to the UK's potential move towards low carbon heating. We have built on this interview data, linking it to our previous working papers and also relating it to relevant grey literature sources in order to enhance and build on ideas raised in interviews. Throughout the paper we highlight key findings, policy recommendations and potential areas for future research.

We firstly considered the potential for changing roles of incumbents in the UK heat sector. The interviews highlighted that incumbents with an interest in gas, envisaged a much greater role for gas based heating in a low carbon economy than interests who were less involved in gas. Interviews with non-incumbents however highlighted that the actual potential of decarbonising the gas grid was associated with a number of uncertainties; these included the potential costs of this approach, the technical possibility of converting the gas grid, expected carbon emission reductions and where the actual energy to produce the hydrogen would come from. Gas networks were highlighted as the incumbents both most at risk and most unable to respond to heat decarbonisation because of the long term nature of the businesses and also because of the regulation that controls their behaviour.

The second empirical section of this paper considers the behaviour of incumbents which could impact the future of the UK heat sector and its decarbonisation. The research has highlighted three key areas where incumbent behaviour may affect the future: lobbying and regulatory pressure, innovation and investment. Our research highlighted significant efforts by heat incumbents associated with lobbying and regulatory pressure, with the aim of maintaining a gas based heating system. These efforts were primarily based around promoting the approach of 'decarbonising the gas grid' and this promotion was almost fully associated with the gas network sector and appliance manufacturing sector. These efforts to promote low carbon gases, including hydrogen, have taken place over the same short time period in which hydrogen has entered the Government's heat decarbonisation discourse. This suggests that incumbents have either (partially) caused the emergence of this discourse, or have capitalised on the low carbon gas discourse as it has emerged elsewhere. Suppliers

and gas producers do not appear to have been particularly active in lobbying associated with heat decarbonisation.

Innovation, which we see as including research and development, and changing business patterns and approaches is seen to be another area where incumbents can affect the future of UK heating. Our research showed that some innovation is taking place in the UK's heat sector but this innovation is piecemeal and incoherent, linked to a lack of clarity by Government on both the actual requirement and approach needed to decarbonise heating. Further still, a significant proportion of the innovation around low carbon heating is being carried out by gas networks under schemes which are provided by Ofgem and funded through consumer bills. However, much of this innovation is linked to maintaining the existing gas system and we have discovered so-called innovation which appears to be research which has received little or no scrutiny and is in some cases being used as evidence to promote a long term role for the gas grid to policy makers. We therefore call for significant changes to the Ofgem innovation scheme under the RIIO2 price control framework to ensure that all research is justified and objective.

While we expected investment to be a particularly important element of incumbent behaviour, overall our research highlighted very limited investment by any actors in low carbon heating in the UK. This appears to be a result of policy and regulatory support for low carbon heat which is not ambitious enough and as a result, the lack of a clear market for low carbon heat.

Interviews highlighted that another area in which incumbents may be having an impact on heat decarbonisation is through their relationships with consumers and heating engineers and installers. We found documentary evidence of appliance manufacturers promoting the benefits of converting the gas grid to hydrogen in the heating engineer trade press. This appears to be an attempt to convince heating engineers that converting the gas grid to hydrogen is a good idea. There is very limited research into, and knowledge of, both heat consumers and the heating installer industry and due to the importance of both sets of actors we call for more research in this area.

Some other elements of incumbency emerged from our research which may also have an impact on the future of the UK heat system. These included the impact of tensions within large incumbents (such as integrated energy companies which have interests in both higher carbon and lower carbon heating technologies and services) which could inhibit change, attempts by incumbents to protect market positions and thereby indirectly inhibiting change, and the development of gas coalitions and networks with the focus of attempting to maintain a gas based system.

Overall, our findings show that incumbents are supportive of heat decarbonisation pathways and approaches which maintain similar business practices in the future and are not opposed to decarbonisation per se. However, it is very uncertain whether a decarbonisation pathway which maintains a gas based heat system will allow the UK to meet its decarbonisation targets while creating a secure and equitable energy system. The promotion of a high gas pathway could therefore inadvertently lead to the UK missing its decarbonisation goals. We

are also concerned that the emergence of the hydrogen pathway, which has been heavily promoted by incumbents, will detract from the need for other technologies and approaches to decarbonise heat including energy efficiency, heat pumps and district heat networks. It is therefore important that policy makers do not pick a hydrogen pathway too early, based on too little evidence about which approaches to decarbonisation of heat are optimal.

Policy and regulatory recommendations

In light of our findings and based on the views from interviewees from across the spectrum of organisations involved in heating, we make the following recommendations for UK heat policy:

1. Whilst technologies to decarbonise the gas grid could play a role in decarbonising heat, they are partly being promoted as a defensive strategy by gas industry incumbents. Government should support careful demonstrations of, and research into, technologies which have the potential to decarbonise the gas grid, and compare the economic, environmental and other performance measures of such demonstrations with more established low carbon heat technologies.

2. It is important that the focus on decarbonising the gas grid does not detract from other technologies. The speed of the required transformation to low carbon heating means that current policy should support the rapid deployment of low carbon heat technologies such as heat pumps, district heating and demand reduction, which are proven at scale around the world.

3. Government and Ofgem should jointly consider supporting the diversification of gas network companies into district heat networks in urban areas. BEIS should consider how the regulatory framework and associated legislation around gas network companies could be modified to support the diversification of these companies into building and operating heat networks. The Ofgem RIIO2 Price Control Review process should also investigate how gas network companies can be incentivised to invest or diversify into heat networks.

4. Government should engage more closely with the UK heat industry, in particular offering support to those sectors particularly at threat from decarbonisation. This support should ease the transformation and diversification of companies towards providing low carbon heat products and services, and reduce the effects of companies attempting to maintain market positions. Key areas where we recognise the potential for diversification are around support for gas networks to enter the district heat market, and for appliance manufacturers to produce heat pumps.

5. Throughout the Ofgem Price Control Review Process for gas networks post 2021, the future of heat must be a central theme. Ofgem will need to devote significant resources

to the issue, to ensure that they are basing decisions on objective and independent evidence.

6. Ofgem must ensure that any future consumer funded innovation work (of all scales) receives independent review both before funding and on delivery of the work. This should be a requirement of funding and would ensure network innovation work has value to current and future consumers and is of high quality. Ofgem should fully review their approach to funding innovation to ensure that new entrants, new ideas and new practices are allowed to access a level playing field for network innovation funding.

7. When designing policy, policy makers must always use information from the private sector in the knowledge that it is produced by vested interests and that it should be handled with care. Independent or peer reviewed data should be used when available.

8. Ofgem needs to ensure that any innovation incentives, if deemed necessary to be financed from consumer bills, does not prioritise particular technologies and that the portfolio of funded research is balanced. This could be achieved through allocating funding to specific themes or technologies, allowing third parties to access network innovation finance, or applying some sort of test to ensure that results have value across networks.

9. Government must be more explicit about the scale of the challenge of heat decarbonisation. Policy for heat must create a market for the deployment of low carbon heat at a level which is commensurate with the challenge and timescale of heat decarbonisation. Significant reforms and extra funding for the RHI (or whatever replaces it) are required to encourage investment and learning in low carbon heat. The existing framework of heat policies will not drive the decarbonisation of heat at the speed required to meet the UK's climate change targets.

10. The views of trade associations and industry groups should not be taken as representative of the entire industry. Active efforts should be taken to consider marginal views such as those from new entrant companies linked to specific ideas or technologies which may be of equal value or more valuable to policy makers in the long run.

1. Introduction

This is the third and final working paper from the UKERC Heat, Incumbency and Transformations project. The project has been investigating the concept of incumbency with a specific focus on the UK's heat sector, considering what incumbency may mean for the UK's transformation towards low carbon heating in line with carbon reduction goals.

Our first working paper attempted to define the term incumbency and in that paper we define incumbency in the context of sustainable transformations as the '*…presence of existing actors within a specific socio-technical system. An incumbent will be currently active in the socio-technical system or a part thereof, and are therefore likely to be, or have been involved in unsustainable*[1] *practices. Incumbents have the economic, social or technological capacity to influence system change*' (Lowes *et al.*, 2017).

Our second working paper, released earlier this year, investigated who the business incumbents in the UK's heat system are and considered the risks and opportunities that the decarbonisation of heating in the UK would mean for these incumbents (Lowes *et al.*, 2018). We identified two key technological pathways for heat decarbonisation.

- Pathway 1 (Decentralised heat): this scenario focuses on primarily reducing heat demand, with the remainder of heat requirements met through either onsite heat generation from heat pumps, electric heaters and solar thermal, or with heat being provided via district heat networks themselves using low-carbon heat.
- Pathway 2 (Hydrogen conversion): this scenario maintains the centralised heat model. Hydrogen is produced from natural gas at centralised hubs where carbon is also being captured and stored from the process. Hydrogen is transported using the existing gas network, then burnt in suitable boilers in each dwelling for space and hot water heating. For houses off the gas grid, primarily electric forms of heating such as heat pumps or storage heaters are used.

The two pathways we identified represent the extremes of a spectrum of perceived potential heat decarbonisation options. It is of course possible that combinations of pathways emerge such as hybrid solutions or indeed completely new pathways emerge. However, it is these two pathways which currently dominate the discourse around UK heat decarbonisation and which represent a harsh dichotomy between gas and non-gas heat options; incumbent technology versus non-incumbent technologies. Overall, our view is that pathway 1 appears more transformative and therefore disruptive to incumbents than pathway 2.

We then carried out a detailed mapping of the UK heat market identifying all of the main businesses operating. This produced, for the first time, a good understanding of the UK's 'heat market' and associated business structures as well as the strategic issues the sector

[1] In light of the various conceptions of sustainability, for the purpose of this project we focus on decarbonisation as our key sustainability issue and therefore for this project unsustainable generally refers to heating practices which are carbon intensive

faces from decarbonisation. From this analysis, we developed a number of hypotheses which we investigate in this paper. These are:

- H1: Incumbents put at risk by pathway 1 are expected to be opposed to this pathway.
- H2: Incumbents who see reduced risk as a result of pathway 2 are expected to be supportive of this pathway
- H3: Incumbents put at risk by both pathways are expected to be opposed to both pathways
- H4: The largest sectors put at risk by decarbonisation are expected to be the most active in their engagement around heat decarbonisation policy, innovation and investment

This working paper concludes the heat, incumbency and transformations project by considering these hypotheses as well as wider issues which the project has been investigating including:

- The effects of heat market incumbents on the development of UK heat policy and whether influence has been increasing
- The current behaviour of incumbents around heat decarbonisation
- The implications for policy makers and others associated with the behaviour of both incumbents

Initially, we had expected this project to take a primarily political and policy based view however, as we developed our understanding of incumbency, it became apparent that focussing solely on policy would miss much of the current behaviour of incumbents around for example innovation, research and investment. We have therefore widened our thinking to include the general behaviours of incumbents that are affecting the UK move towards low carbon heat.

This paper is structured as follows:

- Section 2 briefly considers our methodology
- Section 3 investigates views and issues associated with the changing role of incumbents
- Section 4 considers the behaviour of incumbents which could affect a future heat system
- Section 5 discusses elements of incumbency which have emerged from the research
- Section 6 concludes the paper and considers policy implications of the research

2. Methodological approach

In order to investigate the behaviour of incumbents and consider the implications of the behaviour on policy, we have taken a social science approach based primarily around a number of expert interviews. The innovative nature of this research mean that there is not an existing framework or approach to investigate incumbency or incumbents, and we have therefore had to keep our approach nimble and responsive to emerging findings.

Semi-structured interviews were undertaken with a large number of representatives and experts with knowledge of the UK heat sector. 53 interviews were carried out in person, or on the phone when it was not possible to meet between March 2017 and January 2018. Interviewees included individuals from:

- Incumbent businesses
- Industrial energy users
- Niche and new entrant businesses
- Trade associations representing business groups and think tanks
- Experts working on heat issues not working for private companies such as civil servants, academics, advisors and consultants

The semi-structured nature of interviews allowed the exploration of key project themes with interviewees but also allowed interviewees to focus on their areas of particular interest and allowed further probing by the interviewer in certain areas which appeared interesting. The interview questions are included in annex 1. As issues emerged from interviews, a number of desk-based mini case studies and literature reviews were considered to investigate specific issues in greater detail. All interviews are treated as anonymous to promote honesty and openness and to protect interviewees.

Interviews were coded using NVivo software. The codes were initially based around our research interests which also linked to the research questions however new codes emerged throughout the coding process. Sub-codes were also grouped under codes and there were some sub-sub-codes where a number of codes linked to a specific issue. The list of all codes and shape of the coding structure is shown in annex 2.

The shape of this working paper is based around the key themes which appeared from the coding and also links to the hypotheses developed in the previous working paper and described in the previous section. The detail of the paper is based around the content of the codes and further desk based analysis of grey data and additional mini-case studies have also fed into the results in this paper.

During the interviews, we also asked interviewees for their views on the definition of incumbency. We have not included the results from this interview question in this working paper as we are preparing a separate journal article on the definition of incumbency which we expect to be published later this year.

While interview data has been anonymised, all interviews are referenced with an interview number. This allowed the authors to write the paper coherently (we hope) and gives readers an assurance over the reliability of the data.

3. The changing role for incumbents

In our previous working paper we considered, in light of wider analysis which has investigated potential technological decarbonisation pathways for heat, how the various sectors in the UK's heat market may be affected by decarbonisation (Lowes *et al.*, 2018). We explained that there are seen to be two key technology pathways for the decarbonisation of space and hot water heating in the UK. One pathway is based around a decentralised and low-demand heat system which uses district heating in urban areas supplied with heat from low-carbon heat sources, with heat pumps providing the majority of heat for houses in more rural areas.

The other pathway sees the gas grid converted to transport low-carbon gases, primarily hydrogen produced from methane using carbon capture and storage. Hydrogen is then used in appliances which combust the hydrogen to produce heat, much like a normal gas boiler. For houses not on the gas grid, we would still expect a significant proportion of these buildings to use heat pumps powered by electricity if carbon reduction targets are to be met.

Our paper explored the risks and opportunities that each pathway posed for existing sectors of the UK's heat market. Readers helpfully pointed out that we didn't consider the geography of each pathway suggesting that it could be linked to locational factors and we agree that the likely technology choice for heat decarbonisation could be linked to geographical factors. This is however beyond the scope of our analysis. It was also suggested that we could have widened our analysis to include fuel cell appliances which consume hydrogen more efficiently. While we take this point on board, we do not believe the inclusion of micro-CHP fuel cells would have led to the emergence of different pathways.

Building on our previous working paper, this section considers data from the interviews which considered what the role of incumbent companies would be in the future in light of the development of a decarbonised heat system. Alongside the interview data, we consider the existing evidence and pathway analysis, some of which we described in our previous working paper.

3.1. The potential for low(er)-carbon gas

The largest number of comments during interviews regarding the potential role of incumbents in the future referred to the possibilities for low-carbon gas. In our previous working paper, one of the key pathways which emerged focused on the idea of decarbonising the gas grid using low-carbon hydrogen.

Subsequently, the following sections consider interviewee views around the potential for lower carbon gas. Because of the large number of references on this topic, the following paragraphs are split based on type of interviewee, be they an incumbent (e.g regulated network, big six company, gas appliance manufacturer, LPG supplier), niche actor (e.g. heat-pump and biomass appliance manufacturer, renewable energy supplier, heat storage company), industrial energy user, trade association or non heat-business expert (this included consultants, civil servants, regulators and academics). This split should not only

make the sections easier to read but also provide the context of where views have come from.

A large proportion of the references associated with incumbents moving towards low(er) carbon gases came from incumbents themselves. Incumbent interviewees mentioned various options which have the ability to totally, or in some cases partly, decarbonise the gas grid and these were the same technological options which we considered in our previous working paper (Lowes *et al.*, 2018).

These options mentioned included:

- The potential to use bio-gas or bio-liquified petroleum gas (LPG) to replace natural gas or liquid petroleum gas in off-gas-grid areas (9, 21, 22, 36)
- The potential to use synthetic natural gas (21, 22)
- The potential for hydrogen blending (9, 21)
- The potential for converting the grid to run on 100% hydrogen (9, 21, 22, 27, 28, 29, 40)

One incumbent interviewee also mentioned the potential for methanation, a technique where methane is produced from hydrogen using a bio-chemical process (9).

Among niche actors, there were far fewer references to the potential for low-carbon gas as an option for incumbents in the future. One mentioned the potential for hydrogen conversion (19) and another the limited potential for biomethane in light of the constraints on feedstocks needed for the production of biogas (20).

There were a significant number of references (39 in total) to the potential of low(er) carbon gases as a route for incumbents to fit into a low-carbon heat future from non-business heat experts. Some interviewees from this group of actors suggested that biogas or hydrogen may be technologies in which incumbents can be involved in a low-carbon heat future (7, 14, 28, 32, 34, 41, 44).

Some of these expert interviewees specifically mentioned the idea of decarbonisation of heat using 100% hydrogen conversion of gas grids (23, 25, 30, 43) and interestingly a number saw this as an option which was being promoted primarily by the gas networks (6, 11, 14, 42). There was also a recognition among a number of interviewees that the idea of hydrogen had emerged fairly recently:

- ‘This hydrogen thing is quite network pushed, and fairly new’ (14)
- ‘over the last year it’s gone from being something that was nothing to something that’s on the radar’ (28)
- ‘The hydrogen thing has come in quite recently, and it’s not really clear why it has come in’ (33).
- ‘I would have said three years ago, there was very little in the press about it at all. But since then, just about anyone who is anyone in the research world has done a big, fat document of some description about hydrogen for heat’ (44)

A number of trade associations with an interest in heat also mentioned the potential role of low-carbon gases and similarly recognised the potential for biogas (1, 26), hydrogen (10, 12, 18, 8) or a combination of both (13).

Overall then, a significant proportion of interviewees saw the idea of decarbonising the gas grid as a potential option for incumbents to support the move towards low carbon heating. However, from the interview data, this idea has much greater levels of support from incumbents, particularly gas networks, than other interviewees and seems to have emerged into the heat decarbonisation discourse rapidly and recently.

Finding 1: The idea of decarbonising the gas grid has high levels of support from incumbents, in particular gas networks who have significant investment in gas assets. This supports our second hypothesis that incumbents are generally in favour of a pathway which maintains the gas system and looks to decarbonise gas

Finding 2: The idea of decarbonising the gas grid using hydrogen has emerged both rapidly and recently while it has at the same time received significant support from incumbents

3.1.1. The issues with low-carbon gas

One of the pathways in our previous working paper was based around a scenario which looks to decarbonise the gas grid and so it is not necessarily surprising the idea of decarbonising the gas grid was mentioned by a number of interviewees, particularly those incumbents who face challenges as a result of a non-gas pathway.

Many interviewees recognised that low(er) carbon gases may be an option for incumbents to engage with heat decarbonisation. However, a number of interviewees from across all interviewee groups raised potential issues with the ability of low(er) carbon gases to support the transformation to low-carbon heating. One described the overall concept as 'nuts' (12).

We explored the ideas around decarbonisation of the gas grid in more detail in our previous working paper.

- We discounted biomethane as a key technology for space and hot water heating decarbonisation because of limited available resource and the requirement for high grade heat in industrial processes
- We discounted bio synthetic natural gas produced from waste because of the very limited experience of it and questions over carbon reduction potential
- We suggested that the only scalable pathway to decarbonise the gas grid was using hydrogen produced from methane alongside carbon capture. However we also raised a number of concerns around this approach. These included the expected carbon savings which may not be suitable for a net zero emission target, unknown costs, the reliance on carbon capture and storage and the requirement for a greater quantity of gas than is used today. There is also the potential to produce hydrogen at scale from low carbon electricity and inject this into the gas grid; however because of conversion losses in the electrolysis process if you have electricity, from a system efficiency

perspective, it may make more sense to use the electricity for electrical heating (including in heat pumps).

A number of interviewees also raised issues with the idea of decarbonising the gas grid, which supports and builds on our desk based analysis in the previous working paper.

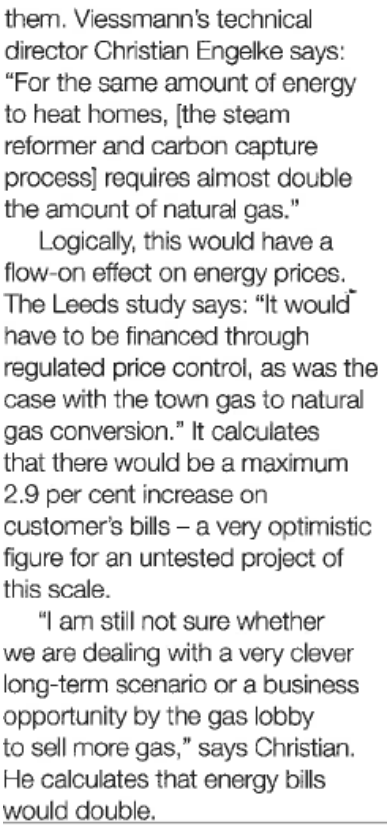
Interviewees raised further issues around the costs of decarbonisation of heat by converting the gas grid to hydrogen. An interviewee explained that the Leeds CitygateH21 project which is a major desk based study carried out by a gas network (Northern Gas Networks *et al.*, 2016) proposed spreading the costs of the Leeds conversion across all UK consumers making the project look cheaper than it would otherwise be (10).

The Leeds Citygate paper explains: 'If the H21 Leeds City Gate project was funded using the current UK regulatory business plan it would have negligible impact on customers total gas bills' (p6), however, further into the document it states that costs to convert Leeds 'are socialised across all UK customers' (p255). While the spreading of costs for innovation projects across consumers is not uncommon, the scale of the Leeds project as proposed in the H21 report would require significant increases in both capital and ongoing expenditure with a suggestion that resulting heat (excluding appliances) would cost around 7.3p/kWh (p265). Significant scrutiny over the finances of a project of this scale would be required before any investment decision is made.

Two interviewees suggested that proponents of the Leeds idea had selectively excluded some costs and included some savings to distort the funding amount needed for the project and make it appear cheaper than it should (10, 11). It is not possible to quantify these issues in detail, however, these comments highlight the cost uncertainties associated with heat decarbonisation using hydrogen and suggest that a significant level of scrutiny should be applied when considering industry cost estimates for heat decarbonisation options. Upcoming research by colleagues at Imperial College London for the Committee on Climate Change is investigating heat decarbonisation pathway costs and is expected to shed some light on these issues[2]. The National Infrastructure Commission is also carrying out other work on comparative cost analysis of heat decarbonisation.

Interestingly, some of the views about potentially high hydrogen costs came from incumbent companies. Appliance manufacturer Viessmann in an article in Gas Engineer Magazine, explained they believed that the use of hydrogen for decarbonisation of heat could double energy bills which goes against the costs suggested in the Leeds Citygate work. An extract of this interview with Viessmann is shown in Figure 1.

[2] Upcoming from Goran Strbac at Imperial College, "Analysis of Alternative UK Heat Decarbonisation Pathways"



them. Viessmann's technical director Christian Engelke says: "For the same amount of energy to heat homes, [the steam reformer and carbon capture process] requires almost double the amount of natural gas."

Logically, this would have a flow-on effect on energy prices. The Leeds study says: "It would have to be financed through regulated price control, as was the case with the town gas to natural gas conversion." It calculates that there would be a maximum 2.9 per cent increase on customer's bills – a very optimistic figure for an untested project of this scale.

"I am still not sure whether we are dealing with a very clever long-term scenario or a business opportunity by the gas lobby to sell more gas," says Christian. He calculates that energy bills would double.

Figure 1. Extract from Gas Engineer Magazine, Issue 97, April 2017

Concerns were also raised by interviewees over the import dependency aspects of the hydrogen decarbonisation scenario which relies on increasing volumes of methane from which hydrogen is produced (7, 11, 12, 31). One interviewee explained that the hydrogen conversion scenario 'would make us long term dependent on methane gas. Imported methane gas, of which we wouldn't have any control over price' (11). One interviewee was more forthright: 'even if they're rabid climate deniers, they're not going to want to increase gas imports' (12). The Leeds Citygate project did indeed suggest greater volumes of natural gas (47%) would be needed to provide the same amount of energy from hydrogen as is currently supplied by natural gas (Northern Gas Networks *et al.*, 2016).

Two interviewees highlighted the technical uncertainty of CCS technology on which low carbon hydrogen produced from fossil fuels relies (4, 12). Interviewees also suggested there was a general lack of detailed evidence to support the idea of hydrogen grid conversion (3, 4, 16, 38). 'There are no products. There's a lot of theory' explained one interviewee (38). Another explained: 'Wholesale hydrogen, I think, is just an idea. I'm worried that BEIS is taking it incredibly seriously and I'm worried that the manufacturers are taking it incredibly seriously' (10). Another interviewee explained: 'The policy looks like its gearing up for something that doesn't exist in technology' (31).

One example was raised by an interviewee where this lack of evidence was brought out in public:

> *[The industry present] 'themselves as the panacea of green gas and hydrogen, with very little evidence to back it up. And I think [name removed]*

who's doing work has definitely got a pro-gas bent running through him, you know?

And I think he's a very good individual, but he presents himself as being objective and categorically is not. And there was a government meeting recently, where someone else who was at the meeting, I wasn't there, said it got to the point where it was so blatant that they had to call him out. And they were like, "No, you're not being fair here." In front of the Minister, "This is a line that you're taking." (16)

It was also suggested that because of conversion losses, the use of hydrogen represented an inefficient solution (9, 30, 31) an issue which links back to ideas of increased gas dependency. One interviewee explained that they believed hydrogen used for heat decarbonisation produced from methane using CCS would be 'lower' carbon but not low-carbon (7). This is because there are likely to be significant emissions as a result of the hydrogen production process. The Leeds Citygate project report itself suggested that the proposed technological solution would produce carbon reductions of only 60% compared to natural gas (Northern Gas Networks *et al.*, 2016).

Hydrogen conversion has been suggested by some to be a solution to decarbonisation which has a minimal impact on consumers compared to alternatives (Northern Gas Networks *et al.*, 2016). However, a number of interviewees suggested that the requirement for new appliances may still mean significant disruption for consumers (8, 9, 33). It was also raised that the deliverability of hydrogen to consumers using street-by-street or neighbourhood at-a-time approaches would be extremely complicated (8, 10).

Summing up these points, one interviewee explained: I'm not sure, quite yet, that the realisation has dawned, that the investment in infrastructure would be equivalent to that which is required for electricity, and the adaption for the products on the network, would require significantly more inconvenience to the end user, or at least equal inconvenience as moving to electric rather than fossil fuel (9).

Finding 3. Despite the views from incumbents that hydrogen represents a sensible approach to decarbonise heating, fundamental uncertainties still remain and the interview process has further highlighted these.

3.1.2. Sub-section summary

Overall, this section has shown that many interviewees suggest that low(er)-carbon gases may be potentially of interest to certain incumbents in a low-carbon heat future. Incumbent actors were generally more likely to discuss the role of low(er) carbon gases than new entrants and smaller players.

In our previous working paper we described one scenario for heat decarbonisation where the gas grid is converted to run on 100% hydrogen (Lowes *et al.*, 2018). Interviewees highlighted many issues associated with the idea of gas grid decarbonisation using hydrogen which we previously identified and highlighted further potential issues.

The interview data does not necessarily suggest that a pathway which decarbonises heat using other technologies, i.e. heat networks and heat pumps does not have issues. However the interview data does show that heat decarbonisation using hydrogen receives significant support from incumbents despite the fact that major uncertainties and issues with this pathway exist.

Our concern is therefore that the idea of hydrogen has rapidly gained significant traction potentially as a result of its promotion by incumbents, despite major uncertainties and clear issues. We therefore make the following policy recommendation:

Policy recommendation 1: Whilst technologies to decarbonise the gas grid could play a role in decarbonising heat, they are partly being promoted as a defensive strategy by gas industry incumbents. Government should support careful demonstrations of and research into technologies which have the potential to decarbonise of the gas grid, and compare the economic, environmental and other performance of such demonstrations with more established low carbon heat technologies.

We also have some concern that the current focus on gas grid decarbonisation could potentially detract from policy efforts to decarbonise heat using other measures such as electrification and district heating. We therefore make this second policy recommendation:

Policy recommendation 2: It is important that the focus on decarbonising the gas grid does not detract from other technologies. The speed of the required transformation to low carbon heating means that current policy should support the rapid deployment low carbon heat technologies such as heat pumps, district heating and demand reduction which are proven at scale around the world.

Our view overall is that the interviews support our use of two separate decarbonisation pathways in our previous working paper as there is a clear belief from some that decarbonised gas can play an important role in UK heat decarbonisation. However in our previous working paper we explained: 'our decision to consider hydrogen conversion as a potential option for low-carbon space and water heating in the UK reflects its current position in the UK future of heat discourse and does not reflect a belief of the authors that it necessarily represents a realistic low carbon heat scenario' (Lowes *et al.*, 2018, p33). We maintain that position and call for further investigation into, and scrutiny of options to decarbonise the gas grid.

Research recommendation 1: Further independent scrutiny and analysis of the technological options for UK heat decarbonisation is required to allow fully objective decision making.

3.2. Investing and diversifying into low-carbon heat

Following low(er) carbon gases, the next most frequently suggested idea for how incumbents in the heat sector may need to change was around investing and diversifying into low-carbon heat. Interviewees mentioned the largest sectors in the UK heat market which we identified

in the previous working paper, including fuel producers, transporters, suppliers and appliance manufacturers.

Firstly, a number of interviewees mentioned a changing role for gas networks (12, 16, 17, 24, 33). As we identified previously, a heat decarbonisation pathway which doesn't use the gas grid represents a clear threat for gas networks. One interviewee who did not believe that gas networks could fit into a low-carbon future explained: 'their asset is going to become worthless, a sunk asset. So they've got an interest in actually repositioning themselves to understand how their particular business model and skill set can fit together with a new reality (24).

A number of interviewees specifically mentioned the potential for gas networks to diversify into district heating suggesting that if the gas networks reduced in scale in urban areas, gas networks would be well placed to become involved in district heat schemes (12, 16, 17).

When asked whether networks would themselves be happy to diversify, one gas network representative explained 'Absolutely I could, absolutely I could. And you know, our parent company, [name of owner redacted], they're well aware of the dynamic across the world, and the different change, and they are looking for investments that actually they can secure into the future over the longer term. And you know, if you do want that infrastructure, then certainly they would be the type of investor who that would be attractive to, absolutely' (17). However, another interviewee suggested that the gas networks were not particularly keen on the idea: 'The gas network industry can only just see gas, and just think, like flipping heck, how hard is it for someone to go, "I build pipes which energy flows through, I could build different types of pipes." And yet, they can't do that.' (16)

The idea of gas network diversifying into district heating may make sense from a geographical angle and the most likely places for district heat networks, in dense urban areas, are likely to currently have gas networks. This type of diversification which clearly supports a move towards low-carbon heat could also provide an approach which works with incumbents and supports them to diversify into low carbon technologies. We therefore make the following policy recommendation:

Policy recommendation 3: Government and Ofgem should jointly consider supporting the diversification of gas network companies into district heat networks in urban areas. BEIS should consider how the regulatory framework and associated legislation around gas network companies could be modified to support the diversification of these companies into building and operating heat networks. The Ofgem RIIO2 Price Control Review process should also investigate the how gas network companies can be incentivised to invest or diversify into heat networks.

A number of interviewees mentioned the potential changes for appliance manufactures which may be caused by heat decarbonisation. There was a view from some that incumbent appliance manufacturers know the UK heat market well and so will be important for the deployment of low-carbon heat (7, 35) and it was also believed that appliance manufacturers would be able to diversify as a result of limited investments in large assets (7, 9, 10, 15). Some interviewees mentioned that rapid change was indeed possible in the appliance sector

with a suggestion that manufacturers could stop manufacturing oil boilers 'overnight; if the incentives were right' (2). A leading gas boiler manufacturer also explained that they would be able to start a heat pump manufacturing line in a week in the UK and the appliance manufacturers could move to heat pumps easily (38).

One interviewee highlighted that while some appliance manufacturers are well placed to diversify, others aren't: 'don't be in any doubt that Worcester have all the technology that we have [to diversify into low carbon]. But for the likes of, Baxi, they have JVs with third parties so they can produce a product. Ideal would have a problem I think. They are the one who have absolutely no interest in anything other than banging out gas boilers as cheaply as possible' (9).

Finding 4: Appliance manufacturers and energy suppliers have the ability to rapidly diversify production and limited sunk assets and will therefore be able to be more nimble than the gas networks who are key incumbents.

'Energy suppliers' was another key sector recognised by interviewees where diversification may be important. It was suggested that suppliers could diversify into decentralised energy (16, 17) and that certain suppliers who also have large electricity generation portfolios may be well placed to diversify into electric forms of heating (5). There were also suggestions that suppliers could invest in district heating (18, 25) and could develop new business models for example working more closely with local authorities (12). Like appliance manufacturers, suppliers were also suggested to be relatively nimble and could easily respond to change because of limited sunk assets (44).

Finding 5: Appliance manufacturers and energy suppliers have the ability to rapidly diversify production and limited sunk assets and will therefore be able to be more nimble in any transformation than the gas networks who have greater levels of sunk and long term assets and therefore a greater incentive not to change.

Finally, it is clear from our analysis in the previous working paper that heat decarbonisation could mean major changes for the upstream gas sector if it reduces the use of gas for heating. However only one interviewee mentioned the upstream sector suggesting that the 'upstream' sector which produces fuel for heating may be the most affected by decarbonisation (7).

Whilst a number of interviews described ideas of business change and diversification, two interviewees mentioned investment by incumbents into low carbon heat. One interviewee suggested that incumbents could 'transformed themselves by buying lots of other assets' (5) and another suggested that 'the major companies already operating in that sector would purchase their way to retain their market share' (10).

3.3. The death of companies

Following investing and diversification, the next most frequently mentioned idea around the changing role for incumbents was around the death or end of companies. Interviewees

suggested that 'some of them may not have a role in the long term' (6) and it would be a case of 'adapt or die' (12) Many of these comments were associated with the requirement to move away from gas heating and the impact that this could have on various companies (4, 11, 14, 31, 33, 34, 41).

A number of interviewees specifically mentioned the gas networks as companies/assets particularly at existential risk from heat decarbonisation (5, 11, 14, 15, 41). Our risk and opportunity analysis in the previous working paper suggested that the heat decarbonisation pathway which saw the majority of heat coming from district heat networks and heat pumps suggested that the gas network was indeed facing an existential threat if that pathway happened. One interviewee explained that there is the option that 'We write it off and it becomes one of those stray assets that lurks under city streets' (11). Another interviewee explained that the gas network 'is currently tabled for closure' (41). One interviewee mentioned the idea of the gas network entering a death spiral where as people disconnect, unit costs for transport increase and this increase, causes greater numbers to disconnect (5).

One interviewee explained that even if some of the gas grid could be converted to hydrogen, there may still be a requirement for parts of the gas network to be decommissioned: 'The networks, that's the most obvious change. To me, it's like there's definitely going to be some sort of decommissioning at some point, because even if you're talking about massive transition to hydrogen, we're not talking about all the current customers on gas moving over to hydrogen' (14). This viewpoint supports our previous working paper which employed two pathways and it is indeed possible that multiple pathways or combinations or hybrid pathways emerge and these could be linked to geography.

In that paper, we suggested that decarbonisation of heat represented a serious (existential) threat for a number of sectors including the gas networks and others linked to gas and this is closely aligned to the views of interviewees. However, this previous working paper also recognised the risks to companies working in the off-gas -grid heat sector supplying LPG and heating oil. The existential risks to these companies was not highlighted during interviews. This is perhaps a reflection of the much larger size of the UK gas market compared to the off-grid market where oil and LPG is used. While the gas networks were seen as being at existential threat under the decarbonised heat pathway by interviewees, we would still maintain the view from our previous working paper that those involved in oil and liquefied petroleum gas heating still face a major risk from heat decarbonisation.

3.4. Further views on the changing role of incumbents

A number of interviewees suggested that the roles of incumbents may not actually change that much. For example if the gas grid was converted to run on purely low carbon gas, that could maintain many existing practices such as the maintenance of the gas network and the manufacture of similar appliances (14, 22, 32, 44).

One supplier also explained that whatever happens, they would expect their business practices to stay roughly the same:

> *'In terms of where we fit in to that future, and I kind of alluded to it before, but people will need some kind of appliance in their home, which will need to be installed, serviced, maintained, repaired. There will need to be some kind of fuel to be provided, either by pipe or wire from some kind of network into their home, and they will need to be billed for that and there will need to be all the customer service elements that go along with that. In many ways that's quite similar to what we have today. We just need to retrain our engineers to be as familiar with a hydrogen boiler or an air source heat pump as they are today with a gas boiler. And we need to be as good at selling electricity or hydrogen as we are at selling gas today' (37).*

Some interviewees believed that how the role of incumbents may change was related to what their current role is (13, 15, 29). Some interviewees also believed that the changing role of incumbents depended on the pathway for heat decarbonisation which emerges (14, 15, 25). These ideas closely link back to our risk analysis exercise carried out in the previous working paper where we identified varying risks for each sector and showed that the risks and opportunities varied by sector and depended on the decarbonisation pathway.

There was also belief among some interviewees that the move towards low carbon heating could develop the use of hybridised heat options and 3 interviewees specifically mentioned hybrid heat pumps which combine an air source heat pump with a gas boiler (6, 17, 38). The implication of this for incumbents was seen as being a continued role for both gas and electricity networks. In our previous working paper, we discounted the role of hybrid appliances in a transformed low-carbon heat system because of their continued reliance on natural gas.

However, hybrid approaches offer some system benefits in terms of their ability to reduce peak electricity load by continuing to use gas. However questions remain over the cost-effectiveness of maintaining two appliances and two networks, the performance of appliances, actual emissions and whether or not lower carbon gas can be used in hybrid systems. We therefore believe that while uncertain and with issues, hybrid appliances may form part of a sustainable heat future. Research mentioned previously which is currently being carried out for the Committee on Climate Change is considering hybrids as a potential low carbon heat option and is expected to shed light on their technical and financial performance[3].

3.5. Section summary

Building on our previous working paper, and considering the views of interviewees, in this section we have considered how the role of incumbents in the UK heat sector may change in the future. Interviewees generally supported the findings in our previous working paper around risks and opportunities. However, in general, incumbents with an interest in the use of gas for heating were more likely to mention the idea of decarbonisation of the gas grid.

[3] Upcoming from Goran Strbac at Imperial College, "Analysis of Alternative UK Heat Decarbonisation Pathways"

Non-incumbents raised a number of issues with the concept of decarbonising the gas grid which we considered in our previous working paper. Our concern is that incumbents are promoting the hydrogen pathway in order to attempt to protect their own interests despite the fact that there are major questions around the feasibility of decarbonising the gas grid using hydrogen. Hence we have developed a policy recommendation that suggests that as a result of uncertainty, the current heat policy strategy must focus on known measures for heat decarbonisation and not divert decarbonisation policy momentum towards uncertain ideas of gas grid decarbonisation.

Our second hypothesis from the previous working paper suggested that incumbents are more likely to support a pathway which maintains a gas based system and the results from this chapter suggest that this is indeed the case.

Our analysis also highlighted that there are significant differences between companies in terms of their ability to respond to heat decarbonisation with gas networks recognised as having particular levels of inertia as a result of the sunk asset nature of the businesses. These gas network companies are also facing the most significant threats from heat decarbonisation. There are also other companies that face existential threat from heat decarbonisation including the oil and LPG heat sectors.

However other companies, such as suppliers and appliance manufacturers appear more able (in general) to shift into other products. As a result of the difference between sectors in both levels of threat and ability to diversify, we suggest that policy makers should take a much more active role in their engagement with, and policy associated with, companies which face major risks from decarbonisation. This would ensure that companies are clear on what the future holds, could help companies diversify into new low carbon sectors and may have the effect of reducing the action by incumbents that could in general attempt to impede sustainable change. Therefore as well as policy recommendation 2 which considers gas networks and support to diversify into district heating we have developed another policy recommendation:

Policy recommendation 4: Government should engage more closely with the UK heat industry in particular offering support to those sectors particularly at threat from decarbonisation. This support should be to ease the transformation and diversification of companies towards providing low carbon heat products and services and to reduce the effects of companies attempting to maintain market positions. Key areas where we recognise the potential for diversification are around support for gas networks to enter the district heat market and for appliance manufacturers to produce heat pumps.

4. Incumbent behaviours in the face of transformation

The previous section considered how incumbents may need to change if the UK transforms its heat system to a low carbon heat system. However, incumbents may not want the UK's heat system to transform and if it does, may want to shape how the system does transform.

In this section we consider the behaviour of incumbents associated with the transformation to sustainable heating. This section includes and subsequently builds on the evidence gained through interviews. Our previous working paper into the concept of incumbency highlighted the potential capacity of incumbents to cause system change through various behaviours including through financial and political power and through directed research and development activities (Lowes *et al.*, 2017). We therefore specifically asked interviewees whether incumbents were attempting to have an impact on heat system change through, firstly lobbying and regulatory pressure, secondly through innovation and thirdly through investment. Following this questioning, we then asked interviewees if there were any other means by which incumbents were affecting or could affect system change towards sustainable heat.

The following sections consider the three specific areas we asked interviewees to consider and then considers other behaviours by incumbents. We build on interview data using a range of literature.

4.1. Lobbying and regulatory pressure

There is very limited academic literature on lobbying associated with UK energy policy and attempts to cause regulatory change. Some recent examples include investigations into the politics of the development of the UK electricity capacity market (Lockwood *et al.*, 2016) and the power of actors in the development of the UK Renewable Heat Incentive policy (Lowes, 2016). There is however a wider recognition in the UK media that energy lobbying in the UK does take place (The Guardian, 2013).

However, despite the small amount of research on lobbying associated with UK energy policy, in this research, involvement with policy and regulation by incumbents emerged as the theme with both the highest number of references and the largest number of interviewees mentioning it. This highlights the idea of lobbying and regulatory pressure as a particularly important element of the behaviour of incumbents in the heat sector and has clear policy implications. In our interviews, at an international level, examples were given of EU level lobbying by incumbents around gas issues highlighted in research by Friends of the Earth. A 2017 report from Friends of the Earth Europe investigated the institutionalised nature of the ENTSO-G group which has an official role but is formed of private gas interested companies (Friends of the Earth Europe, 2017). Another interviewee highlighted the involvement of the 'gas and hydrogen lobby' suggesting that activity was 'reflected in the amount of policy reports you probably see coming out in London and Westminster at the moment, looking at hydrogen, for example' (28). Indeed in 2016, there were reports released linked to the trade

bodies which represent two of the sectors of the heat market identified which suggested a significant ongoing role for hydrogen and the gas system:

- A report by KPMG funded by the Energy Networks Association 'Gas Futures Group' investigated possibilities for heat decarbonisation which included pathways which maintained a role for the gas grid including converting it to hydrogen (KPMG, 2016). According to the Energy Networks Association: 'This analysis places important emphasis on the customer and shows that making efficient use of the extensive gas network available to us in the UK offers an affordable and practical solution to this challenge' (ENA, 2016)
- In 2016 a report by think tank Policy Exchange was released funded by the Energy and Utilities Alliance (which represents the gas appliance sector, among others) and LPG supplier Calor Gas. This report also called for a heat decarbonisation approach which included attempting to decarbonise the gas grid using biogases and hydrogen and more efficient gas based appliances (Policy Exchange, 2016)
- In Summer 2016 a so-called 'Green Gas Book' was released which was sponsored by the Energy Networks Association which included contributions from MPs, The Energy and Utilities Alliance, Calor Gas and the Energy Networks Association

More recently, think tank, Carbon Connect, has been working on a set of reports called 'The Future Gas Series'. This has received support from the Energy and Utilities Alliance and the Institute for Gas Engineers and Managers (Carbon Connect, 2017a). The Institute of Gas Engineers and Managers, the Energy Networks Association and gas network Wales and West Utilities have also recently supported a report published by the Institute of Mechanical Engineers discussing future uses of gas calling for:

- Greater policy support for gas in the form of an industrial forum
- Support for the injection of hydrogen into the gas grid

(Institute of Mechanical Engineers, 2018):

Finding 6: It is clear that elements of the UK heat industry are investing in a number of pieces of research for lobbying purposes which are promoting an ongoing role for gas

In general with regards to the energy industry, one interviewee from Government explained: 'It's a huge industry; they are very powerful companies and all powerful companies particularly in a highly regulated market have a huge government lobbying and influencing role to protect their position for the future. I mean, clearly they are having a big influence the whole time' (44). A number of interviewees believed that the larger companies have better access to Government because of the size of companies and their large budgets (4, 16, 24, 26).

Despite the size of the energy supply industry, there were very limited references regarding lobbying by energy suppliers. One incumbent recognised that energy suppliers were involved in discussions but were not actively lobbying (45). Reflecting this, a recent report by trade body Energy UK which represents some suppliers has highlighted the importance of UK heat decarbonisation but did not promote specific approaches (Energy UK, 2018).

A large proportion of comments regarding lobbying and regulatory pressure during interviews were associated with the heating appliance industry and gas networks. These sectors are broken down in more detail below.

4.1.1. The heating appliance sector

Interviewees highlighted lobbying and regulatory pressure associated with the heating appliance sector. Interviewees, including incumbents, described engagement with Government by boiler and appliance manufacturers both directly (3, 15, 35) and also through trade associations (10, 12, 15, 22, 38, 40). A number of interviewees mentioned that one boiler company actually employed a full time lobbyist (2, 9, 10, 40) which does not appear the norm for appliance firms. The individual being referred to was interviewed as part of this project and explained: 'we do try hard to influence departments, obviously BEIS now and ministers' (40) and they provided the interviewer with a document which is described as the company's 'Heat lobbying strategy'. This document proposed focusing on converting the gas grid to run on low carbon gas and using bio-energy for homes not connected to the gas grid. This again highlights our previous finding that incumbents interested in gas are looking to maintain a gas based UK heat system.

Two interviewees suggested that this lobbying by appliance manufacturers was intended to prevent change (5, 19) and in the words of one interviewee was not 'in what I would term a progressive direction' (5).

One interview also highlighted that the off-grid LPG sector engaged very actively with Government around maintaining LPG heating and requesting support for bio-LPG which can replace LPG (36). A publicly available document produced by the LPG trade body UKLPG in 2017 which discussed heat decarbonisation did indeed promote the potential future role of LPG heating and suggested it could be decarbonised by using gas from biological sources (UK LPG, 2017). Interestingly, one new entrant company explained: 'The culprit that we are wary of is Calor. We have seen Calor commission documents' (46) and there was a belief that Calor is attempting to protect their small and off-gas-grid market from the development of heat pumps.

There was also a belief from one incumbent interviewee that trade associations which represent the heat appliance sector were also lobbying Government specifically around hydrogen and they saw 'the main protagonists as the EUA. The Energy and Utilities Alliance' (9). One example given of lobbying was the sponsoring of the 'Too Hot to Handle' report which was supported by the EUA and Calor Gas and was mentioned in the previous section. This report promoted a scenario in which: 'the number of households using gas boilers remains broadly flat to 2050' (p10) but which reduced emissions from buildings by 80% rather than deeper decarbonisation and relied on significant volumes of low carbon gas such as hydrogen (Policy Exchange, 2016).

One interviewee explained that the gas industry had employed an ex-MP to promote the industry: 'the guy who was the MP, I can't remember his name…Foster.' (23). This interviewee was referring to the chief executive of The Energy and Utilities Alliance trade

association which was discussed in the previous section. This interviewee did however explain that her description of the work of the gas industry's political engagement was not necessarily 'pejorative' (23). Another interviewee also suggested the appliance and installer industry represented by the 'Heating and Hot Water Council' (HHIC, part of the EUA) and the 'Energy and Utilities Alliance' had been actively lobbying Government 'stating some difficult truths, to make it look politically unattractive' (30). There was a belief that the EUA and HHIC are particularly active in this sector (2) and a suggestion that the EUA had become 'a lot more negative in the last two years (12).

The EUA, of which the HHIC is a part, released a manifesto in 2017 in which they explained: 'the UK has the world's leading gas grid infrastructure in place, directly supplying the energy to heat 85 per cent of UK homes. It would be a travesty not to use this existing infrastructure as part of the solution to the trilemma, and "green" gas could be the key.' (EUA, 2017).

The examples described in this section describe clear and deliberate attempts by incumbents in the appliance sector to lobby and create regulatory pressure with the aim of maintaining a gas based heat system in the UK.

4.1.2. Gas networks

A large number of interviewees referred to lobbying and regulatory pressure associated with the gas networks (2, 6, 14, 16 23, 25). Interviewees also suggested that the gas networks had been increasingly involved in lobbying (2, 6, 14) and this ramp up of activity was because 'they've got terrified that the gas networks are going to become redundant' (16) in light of the scenario for heat decarbonisation which sees only a limited role for gas.

One interviewee mentioned the ENA trade association which represents the UK regulated networks: 'I think ENA has done more on heat and gas networks in the last 18 months than maybe they've done in the past, so the whole heat decarbonisation story has only really come to the fore in that 18 months. There's been a lot more discussion of it in the last 18 months than in the 18 months before that. And ENA did a big set piece themselves on the future of gas.' (15). These comments seem to refer to reports around the future of gas considered in section 4.1 released by and connected to the Energy Networks Association.

As well as becoming more active, another interviewee explained that the UK gas networks had become much clearer in their view that they back the idea of decarbonising the gas grid and are now saying: '"This is what we should do to decarbonise heat." I think that's the change that has happened, combined with an increase in activity in that area.' (14).

There was a suggestion that short term business interests were part of the reason for some of this activity. National Grid Gas (now Cadent) had been promoting a long future for its network 'to make sure their gas network has a profitable future, so that they could sell it' (30) and a share of National Grid's ownership was indeed sold in 2017 (National Grid, 2017). Another interviewee also recognised that National Grid had become increasingly interested in ideas around the future of gas (33). Indeed, in 2015 National Grid released a whole series of publications around the topic of 'The Future of Gas' (National Grid, 2015). Another

suggested that the gas networks have reinforced a move away from the idea of electrification of heat (32), a technology pathway which represents a threat to the gas networks.

One interviewee suggested that one particular element of lobbying by gas networks was around the Leeds H21 project, a desk based study which investigated the potential of converting the whole of the Leeds gas network to run on hydrogen (25). This was a project we discussed in some detail in our previous working paper (Lowes *et al.*, 2018). Asked whether they had experience of lobbying or regulatory pressure, the interviewee explained: 'Yeah, that's almost what the H21 study was. It wasn't… That's probably a bit unfair to [name redacted] and others who were genuinely looking at how you would do it, but I imagine the only reason they got to do it was because NGN and others were asking that sort of question. The fact that the people doing the study then went and worked in DECC, as it then was, and have put a lot of effort into going around, talking to people about it, is quite good lobbying' (25).

The H21 project was also mentioned by another interviewee who explained 'the company that are championing it have a vested interest in re-utilising their assets, rather than just digging them up and going home' (42). Another interviewee explained that the 'decarbonising the gas grid' plan had risen up the agenda because of the promotion of the idea by gas networks in response to the threat of an electric heat future (6). In the words of another interviewee the gas networks 'are lobbying, very, very, very hard on that [hydrogen]' (7). There was a recognition from another interviewee that the idea of gas grid decarbonisation had emerged very rapidly and it was not clear where it had come from but was likely associated with lobbying.

An interviewee from an energy supply company also suggested that while they were interested in hydrogen as a technology, they were relying on what the gas networks had been promoting (37):

> *Respondent: 'there's an opportunity there if you've got the money, and the technology and if hydrogen works in the way people might hope.*
>
> *Interviewer: Hope is an interesting word.*
>
> *Respondent: I mean it's often the gas networks who are leading this charge for quite obvious reasons'*

It was also suggested that some current work investigating the future of heating being carried out by Carbon Connect considered briefly in section 4.1 (which describes itself as an 'independent, cross-party forum that seeks to inform and guide a low carbon transformation underpinned by sustainable energy'[4]) has an element of lobbying associated with it (33). Carbon Connect's most recent report into heat which considered the future of the gas grid was indeed sponsored by the Institute of Gas Engineers and Managers of which many gas industry employees are members (Carbon Connect, 2017b). However, while industry clearly

[4] http://www.policyconnect.org.uk/cc/about

sponsors this work, we have found no evidence that the Carbon Connect research has been captured by industry.

Interestingly, some of these incumbents frankly described their own engagement in attempting to influence the development of policy and regulation. One gas network company explained that they actively lobby Ofgem to show a need for continued investment in the gas grid (17). In their own words:

> *'clearly for them [Ofgem] to sanction kind of eight years worth of investment in the gas distribution network, and the gas transmission network, what we need to be doing is justifying to our independent regulator that actually that investment is going to deliver value for money, for users. So all the work that we're doing now, is building the story to show this is why you should invest in the gas networks, because that will actually be a valuable investment, on the path to 2050' (17).*

The interviews also contained evidence of gas network companies aiming to influence central Government decision by in particular highlighting the uncertainty of heat decarbonisation options (17, 21). As one gas network explained:

> *'our aim has got to be to influence the regulator to support the investments. But actually the policy makers are BEIS and DECC - was DECC, now BEIS - so what we're aiming to do is develop the objective, independent evidence; provide them with the understanding that actually you shouldn't be ruling out the gas network or selecting this pathway at the minute because we don't really know what the solution is' (17).*

The promotion of the benefits of gas networks was associated by some interviewees with the upcoming Ofgem price control review process with gas networks seen to be attempting to shape the view of Ofgem in order to get a positive regulatory settlement (7, 42, 47). The behaviour of incumbents associated with heat decarbonisation therefore clearly has implications for both Ofgem's regulation of the networks and the price control review process itself.

Policy recommendation 5: Throughout the Ofgem Price Control Review Process for the gas networks post 2021, the future of heat must be a central theme. Ofgem will need to devote significant resources to the issue and to ensure that they are basing decisions on objective and independent evidence.

Case Study 1 – Framing competing technologies as overly expensive

Two interviewees suggested gas networks had been lobbying against the development of district heat networks as a way of protecting their own assets (16, 18). According to one interviewee a gas network has said that 'district heating needs 75 pence a kilowatt hour subsidy to be built. And it was like, you're not in the industry, you don't. And this was him, going, you need an eight year payback? Do you build your network with an eight year payback, Wales and West? No. I don't think you do.' (16).

Further investigation into this specific example leads towards a report by gas network Wales and West Utilities which does indeed suggest that installing district heat networks in one area in their network would require a subsidy of 75.03p/kWh. However, this number was based around a 3 year financial payback for the district heat system. For an infrastructure technology, this does appear an extreme number to highlight when for example, in comparison, gas network assets have a financial depreciation time period of 45 years (Ofgem, 2013). It appears therefore that the analysis conducted has purposively attempted to make district heating appear more expensive than it should be in order to protect their own technology. Figure 2 below shows an extract from the Wales and West Report highlighting the extreme nature of the number used.

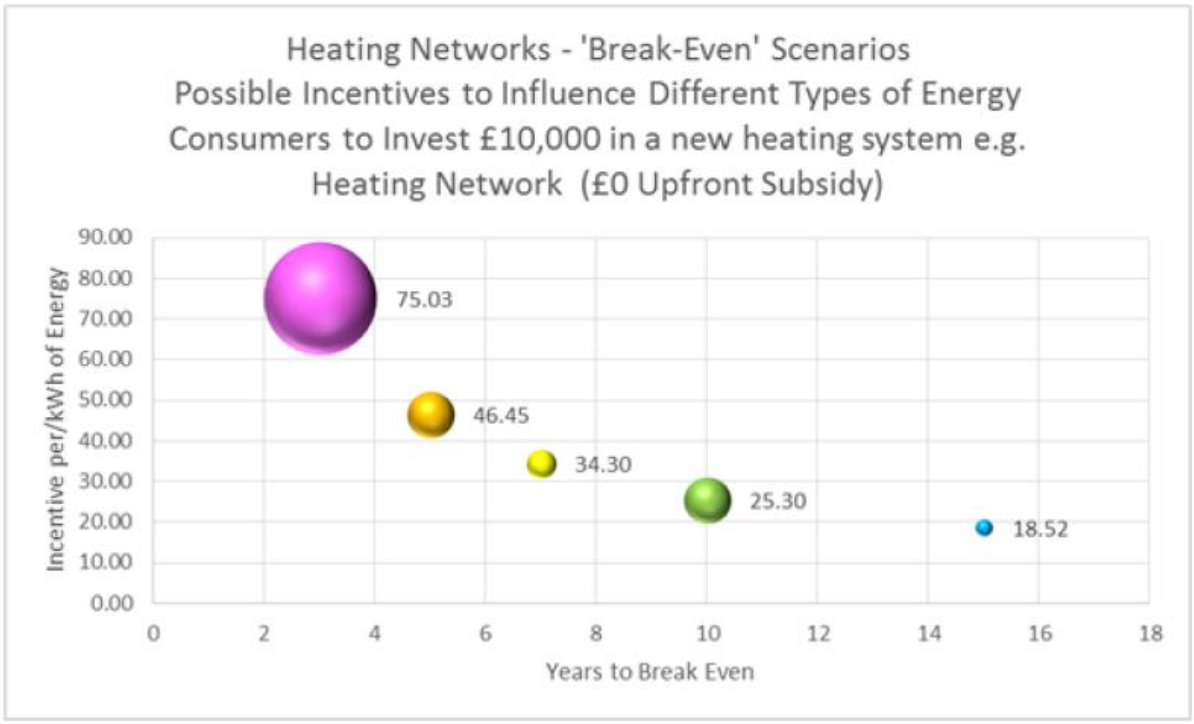


Figure 2. Graph of potential heat network costs from Wales and West Utilities Report (Wales and West Utilities and Business Navigators, 2015, p22)

The report by Wales and West was paid for by gas consumers through network charges at a cost of over £40,000 and appears to have had no independent review. This example highlights some issues with the current innovation regime for gas networks around value for money, research quality and actual benefits of the research. This example also seems to show a gas network company using consumer innovation funding to finance research which is primarily produced for lobbying purposes.

While this is an interesting example, this approach of attempting to damage other technologies may not be limited to gas networks. Another interviewee also suggested that the oil heating industry was attempting to make other competing low-carbon technologies look more expensive than they actually are (8) and another example was highlighted on apparently independent experts being financed by incumbents to work for them when they are in fact not independent (16).

The case study provides an interesting example of an incumbent looking to slow the development of heat networks. Interestingly, we have discovered a previous article in journal Energy Policy from 1980 which explains that the then British Gas Corporation was against the development of district heating and combined heat and power systems (Jenkins, 1980).

The previous case study also highlights a clear and specific issue with the Ofgem innovation funding scheme for networks and shows that rather than using the funds to produce objective and societally valuable research, innovation funds are being used to produce non peer reviewed analysis which has potentially limited value. One other example we have come across is another consumer funded report released by Cadent considering the potential for UK bioenergy potential which seems to promote the use of bio-energy in the UK gas grid (Anthesis and E4tech, 2017). We are aware however that the UK Committee on Climate Change is currently carrying out their independent review into bioenergy and so the report by Cadent could either be unnecessary duplication or, an attempt to influence the CCCs review[5]. This section also highlights more general issues around the reliance by policy makers on industry information. For example, the H21 Leeds conversion work is believed to have had an impact on Government policy but has not been independently reviewed and has clearly been produced by a vested interest.

4.1.3. Sub-section summary

In this section we have discovered significant activity by incumbents to attempt to influence Government policy and promote a gas based heat system in order to protect their existing assets. Much of this behaviour is linked to the gas networks and also the heating appliance sector. We have discovered limited engagement around this lobbying work by suppliers and upstream gas producers.

Hypothesis 4 developed from our previous working paper was that the largest sectors at risk from heat decarbonisation would be most active in their attempts to affect change. However, the largest sector we identified in our previous working paper, upstream gas appears not to be significantly involved and energy suppliers, a sector which is much larger than appliance manufacturers also appears not to be involved. The relative sizes of these sectors is shown in Figure 3.

Finding 7. The size of the sector at risk is not a good indicator of levels of engagement with political and regulatory lobbying and smaller sectors appear to be at least as engaged as some of the larger ones.

[5] https://www.theccc.org.uk/bioenergy-review-2018-call-evidence/

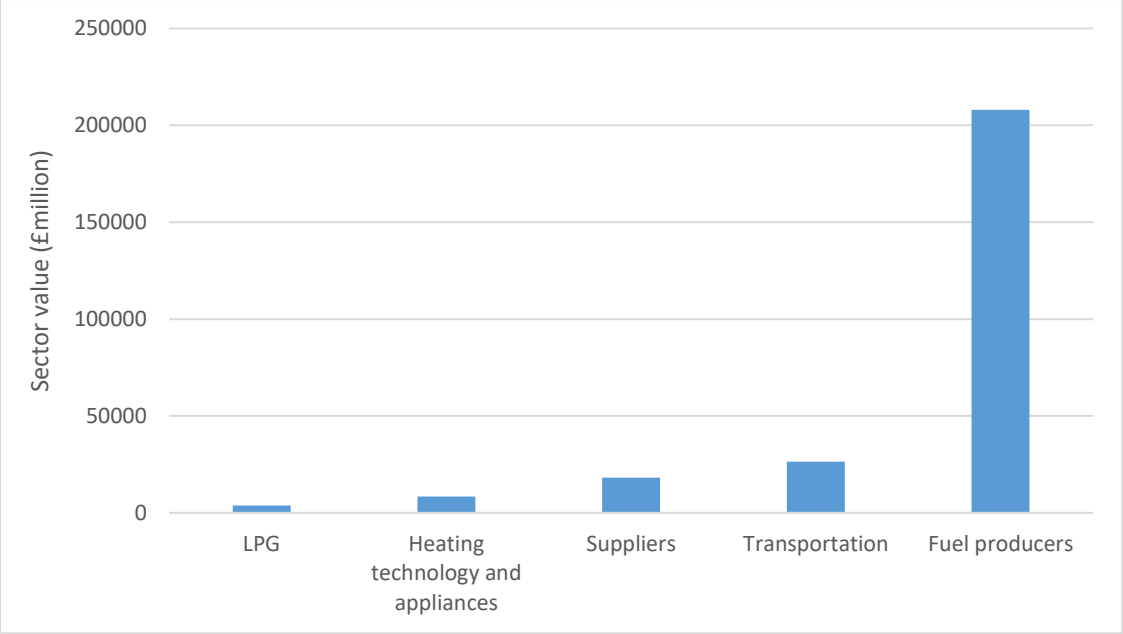


Figure 3. The value of businesses active in the UK heat market split by sector (Lowes *et al.*, 2018)

In light of the findings in this sub-section around innovation work by companies and the potential impact of company innovation on Government policy, we make the following specific policy recommendations.

Policy recommendation 6: Ofgem must ensure that any future consumer funded innovation work (of all scales) receives independent review before both funding and on delivery of the work. This should be a requirement of funding and would ensure network innovation work has value to current and future consumers and is of high quality. Ofgem should fully review their approach to funding innovation to ensure that new entrants, new ideas and new practices are allowed to access a level playing field for network innovation funding.

Policy recommendation 7: When designing policy, policy makers must always use information from the private sector in the knowledge that it is produced by vested interests and that it should be handled with care. Independent or peer reviewed data should be used when available.

4.2. Innovation

The next key area of interest around the behaviour of incumbents was around innovation, a term which we do not specifically define. Our general understanding of innovation includes research and development and changing business patterns and approaches. Investment, which we believe is linked, is considered separately in the following section.

While the interviews made a number of references to innovation, much of what was described was fairly diverse and a number of interviewees actually did not believe there was significant innovation going on in the UK heat sector (6, 8, 9, 30, 36). However, some interviews also suggested that it may not be obvious what is actually going on because not all innovation is public (14, 35, 20). It was suggested that overall the lack of innovation is not

necessarily a problem but the small market for low-carbon heating and lack of clarity on direction is a problem (4, 6, 25).

It was suggested that incumbents were seen to be important drivers of innovation because of their ability to acquire smaller companies and to find and deploy innovations at scale (29) linking ideas of innovation to investment, the subject of the next section.

Examples from interviewees of innovations delivered by incumbents included (in no particular order):

- The importation and introduction of propane produced from organic sources by Calor Gas (1, 36)
- The involvement of large upstream interests in low-carbon gases, primarily hydrogen (9, 14, 32)
- General ongoing innovation within appliance manufacturers (12, 14, 16).
- The development of micro-CHP appliances, historically by British Gas and more recently by Baxi (10)
- The development of a hydrogen boiler, supported by a Government grant (10, 40)
- Flow Boilers offering micro-CHP at no upfront cost with a peer to peer loan (20)
- Appliance manufactures working to develop smart controls (9, 35, 38)
- The involvement of big 6 companies including Centrica in CHP and district heating (much of which is funded through the Energy Company Obligation scheme (11, 12, 20)
- The involvement of big 6 companies in smart metering, smart controls and Centrica has been heavily involved with the development of smart controls (20) and another suggested that much of the innovation around smart metering and data sat with suppliers (24)
- SSE was described as having been involved in the deployment of heat pumps in collaboration with local authorities but this activity has apparently stopped (18). Eon has more recently become interested in heat pumps according to marketing material

Of the innovation taking place, much of this appears to be piecemeal and there is no coherent direction. Overall however, innovation is limited and this seems likely to be associated with the fact that there are no regulatory drivers to mandate low carbon heating and the Renewable Heat Incentive, the key policy to support renewable heat is not delivering at the scale originally envisaged (National Audit Office, 2018).

4.2.1. Network Innovation

Many of the references to innovation taking place led by incumbents were associated with regulated network companies and primarily gas networks. One interviewee suggested that electricity networks were not very involved in innovation around heat (42) and one electricity network themselves explained that much of their innovation was around changing business models for the electricity sector (45). It was noted that network innovation was primarily being funded through the Ofgem regulated innovation schemes (5, 14, 15, 44). Two specific examples of network delivered, so-called, innovation work was described in section 4.1.2.

In fact, all of the innovation mentioned by interviewees delivered by regulated network companies was funded through the Ofgem schemes. This included research into

- The option of converting the gas grid to hydrogen (14, 15, 21, 44)
- The Leeds Citygate H21 project (6, 7, 13, 21, 22, 28, 37, 40, 42)
- Potential collaborative follow on project from Leeds Citygate (14, 17, 43)
- The 'HyDeploy' project looking to blend hydrogen into the gas grid at Keele (21, 28, 42, 43)
- Research by gas network Cadent investigating bio-synthetic-natural-gas produced from waste (13, 14, 32, 42) with one interviewee explaining 'they're very optimistically pushing bio-SNG' (14)
- A project by Wales and West Utilities to install and test a number of hybrid heat pumps which combine a gas boiler with a heat pump (7, 13, 14, 21, 39)
- Innovation around the use of biomethane being injected into the gas grid (13, 21, 26, 44)

Despite the fact that there appears to be a significant quantity of innovation associated with the heat sector being carried out by the gas networks, there was a recognition from some interviewees that there were some issues with this innovation. One interviewee explained: 'The network companies are like that; what they regard as being innovative, in other companies would be regarded as business as usual.' (16). There was also a belief by one interviewee that the only reason they do any innovation work is because Ofgem provides the funding for them to do it (7). Another interviewee suggested that the regulated network model in general limits innovation (12).

In the words of another interviewee: 'It doesn't seem, in any sense, that the networks do anything that isn't directly incentivised by the regulator. I mean there's sort of another thing isn't there, that these privately owned companies; they have shareholders but potentially won't move a foot unless they can then claim it under some sort of incentive.' (23)

Previous analysis by researchers at UKERC has shown that the innovation incentives provided by Ofgem have indeed increased investment in electricity network innovation significantly compared to previous levels (Frame *et al.*, 2016).

Two interviewees highlighted the two new innovation schemes in the RIIO price control had stimulated networks to work on innovation (44, 32). Indeed, the RIIO GD1 framework did introduce greater levels of incentives for the networks to innovate including the Network Innovation Allowance for more business as usual innovation and the Network Innovation Competition for large more strategic projects, some of which have an environmental focus (Ofgem, 2012). Two representatives from networks believed this because of all of the innovation funding, explaining: 'there's a lot that they're [gas networks] well positioned to add to that debate in terms of those future options' (13) and 'our role in that has got to be

providing robust, objective evidence, that may be filling the gaps that people don't understand'.

Case study 2: The network innovation lean towards gas based solutions

This project hasn't attempted to analyse in detail what innovation is currently taking place in networks companies. However, a brief analysis of data from the Smarter Networks Portal which contains data from all Ofgem funded innovation projects has yielded some interesting results. We searched through this database for Network Innovation Competition or Network Innovation Allowance Projects involving heat for gas transmission and distribution networks. There were in total 12 gas network projects interested in hydrogen, 6 in biomethane, 4 investigating policy and technology research, 2 projects on bio-synthetic natural gas, 2 projects on shale gas, 1 project on 'green gas' and 1 project on the availability of bio-resource to produce green gas from.

When we searched through the electricity network innovation we found a much smaller total number of projects interested in heat. We found 4 projects where heat was being considered as part of a wider range of issues, 1 project on hybrid heat pumps, 1 on storage heaters and one on electric heat decarbonisation scenarios.

While our analysis has been limited by time constraints, we have clearly identified a significantly greater volume of research being carried out into heat decarbonisation by gas networks than power networks. The research we have identified by gas networks also appears to support the maintenance of the gas system by focussing on and promoting low-carbon gases.

4.2.2. Research of questionable quality

Overall, innovation around heat decarbonisation appears piecemeal and limited. A significant area of innovation is associated with networks, particularly gas networks. While innovation can of course be a good thing, as we highlighted earlier, we have found evidence of networks using innovation funding to produce research of potentially questionable quality at the consumers expense which is not independently reviewed and which appears to support the network's own interests.

The data considered in this section has also highlighted that while there is some innovation being carried out by the gas network companies into low carbon heat, this is focused around gas based technologies. At the same time there appears to be little in the way of network innovation for low carbon heat by the electricity networks. As a result, there is an unbalanced network innovation landscape for low carbon heat which is dominated by gas related research which considers gas decarbonisation pathways with little other heat decarbonisation pathways. There is likely to of course be significant innovation potential linked to heat decarbonisation for other networks such as district heat networks and electricity networks.

In light of these issues, we have developed one policy recommendation and one research recommendation:

Policy recommendation 8: Ofgem needs to ensure that any innovation incentives, if deemed necessary to be financed from consumer bills, do not support particular technologies over others and that the portfolio of research funded is balanced. This could be achieved through allocating funding to specific themes or technologies, allowing third parties to access network innovation finance or applying some sort of test to ensure that results have value across networks.

Research recommendation 2: More detailed research into the results and value of innovation by gas distribution networks would be of value. This could build on the research previously carried out by UKERC into electricity network innovation[6].

4.3. Investment

Investment was the final specific area of incumbent behaviour where we believed incumbents may be behaving in a way which could affect the transformation towards low carbon heat.

In advance of the interviews it was unclear where (if anywhere) there was any significant investment into low carbon heat taking place in the UK. Under the Renewable Heat Incentive Scheme, which is the key scheme looking to transform the heat system, there has primarily been delivery of biomass combustion systems and some biomethane projects (BEIS, 2018).

There was a belief among some interviewees that the financial scale of some of the incumbents gave them the ability to invest where smaller companies couldn't (11, 29). One interviewee explained: 'Well they, I guess are the major financial interests in the picture, so they can use their financial muscle to consider how they do or don't invest?' (11). Two interviewees also mentioned that investment by incumbents may be the consolidation or incorporation of companies into larger companies (10, 22) with one suggesting that if the low carbon market grows, incumbents will 'start to swallow up these companies' (10).

However, it was also recognised that in markets which were historically seen to be growth areas such as heat pumps which appliance manufacturers and suppliers had moved into (32, 35, 44, 46), companies have now left the market (10, 35, 45). This specific area appears to be a result of policy failures as the RHI has failed to increase the uptake of heat pumps since its' introduction (BEIS, 2018) despite these being originally seen as a very important strategic technology (DECC, 2013).

The areas where interviewees highlighted that some investment had taken place were:

- Historic investment by Centrica into biomass combustion (10, 18, 37).

[6] http://www.ukerc.ac.uk/publications/a-review-and-synthesis-of-the-outcomes-from-low-carbon-networks-fund-projects.html

- Investment in combined heat and power (CHP) and biomass CHP was mentioned (5, 22).
- Some investment by incumbents in biomethane (13, 36, 44).

The most highly mentioned area of investment in low carbon heating was district heating with a number of interviewees raising this (5, 10, 13, 17, 32, 37). According to one interviewee referring to investment in low carbon heat by incumbents: 'I guess the heat networks would be the biggest, most visible bit of it.' (15). There was a recognition that much of the investment by incumbents in district heating was by the big 6 companies (10, 20, 24) with Eon (11, 15, 16, 24, 29, 30, 33), SSE (7, 16, 24, 33) and British Gas (8, 15, 24, 34) being mentioned specifically.

Some of the investment by large energy suppliers into district heating has been through the Energy Company Obligation (ECO). The final report for the first phase of ECO does not give precise numbers but shows that some connections have been made (Ofgem, 2015). The most recent data from Ofgem for the second phase of ECO (2015 to present) show that 12,653 district heat connections have been made under the scheme (Ofgem, 2018).

Overall, general investment by incumbents in low carbon heat in the UK is limited and this appears to be primarily as a result of a limited market for low carbon heat and policies which are not ambitious enough. The investment by incumbents that has taken place is primarily associated with biomass, biomethane and district heating and this is primarily linked to the RHI and the Energy Company Obligation.

Policy recommendation 9. Government must be more explicit about the scale of the challenge of heat decarbonisation, and policy for heat must create a market for the deployment of low carbon heat at a level which is commensurate with the challenge and timescale of heat decarbonisation. Significant reforms and extra funding for the RHI (or whatever replaces it) are required to encourage investment and learning in low carbon heat. The existing framework of heat policies will not drive the decarbonisation of heat at the speed required to meet the UK's climate change targets.

4.4. Other behaviours of incumbents

The vast majority of comments regarding the behaviour of incumbents were linked around our three key themes of lobbying and regulatory pressure, innovation and investment however a number of other behaviours by incumbents were mentioned as being potentially significant.

Firstly, a number of interviewees highlighted the importance of the links between heat decarbonisation and consumers, specifically highlighting the links and relationships that incumbent companies can have with consumers. Interviewees suggested that consumers are clearly an important consideration associated with heat decarbonisation (7, 10, 14, 15, 33, 42). Indeed it is apparent that energy consumers will need to engage with heat decarbonisation much more closely than with other elements of decarbonisation. Much of the decarbonisation of the power sector seems to be taking place away from consumer's

homes (although some, such as the deployment of solar PV and onshore wind is closer to people). The decarbonisation of road transport also appears to have momentum towards electric vehicles which appear to be able to replace petrol and diesel cars like for like. However, any heat decarbonisation pathway (including converting the gas grid to hydrogen) will require changes in people's homes, including new appliances, greater levels of energy efficiency and some new heat distribution systems.

A number of interviewees specifically highlighted concerns that consumer preferences could be actively being shaped by incumbents in a way which supports the existing gas system (11, 16, 29, 31). One interviewee suggested that incumbents 'can guide the public narrative and public opinion on it' (31). Despite a concern that incumbents may be undertaking this behaviour, interviewees did not raise specific instances of this happening.

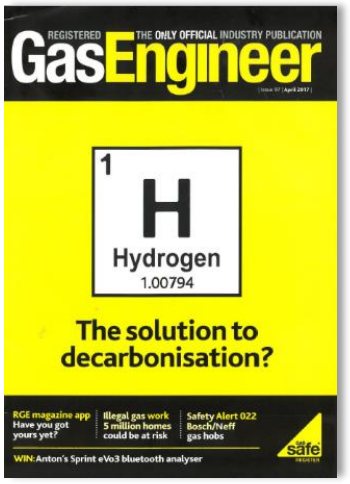
There are two key publications which exist on consumers and heating. Firstly, Hoggett *et al.*, (2011) considered existing analysis on consumer heating. More recently, Frerk and Maclean, (2017) considered the potential impact of heat decarbonisation on consumers and impacts on fuel poverty, suggesting that a much greater focus on these issues must be considered in plans for decarbonisation. The issue of heat decarbonisation and consumer engagement/impact is a major issue and there is a lack of research in this area.

Research recommendation 3: Research on consumers and heat is extremely limited and much more work in this area is needed.

Linked to the issues of consumer perception and engagement, interviewees also highlighted the importance of the views and behaviours of the heating installer industry (9, 25, 35). When energy consumers do engage with heating issues, this will either be through contact with an energy supplier or through a heating engineer, most likely, replacing or servicing an appliance. There are around 130,000 registered gas engineers (and 74,000 businesses)[7] in the UK and there will of course be other heat engineers working on oil, electrical and renewable heating.

It was suggested that the appliance manufacturers have a very good relationship with the installer industry through training courses offered by manufacturers (35). One interviewee believed that an article published in industry magazine 'Gas Registered Engineer' around the idea of converting the gas grid to hydrogen was an example of certain appliance manufacturers 'sowing seeds with coalface heating engineers.' (9). Indeed, an article for the April 2017 issue of the magazine contains an article on hydrogen in which a representative from boiler manufacture Baxi states:

[7] Personal communication with Gas Safe register



'To the end-user, hydrogen is business as usual…It's the best fit for the majority of UK housing stock with minimal upheaval for the consumer. It's much more cost effective that the electrification of heat; it resolves a lot of the issues around consumer acceptance, and you can produce high-grade heat with the same level of performance that you get from today's boiler. It's a good retrofit answer' (Gas Registered Engineer, 2017)

There are a large number of heating engineers in the UK who have a close relationship with energy consumers and appliance manufacturers. It is these engineers who, in any low carbon transformation will need to be working with consumers to install new heating appliances. In this project, our focus on incumbents has meant that we have primarily focused on large companies. We therefore believe that the installer sector is a very important element of the UK heat sector worthy of further investigation.

Research recommendation 4: A much greater understanding of the heating installer industry would benefit policy makers and may be a fruitful area of research.

4.5. Chapter summary

In this chapter, we have considered the behaviour of incumbents based on data gathered during interviews and wider grey data sources. Much of the behaviour of incumbents can be associated with regulatory and lobbying pressure, innovation and investment. We have highlighted significant levels of lobbying and regulatory pressure, much of which is associated with the heating appliance industry and gas networks. The focus of this is looking to maintain a gas based heating system, however it is unclear whether a gas based decarbonisation pathway is compatible with a sustainable and secure energy system.

We have discovered that while some innovation around heat decarbonisation is taking place, much of the research is associated with gas network led and consumer financed innovation. Associated with this is research primarily focused on maintaining a gas based system which has received very limited external scrutiny or review. We believe the Ofgem innovation incentives require some significant changes.

Investment in low carbon heat in GB is limited and is not commensurate with the challenge of decarbonising heating by 2050. Investment which has been undertaken, has been linked to the Energy Company Obligation led by suppliers and linked to the Renewable Heat Incentive apparently financed on a project by project basis.

Our second hypothesis suggested that incumbents who see reduced risk as a result of pathway 2 (i.e. converting the gas grid to hydrogen) are expected to be supportive of this pathway. Our research indicates that this hypothesis is correct and in particular gas networks have been active in both innovation, and lobbying and regulatory pressure. Appliance manufacturers appear to have been more involved in lobbying and regulatory pressure but still support this pathway.

Our fourth hypothesis suggested that the largest sectors put at risk by decarbonisation are expected to be the most active in their engagement around heat decarbonisation policy, innovation and investment. Interestingly our results suggest that this is not the case and the largest sector (upstream gas) hasn't been particularly involved nor have energy suppliers (the third largest sector).

This chapter has also highlighted the potential links between incumbents and consumers including the relationship via the installation industry. We suggest further research in this area would be of value.

5. Other elements of incumbency

The previous chapter considered the behaviour of incumbents that may affect system change. This section highlights other elements of incumbency that have emerged from our research which may have an impact on transformation of the UK's heat system. While these elements may be linked to the behaviour of incumbents, we see these as less active or purposive attempts to affect the move towards low carbon heating. We do however believe they are important elements of incumbency we have identified.

5.1. Tensions within incumbents and within incumbent networks

One element identified through our research was that internal tensions and differences exist both within large incumbents and within groups of incumbents. (4, 18, 30). These tensions exist because organisations are being put at risk by, or challenged by change, but different elements of companies, or people within companies can have different views or interests.

One specific example highlighted in interviews was associated with a large integrated energy company SSE (18). In SSE, one part of the business is looking to invest in and grow the number of district heating customers, while another is looking to maintain and grow gas networks in the same areas, resulting in two parts of a business lobbying for different outcomes (18). In this particular example, it is possible that the work of both elements of the incumbent cancel each other out with the overall effect of system inertia.

These issues will be specific to certain companies who have business interests spread across heating. Other integrated companies may have less diverse interests, for example some companies may be more interested in electricity and others more interested in gas. In these situations it may possibly be a case of incumbents disagreeing with each other rather than having internal disagreements.

Highlighting the potential for intra-company disagreements, two interviewees explained that developing joint positions at trade associations could be a challenge because of the varying views of member companies (1, 10). As an example, between appliance manufacturers, views on what a future heat system should look like were believed to vary significantly (9, 22, 35). This therefore implies that the publicly stated views of bodies and associations representing groups of companies may not be representative of actual member views. It may also mean that these intra company groups are unable to give any meaningful view.

Overall, we believe this is an interesting area for further analysis and we make the following recommendation.

Policy recommendation 10: The views of trade associations and industry groups should not be taken as representative of the entire industry by policy makers. Active efforts should be taken to consider marginal views such as those from new entrant companies linked to specific ideas or technologies which may be equally valuable or more valuable to policy makers in the long run.

5.2. Protection of market positions

Incumbent attempts to inhibit change were associated with maintaining market positions rather than stopping change per se. There was recognition amongst a number of interviewees that an important element of incumbent behaviour was primarily about protecting market positions rather than protecting a specific technology (2, 10, 9, 11, 12, 15, 29, 35). This therefore implies that while incumbents may not be actively attempting to slow down change in general, their behaviours may passively slow down the move towards low carbon heating.

In the words of one interviewee: 'It may not be because they're against the idea of a low carbon transition, it might simply be because they want to make money, and they want to sell as many bits of kit as they possibly can.' (15). This view of incumbents suggests that it may make sense for government to work with incumbents early on, in order to support incumbents to diversify into low carbon heating and protect (to a point) market positions.

This should be an important consideration for policy makers. Why would an incumbent company in a market leading position want to see that market fundamentally changed, putting their market position at risk? Therefore, we restate our third and fourth policy recommendations:

Policy recommendation 3: Government and Ofgem should jointly consider supporting the diversification of gas network companies into district heat networks in urban areas. BEIS should consider how the regulatory framework and associated legislation around gas network companies could be modified to support the diversification of these companies into building and operating heat networks. The Ofgem RIIO2 Price Control Review process should also investigate the how gas network companies can be incentivised to invest or diversify into heat networks.

Policy recommendation 4: Government should engage more closely with the UK heat industry in particular offering support to those sectors particularly at threat from decarbonisation. This support should be to ease the transformation and diversification of companies towards providing low carbon heat products and services, and to reduce the effects of companies attempting to maintain market positions. Key areas where we recognise the potential for diversification are around support for gas networks to enter the district heat market and for appliance manufacturers to produce heat pumps.

5.2.1. Resistance and delay tactics

Closely linked to ideas of the protection of market positions, a number of interviewees mentioned a general element of incumbency associated with resisting change. Some interviewees associated incumbent behaviour with resistance (10, 16, 31) and specifically, one interviewee suggested that the culture of incumbents is 'a resistance to change' (16).

Some interviewees suggested that incumbents may also be attempting to use delay tactics to slow change (10, 12, 18). A specific example of this was that two interviewees believed that some companies were making the most of the uncertainties around pathways for heat decarbonisation to slow down the decision making process (12, 21). According to one interviewee, 'they're literally trying to muddy the waters, so that everybody is, "Maybe we'll do this, maybe we'll do that." And slow it down.' (12). Two interviewees suggested specifically that the idea of converting the grid to hydrogen was being promoted as an idea in order to slow change (7, 8).

We also discovered evidence of incumbents 'talking down' low carbon heat technologies which could challenge incumbency, much of which happened during interviews. This included:

- Suggesting heat pumps aren't suitable for UK homes (40)
- Suggesting heat pumps wouldn't work in off gas grid properties (1, 36)
- Highlighting impacts on the electricity networks and electricity generation caused by a potential move to more electrified heating (17, 38, 39)
- Suggesting heat pumps may become a future payment protection insurance type issue leading to major consumer problems: 'You know, people have been ripped off; this is a future PPI, I reckon, when people find that they've been ripped off through putting heat pumps in - which is costing them more, and isn't saving the planet' (17)

Amongst UK policy makers, it is apparent that a specific pathway for heat decarbonisation is not obvious. The Government's Clean Growth Strategy recognised that fully decarbonising heat was likely needed by 2050 but suggested that two key pathways were currently envisaged. One which focuses on electrification of heat and one which adapts existing gas infrastructure to rely on hydrogen (HM Government, 2017). They went on: 'However, at present it is not certain which approaches or combination of them will work best at scale and offers the most cost-effective long-term answer. Decarbonising heat is our most difficult policy and technology challenge to meet our carbon target' (p75).

There are significant technical uncertainties associated with decarbonising the UK's heating using hydrogen as we have explored previously. Yet the idea, as we have shown in this paper is receiving strong support through both lobbying and innovation associated with incumbents. Because such a rapid and transformational change is required for the UK's heat system, which could use known technologies already demonstrated on a global level, and because of the uncertainty of hydrogen, we re-state our first and second policy recommendations:

Policy recommendation 1: Whilst technologies to decarbonise the gas grid could play a role in decarbonising heat, they are partly being promoted as a defensive strategy by gas industry incumbents. Government should support careful demonstrations of, and research into technologies which have the potential to decarbonise of the gas grid, and compare the economic, environmental and other performance of such demonstrations with more established low carbon heat technologies.

Policy recommendation 2: It is important that the focus on decarbonising the gas grid does not detract from other technologies. The speed of the required transformation to low carbon heating means that current policy should support the rapid deployment of low carbon heat technologies such as heat pumps, district heating and demand reduction which are proven at scale around the world.

5.3. Incumbent networks, coalitions and supply chains

While in section 5.1, we recognised potential tensions both inside incumbents and between groups of incumbents, there was also a recognition from interviewees that incumbents may work together and behave in symphony to work as coalitions. One interviewee linked this idea to ideas around the development of so-called actor networks (11).

Interviewees gave evidence of certain trade associations working together to produce joint responses to government consultations where there were shared messages and outcomes (1). It was also suggested that the power of companies could be enhanced when supply chains work together, such as different energy suppliers with preferred appliance manufacturers (10). The relationship between appliance manufacturers and the installer industry is one we explored in section 4.4 but we believe it warrants further expansion here. In one particular supply chain in the heat industry, Centrica, which owns supplier British Gas, operates across the entire gas supply chain. Centrica has interests in upstream gas production, it owns British Gas which, as well as being an energy supplier also owns 8% of the domestic gas installer market (40). Through its installation arm, British gas has links to appliance manufacturers through bulk purchase agreements (37). According to one interviewee:

> *'If you're a British Gas, you have huge purchasing power and quite a bit of control over the supply chain. Appliance manufacturers and installers. Actually in that case, they're an installer themselves, but they'd be buying initially hundreds of thousands of boilers or whatever a year, and they could demand quite a lot, if they wanted to….so then there might be a certain amount of market control that an incumbent like that has. (15)*

This particular example of the links between actors across a supply chain emerged from the interviews and may not be representative across the sector. It does however highlight Centrica's high level of involvement in a number of gas market based activities and potential high level of influence across both the installation and the appliance industry. We therefore see Centrica as a central business actor in the UK's heat system beyond simply being the largest gas supplier. It is worth highlighting that interviewees also recognised that other suppliers also had relationships with appliance manufacturers (10, 15, 40).

However, our analysis highlighted other elements of coalition and network building in the UK heat sector. One example was announced publicly via Twitter where the Chief Executive of the EUA trade association which represents gas appliance manufacturers explained that he had: 'just finished an interesting meeting with industry, trade unions and wider stakeholders

on the future role of gas'. An employee at Cadent retweeted the comment confirming details of other attendees, including three of the UK gas network operators, two trade unions, and the networks arm of the EUA (screen grab of tweet below). This example implies active work to build a network with a focus on maintaining the gas system. While it is no huge surprise that these sorts of meetings take place, it seems odd to announce the meeting publicly.

Figure 4.Retweet by David Parkin of Cadent on 30th October 2017

Linked to this tweet, there were two comments from interviews regarding the EUA trade body which interviewees has suggested had become increasingly pro-gas (3, 12):

> *'they seem to have made a strategic decision that now, what they have to focus on, is protecting gas…And then at the same time that they started doing that, this whole narrative around hydrogen stuff is emerging as well, it's like they've said, "We're only going to have one message, and it's going to be this' (12)*

> *'When the old chairmen left, they had a group with it call the Low Carbon Technologies group. That got changed to the Policy group. So just within the last three years, that total rhetoric of that organisation has changed to gas-centric and no longer renewables.' (3)*

Together, the tweets and comments suggest an increasing gas focus, supportive of a pathway which maintains a gas based system which as we described previously has a number of uncertainties and issues associated with it. In light of these comments, we re-affirm our ninth policy recommendation:

Policy recommendation 9: The views of trade associations and industry groups should not be taken as representative of the entire industry by policy makers. Active efforts should be taken to consider marginal views linked to specific ideas or technologies which may be far more valuable to policy makers.

5.3.1. The 'Decarbonised Gas Alliance' and the role of the shale gas lobby

As we explained in our previous working paper, one of the proposed methods to produce hydrogen is by using steam methane reformation where natural gas is used as a feedstock.

Shale gas could be used in the same process to produce hydrogen and therefore hydrogen can be promoted as a technology which requires gas. The hydrogen pathway therefore offers a potential new market for shale gas.

A number of interviewees mentioned an emerging network known as the 'Decarbonised Gas Alliance' (DGA) and this network is associated with a group which represents shale gas interests, the UK Onshore Operators Group, UKOOG. One interviewee explained that the DGA is: 'being coordinated obviously by UKOOG' (14).

Another interviewee explained:

> *'UKOOG convened a series of meetings about using hydrogen in gas networks and using hydrogen in general, but focused on gas networks and heat decarbonisation, which I went to at least one, and I'm on the email list. That was pretty transparent attempt to say, "Gas still has a future, this is how it has a future", but because hydrogen has very widespread support in some quarters, quite a few people have signed up to this group. They've now signed over the secretariat function to, what are they called? DNV GL.' (6).*

A number of papers produced by the DGA were shared by some interviewees with the research team. According to a recent presentation given to BEIS on the 9th January 2018 by the DGA, shared with us by an anonymous interviewee, the DGA believes 'Decarbonised gas is the only realistic way to meet the challenge of decarbonising heat'; much of the focus of the presentation was around hydrogen.

The development of the DGA by the UK Onshore Operators Group and its move to using DNV GL as an independent secretariat is also corroborated by DGA steering group papers shared with us by an anonymous interviewee which explain that an employee at the UKOOG: '[NAME REDACTED] Will continue to produce drafts and make edits to DGA papers and consultation responses' following the move to DNV GL.

Documents from the DGA explain that the organisation has a steering group formed of:

- Energy Networks Association;
- Energy and Utilities Alliance;
- Carbon Capture and Storage Association;
- University of Chester;
- Shell;
- Institution of Gas Engineers and Managers;
- United Kingdom Onshore Oil and Gas.

These members are clearly gas interested parties, many of whom have appeared already in the analysis in this paper. The University of Chester is also linked to shale gas, hosting the so-called 'National college for onshore oil and gas'[8] (the building to host the courses was gifted

[8] http://www.ukoog.org.uk/about-ukoog/press-releases/137-national-college-for-onshore-oil-and-gas-unveiled

by Shell[9]). One interviewee also linked Centrica to UKOOG (31) however we couldn't find any evidence that Centrica had been involved directly with the DGA but, according to Companies House, a member of Centrica staff is a director of UKOOG[10] and Centrica is known to have financial interests in fracking[11].

Finding 8: There is a clear relationship between the shale gas lobby group, UKOOG and a new network, the Decarbonised Gas Alliance. The Decarbonised Gas Alliance has been promoting a future energy system which maintains a gas based heat system and as well as being linked to shale gas, is also linked to a number of incumbents in the UK heat sector.

[9] https://www.chesterchronicle.co.uk/news/chester-cheshire-news/chancellor-opens-science-park-outskirts-8461799

[10] https://beta.companieshouse.gov.uk/company/08257978/officers

[11] https://cuadrillaresources.com/media-resources/press-releases/cuadrilla-welcomes-centrica-as-new-investment-partner-in-lancashire/

6. Conclusions and policy implications

In this working paper, we have discussed some of the results from a large number of interviews with experts from the UK's heat sector, considering the idea and importance of incumbency in the UK's potential move towards low carbon heating. We have built on the interview data, linking it to our previous working papers and also relating it to relevant grey literature sources.

The first empirical section considered the changing role of incumbents. Interviews highlighted that incumbents with an interest in gas envisaged a much greater role for gas based heating in a low carbon economy than interests who were less involved in gas. The interviews (from non-incumbents) however highlighted the uncertainties and issues associated with decarbonising the gas grid. Gas networks were highlighted as the incumbents both most at risk, and most unable to respond to heat decarbonisation because of the long term nature of the businesses and also because of the regulation that controls their behaviour.

The second empirical section considered the behaviour of incumbents which could impact the future. Our research highlighted a significant amount of work by heat incumbents associated with lobbying and regulatory pressure, although this was almost fully associated with the gas network sector and appliance manufacturers. Suppliers and gas producers do not appear to have been particularly active in heat decarbonisation policy networks.

Our research also showed that some innovation was taking place in the UK's heat sector but this innovation is piecemeal and incoherent, linked to a lack of clarity by Government on the requirement to decarbonise heating and approaches to do so. Much of the innovation around low carbon heating is being carried out by gas networks under the Ofgem innovation schemes. However, much of this innovation is linked to maintaining a gas system and we have discovered so-called innovation of potentially questionable quality which appears to be being used for lobbying purposes. We therefore call for significant changes to the Ofgem innovation scheme to ensure that all research is justified and objective.

While we expected investment to be a particularly important element of incumbent behaviour, overall our research highlighted very limited investment in low carbon heating in the UK. This appears to be a result of limited policy support and the lack of a clear market for low carbon heat. Interviews highlighted that one area incumbents may also be having an impact on heat decarbonisation, or have an impact in the future, is through their relationships with consumers and heating engineers and installers however, no examples of this behaviour emerged.

Some other elements of incumbency emerged from our research which may also have an impact on the future. These included the impact of tensions within large incumbents which could inhibit change, attempts by incumbents to protect market positions, thereby inadvertently attempting to maintain incumbency and the development of gas coalitions and networks with the focus of attempting to maintain a gas based system.

In our previous working paper, we developed a number of hypotheses and we now build on these in more detail.

- H1: Incumbents put at risk by pathway 1 are expected to be opposed to this pathway.

Pathway one sees much of UK heat demand converted to electric heating or served by heat networks. Overall, we discovered significant evidence of incumbents behaving in a way which looks to promote their own technologies rather than the technologies in this pathway, but we also found specific evidence of incumbents from the gas sector and indeed off-grid technologies 'talking down' ideas of electrification and heat pumps. Much of this behaviour appears to be linked to lobbying and regulatory pressure. In particular, gas and off grid incumbents appeared opposed to the expansion of heat pumps. Our research supports hypothesis 1.

- H2: Incumbents who see reduced risk as a result of pathway 2 are expected to be supportive of this pathway

We found clear evidence of incumbents interested in gas, supporting the pathway which maintains the gas system and converts it to hydrogen. This was primarily associated with gas networks and appliance manufacturers who engaged in both lobbying activity, and innovation and research and development which aim to maintain a gas based system. Our research supports hypothesis 2.

- H3: Incumbents put at risk by both pathways are expected to be opposed to both pathways

Our previous working paper highlighted that those involved in the off-gas grid sector are some of the business sectors most at risk from heat sector decarbonisation. This includes those involved in oil and liquid petroleum gas heating. These sectors didn't feature particularly significantly throughout interviews potentially because of their size. However grey literature suggests that both the oil and LPG sector support a decarbonisation pathway for off-gas-grid areas which maintains oil or LPG by replacing this with bio-energy including bi-diesel or bio-LPG. This therefore supports hypothesis 3.

- H4: The largest sectors put at risk by decarbonisation are expected to be the most active in their engagement around heat decarbonisation policy, innovation and investment.

In general, the majority of involvement in lobbying and regulatory elements of heat decarbonisation was from the gas networks and the gas appliance sector, and it was primarily networks involved in innovation. We discovered very limited engagement by gas producers and energy suppliers, despite these sectors being the 1st and 3rd largest sectors (respectively). There was however some engagement from the upstream and supply sector via the so-called Decarbonised Gas Alliance. Our research therefore does not support our fourth hypothesis. It appears that the supply and upstream sectors are more focused on shorter term issues as opposed to strategic and long term questions.

Overall, our findings show that incumbents are supportive of heat decarbonisation pathways and approaches which maintain similar business practices in the future and are not opposed to decarbonisation per se. However, it is very uncertain whether a decarbonisation pathway which maintains a gas based heat system will allow the UK to meet its decarbonisation targets while creating a secure and equitable energy system and the promotion of a high gas pathway could inadvertently lead to the UK not reaching its decarbonisation goals. We are also concerned that the emergence of the hydrogen pathway, which has been heavily promoted by incumbents, will detract from the need for other technologies and approaches to decarbonise heat including energy efficiency, heat pumps and district heat networks.

6.1. Policy implications: The importance of policy for the heat transformation

Throughout this document, we have developed a number of policy recommendations based on our findings. Interviewees from both heat sector incumbents and new entrants recognise a vital role of policy and governance to drive heat decarbonisation.

Amongst views from incumbents, it was suggested that companies will not act on decarbonisation on their own. One interviewee explained: *'I think it would be naive to think that people are going to switch of their own free will…it need to be stick, not carrot sometimes…do this because it's the right thing to do," is really not going to wash with probably the power play that goes on in the boardrooms of many of these incumbent companies'. (1).*

Another explained: '*at the moment there's no pressure on them* [incumbents] *to make that move*' (10). One interviewee from an incumbent explained the view of incumbents is: "*we're just about making profits for our shareholders, and that's* [dealing with climate change] *somebody else's job, that's the job of government to sort that out.*" (2)

Incumbents also mentioned the importance of long term certainty from Governments highlighting the importance of guaranteed markets if investment is to be made in for example heat pumps or hydrogen (38, 40). A number of new entrants also highlighted the importance of policy to cause heat system change (3, 24).

Around district heating, preferential treatment for gas over district heating was highlighted (16) as was a general lack of pressure to cause change (19). As a result, rather than seeing any transformation, it is seen as 'business as usual…the weakest link has always been the failure of government policy to give consistent focus going forward (40). One interviewee made their point simply:

'Without helpful policy, there is no [low carbon heat] *market.' (46)*

Interviewees not associated with heat businesses agreed on the importance of policy to drive change. One interviewee specifically mentioned the importance of political leadership:

> *'Yeah, it has to be politically led…because why would a company do it if they think the next energy minister - i.e. in a year's time - is going to change it?' (25)*

One interviewee believed that incumbents had often been asking for more government support to change (28). There was a belief that the market would not lead the move towards low carbon because there are no drivers to make this happen (32, 35). There was also a suggestion that because of the potentially local nature of heat decarbonisation, in particular around the role of gas networks, planning by government interests would be necessary (33).

Specifically with regard to gas network companies, it was suggested that it was impossible for regulated network companies to change without Government support because of their regulated nature (30).

Overall, there was agreement from across the different categories of stakeholders that major government intervention will be needed to drive the decarbonisation of the heat system. There are of course some differences of opinion from stakeholders on what form that intervention should take.

Annex 3 contains our full list of policy recommendations, key findings and recommendations for further research.

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Annex 1 – Semi-structured interview questions

1. What do you understand by the term 'incumbency' in the context of the UK's heat system?

2. If the UK moves to a low-carbon heat system, will the role of incumbents change? If so, how?

3. Are incumbents helping the UK to achieve a move towards low carbon heating? Why/how?

4. Are incumbents affecting the UK's approach to move to low carbon heating through:
    a. Lobbying and regulatory pressure?
    b. Innovation?
    c. Investment?

    3.5 to 6.5
5. When we have been thinking about the role of incumbents, we have considered primarily lobbying and regulatory pressure, innovation choices and investment choices. Are there any other ways incumbents could affect the transformation to a sustainable heat system?

6. Has the impact of these incumbent companies on governance, policy and regulation been increasing?

7. What could the effects of the behaviour of incumbents be for a future low carbon heat system?

8. Are new entrants playing a significant role in the UK's transformation to low carbon heating?
    a. If so, how?

9. What impacts if any, are new-entrants having on incumbency in the heat sector?

10. Could you recommend any other potential interviewees?

Annex 2 – Emergent coding structure

Parent codes are in bold and sub-codes and sub-sub-codes are not in bold and indicated by an indent. 'Sources' indicated the number of interviewees or other sources who/which have referred to a particular code. 'References' refers to the total number of references within that code. Sources were also coded by type of interviewee for analysis purposes.

Name	Sources	References
Cost driving industrial change	1	1
Customer issues	22	38
Definition of incumbency	1	1
Already in the market	27	36
Big 6	9	11
Gas associated companies	20	26
Have power	5	6
Incumbency does exist	1	1
Incumbency in government	1	1
Incumbents are unable to change	1	1
Inertia	14	24
Lack of diversity	1	2
Large	3	4
Linked to an actor	2	2
Linked to technology	2	2
Networked	3	4
Not aware of term	4	4
Operating for a period of time	4	6
Regime actors	2	3
Retrofit	1	1
Status quo	1	1
Technology	1	1
Vested interests	1	2
Effects of incumbents on the future heat system	5	5
Power is with big incumbents rather than installers	3	3
Housebuilders	1	2
How incumbents may impact the future	1	1
Centrica are very important	1	1
Delay tactics	5	11
Difference in responses between upstream and transportation	1	1
District heat is too hard	3	5
Divestment	1	1
Drawing on international experience	6	8
Engagement with consumers	13	19
Engagement with installers	4	8
Engagement with unions	1	1

EUA becoming more gas focussed	3	4
Financial clout	2	3
Focus on efficiency rather than decarbonisation	1	1
Focusing on core	1	1
Foreign ownership	1	1
Gas coalitions	8	20
Gas connections new build homes	1	1
Increased competition	1	1
Increasing focus on heat	1	1
Incumbents can be the driving force of change	3	4
Innovation	46	119
Network innovation	8	12
Internal tensions in large organisations are causing issues	13	29
Investment	19	25
Investment in DH	18	32
Investment in electric heating	1	1
Investment in heat pumps	7	12
Limited heat expertise	1	4
Lobbying and regulatory pressure	51	157
Maintenance of market positions	12	22
New business models	2	2
Open-mindeness	7	8
Organisations working together	1	2
Promotion of bio-energy	4	8
Promotion of gas system benefits	3	4
Promotion of hydrogen to maintain gas	13	26
Providing evidence to shape the debate	2	2
Resistance	10	15
Risk aversion	1	1
Short term business planning	2	2
Suggest heat decarbonisation is too hard	1	1
Suggesting electrification is too hard	13	27
Talking down other technologies	1	1
Raising issues with solar PV	1	1
How will incumbents need to change	1	1
Be nationalised	1	1
Death of companies	16	19
Depends on the scenario	3	3
Depends on their current role	3	4
Focus on local	1	1
greater competition	1	1
Hybridisation	3	4
Incumbents will be changed by tech	1	1
Investing and diversifying into low-carbon	17	37
Low-carbon gases	39	109

Low-carbon gases have problems	16	33
Off-gas-grid focus	1	1
Reduced role for gas grid	6	7
They won't	6	9
Tokenism by incumbents	2	2
Incumbency as positive, negative or mixed	0	0
Incumbency as positive	4	5
Incumbents a negative force	13	22
Mixed	12	14
to drive change if they choose too	2	3
Industrial road map	1	1
Power of climate science has reduced incumbency	2	2
Power of policy to drive change	28	54
Heat pumps damaged by policy	2	5
Increased reliance on industry	3	4
RIIO GD2	1	1
Shale gas	7	24
Social construction of technology	1	1
Supply chains	14	26
Lack of supply chains	1	1
Technology driving incumbents	1	1
The role of new entrants	23	49
Architects	1	1
Biomethane	3	3
Heat pump companies moving in	7	8
Limited power of new entrants	6	10
Local authorities becoming involved	4	4
New business models	3	4
Still affecting debates	1	1
Struggling	2	4
The role of SAP and architects	1	3
The role of the installation industry	13	28
Trade Unions	1	1
Type of actor	0	0
Incumbent	11	37
Industrial energy user	3	8
Niche actor	7	22
Non-business heat expert	20	68
Trade association	10	35

Annex 3 – List of policy recommendations, key findings and recommendations for further research

Policy recommendations

1. Whilst technologies to decarbonise the gas grid could play a role in decarbonising heat, they are partly being promoted as a defensive strategy by gas industry incumbents. Government should support careful demonstrations of and research into technologies which have the potential to decarbonise of the gas grid, and compare the economic, environmental and other performance of such demonstrations with more established low carbon heat technologies.

2. It is important that the focus on decarbonising the gas grid does not detract from other technologies. The speed of the required transformation to low carbon heating means that current policy should support the rapid deployment low carbon heat technologies such as heat pumps, district heating and demand reduction which are proven at scale around the world.

3. Government and Ofgem should jointly consider supporting the diversification of gas network companies into district heat networks in urban areas. BEIS should consider how the regulatory framework and associated legislation around gas network companies could be modified to support the diversification of these companies into building and operating heat networks. The Ofgem RIIO2 Price Control Review process should also investigate the how gas network companies can be incentivised to invest or diversify into heat networks.

4. Government should engage more closely with the UK heat industry in particular offering support to those sectors particularly at threat from decarbonisation. This support should be to ease the transformation and diversification of companies towards providing low carbon heat products and services and to reduce the effects of companies attempting to maintain market positions. Key areas where we recognise the potential for diversification are around support for gas networks to enter the district heat market and for appliance manufacturers to produce heat pumps.

5. Throughout the Ofgem Price Control Review Process for the gas networks post 2021, the future of heat must be a central theme. Ofgem will need to devote significant resources to the issue and to ensure that they are basing decisions on objective and independent evidence.

6. Ofgem must ensure that any future consumer funded innovation work (of all scales) receives independent review before both funding and on delivery of the work. This should be a requirement of funding and would ensure network innovation work has value to current and future consumers and is of high quality. Ofgem should fully review their

approach to funding innovation to ensure that new entrants, new ideas and new practices are allowed to access a level playing field for network innovation funding.

7. When designing policy, policy makers must always use information from the private sector in the knowledge that it is produced by vested interests and that it should be handled with care. Independent or peer reviewed data should be used when available.

8. Ofgem needs to ensure that any innovation incentives, if deemed necessary to be financed from consumer bills, do not support particular technologies over others and that the portfolio of research funded is balanced. This could be achieved through allocating funding to specific themes or technologies, allowing third parties to access network innovation finance or applying some sort of test to ensure that results have value across networks.
9. Government must be more explicit about the scale of the challenge of heat decarbonisation and policy for heat must create a market for the deployment of low carbon heat at a level which is commensurate with the challenge and timescale of heat decarbonisation. Significant reforms and extra funding for the RHI (or whatever replaces it) are required to encourage investment and learning in low carbon heat. The existing framework of heat policies will not drive the decarbonisation of heat at the speed required to meet the UK's climate change targets.

10. The views of trade associations and industry groups should not be taken as representative of the entire industry by policy makers. Active efforts should be taken to consider marginal views such as those from new entrant companies linked to specific ideas or technologies which may be equally valuable or more valuable to policy makers in the long run.

Key findings

1. The idea of decarbonising the gas grid has high levels of support from incumbents, in particular gas networks who have significant investment in gas assets. This supports our second hypothesis that incumbents are generally in favour of a pathway which maintains the gas system and looks to decarbonise gas.

2. The idea of decarbonising the gas grid using hydrogen has emerged both rapidly and recently while it has at the same time received significant support from incumbents.

3. Despite the views from incumbents that hydrogen represents a sensible approach to decarbonise heating, fundamental uncertainties still remain and the interview process has further highlighted these.

4. Appliance manufacturers and energy suppliers have the ability to rapidly diversify production and limited sunk assets and will therefore be able to be more nimble than the gas networks who are key incumbents.

5. Appliance manufacturers and energy suppliers have the ability to rapidly diversify production and limited sunk assets and will therefore be able to be more nimble in any transformation than the gas networks who have greater levels of sunk and long term assets and therefore a greater incentive not to change.

6. It is clear that elements of the UK heat industry are investing in a number of pieces of research for lobbying purposes which are promoting an ongoing role for gas.

7. The size of the sector at risk is not a good indicator of levels of engagement with political and regulatory lobbying and smaller sectors appear to be at least as engaged as some of the larger ones.

8. There is a clear relationship between the shale gas lobby group, UKOOG and a new network, the Decarbonised Gas Alliance. The Decarbonised Gas Alliance has been promoting a future energy system which maintains a gas based heat system and as well as being linked to shale gas, is also linked to a number of incumbents in the UK heat sector.

Recommendations for further research

1. Research recommendation 1: Further independent scrutiny and analysis of the technological options for UK heat decarbonisation is required to allow fully objective decision making.

2. More detailed research into the results and value of innovation by gas distribution networks would be of value. This could build on the research previously carried out by UKERC into electricity network innovation[12].

3. Research on consumers and heat is extremely limited and much more work in this area is needed.

4. A much greater understanding of the heating installer industry would benefit policy makers and may be a fruitful area of research.

[12] http://www.ukerc.ac.uk/publications/a-review-and-synthesis-of-the-outcomes-from-low-carbon-networks-fund-projects.html