The Future of Heating: A strategic framework for low carbon heat in the UK

Response to DECC's *The Future of Heating: A strategic framework for low carbon heat in the UK* consultation.

This response has been developed by:

- The Royal Academy of Engineering
- The Institution of Engineering and Technology (The IET)
- The Chartered Institution of Building Services Engineers (CIBSE)

This response is also supported by

- The Institution of Chemical Engineers

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Engineering the Future is a broad alliance of engineering institutions and bodies which represent the UK's 450,000 professional engineers.

We provide independent expert advice and promote understanding of the contribution that engineering makes to the economy, society and to the development and delivery of national policy.

Annex 1 – Response Template

1. The Department is seeking comments by Thursday 24 May 2012.

2. DECC will then publish a summary of the comments received on the DECC Website, and continue to work through the issues set out in this document for the remainder of the year, following up specific points with stakeholders and expanding the evidence base. This should then enable the Department to publish a document containing a range of policy proposals for decarbonising heat within 12 months.

3. Please use the table below as a template to respond to the published questions. It will help us to record and take account of your views. Responses should be sent to heatstrategy@decc.gsi.gov.uk
by Thursday **24 May 2012**.

4. Also, please provide evidence for your answers and comments where possible.

PERSONAL DETAILS
Respondent Name: ***Engineering the Future*** Email Address: **thomas.man@raeng.org.uk** Contact Address: **The Royal Academy of Engineering, 3 Carlton House Terrace, London SW1Y 5DG** Contact Telephone: **020 7766 0654** Are you responding as an individual or on behalf of an organisation? **This response has been developed by an alliance of engineering institutions and professional bodies called *Engineering the Future.* Full details of membership of the alliance and previous work is available through the following link: www.engineeringthefuture.co.uk** Organisation Name: ***Engineering the Future*** How were members' views assembled: **Members of the *Engineering the Future* alliance were asked to provide their views and evidence to respond to the questions as set out in the response template.** Would you like this response to remain confidential? **No**

If yes, please state your reasons:

EXECUTIVE SUMMARY: THE HEAT CHALLENGE

Q1: Do you agree with the nature of the challenge described for reducing emissions from heating and cooling across the UK?

Engineering the Future (EtF) agrees with the challenges as set out in the consultation document.

EtF welcomes DECC's recognition of heat as an important issue that must be addressed if the targets of the Climate Change Act 2008 are to be met. The analysis of the role heat plays in energy demand and carbon emissions appears to be robust as does the breakdown of sectors, technologies and fuels.

While we agree that decarbonising the electricity system will be vital to achieve the emissions reduction targets, it is an extremely difficult challenge. The added load that electrification of heating would require could make this challenge all the more difficult given the recent setbacks in the development of CCS and new nuclear power.

There is also concern that the focus on carbon emissions may lead to a failure to emphasise the need for greater efficiency in the use of heat. We need to reduce the emissions from the energy we do use, but we also need to look at ways to use **less** energy for heating homes. EtF would encourage the connection of the heat strategy with the policy development already underway within the recently formed Energy Efficiency Deployment Office (EEDO).

Q2: Do you have evidence that we should be taking account of as we develop our view of this challenge?

The Royal Academy of Engineering recently published a report on this subject: *Heat: degrees of comfort?*
www.raeng.org.uk/news/publications/list/reports/RAE_Heat_Booklet.pdf

We would strongly recommend this report to DECC, which goes into more detail on many of these issues raised in this consultation. We would also recommend that DECC studies successful modern district heating schemes such as that at Malmo in Sweden.

In addition, a number of relevant peer reviewed papers were presented at the 2011 and 2012 The Chartered Institution of Building Services Engineers (CIBSE) Technical Symposia:

www.cibse.org/index.cfm?go=page.view&item=2210

www.cibse.org/index.cfm?go=page.view&item=2374

In addition, CIBSE publishes an Applications Manual, CHP in Buildings, which is currently being updated and should be available in Summer 2012.

Q3: Are there other dimensions that we should be factoring in as we pursue our responses to this challenge?

The main aspects of heat are dealt with in the consultation document - demand reduction, domestic and commercial sectors, primary fuels and technologies and district heating.

What is perhaps less clear is how the proposals relate to other departmental policies. The provision of heat cannot be analysed in isolation. The type of renewable energy best suited to a particular application and how it is used can only be decided in the context of a national energy policy addressing all sources and uses that provides a coherent framework for decision making. At present, while there is linkage between the Heat Strategy and schemes such as the Feed-in tariff and the Renewable Heat Incentive, the overall framework does not exist.

It is also impossible to entirely disassociate low-carbon energy policies from the current economic climate. In difficult economic circumstances, it becomes even more essential for government policy to signal firm, long-standing commitments to emissions targets in order to encourage and promote investment in infrastructure and technology. There is also a need to consider the role of energy efficiency and in particular the links between the Heat Strategy and the Green Deal.

In addition, the concept of "most appropriate distribution temperature" for heat is missing. Ultra low temperature heat distribution with heat pumps to upgrade the temperatures in buildings has been used in many inter-seasonal thermal storage systems in the Netherlands, Scandinavia and USA, often as a retrofit solution. This can allow storage of heat extracted from buildings in summer for winter use, and can avoid the need for expensive insulated district heating pipework.

Q4: Do you have evidence about the role that different technologies or approaches might play in our response to the challenge, or the key barriers that we will have to address?

EtF would refer DECC to the report and papers noted in answer to Q2.

District heating potentially has an important role to play in providing heat through to 2050, particularly to high heat density locations such as city centres. Once gas fired combined heat and power plant comes to the end of its life, then other lower carbon technologies can be connected to the infrastructure to provide heat. Also, the future role of combined heat and power – district heating with heat storage allowing CHP plant to meet electricity demand peaks – should not be ignored. The heat strategy does recognise this role in the medium term but could reflect an even longer term role. The important message here is to consider both electricity and heat provision as an integrated system.

CHAPTER 1: MANAGING HEAT DEMAND IN BUILDINGS

Q5: Do you agree with the barriers and opportunities set out in relation to managing demand for heat in buildings?

Engineering the Future agrees with the barriers and opportunities as set out in the consultation document.

Managing **heat demand** is rightly seen as the most important and cost-effective way to reduce emissions from heat and to reduce costs to customers. The majority of homes in 2050 have already been built, making retrofitting critically important. However, the proportion of homes requiring retrofit is based on research carried out before the 2008 financial crisis that seriously affected the property market, so the number of new homes is probably over–estimated meaning retrofitting will be even more important than the consultation suggests.

We recognise the situation described in the consultation document, paragraphs 1.17 and 1.18 and support the principles behind the policy:

“The UK has some of the oldest and least thermally-efficient building stock in Europe. Taking action now to improve our buildings will reduce bills and cut emissions this decade, and help the mass roll out of low carbon heating technologies in the next. … The fabric quality of our existing buildings can be improved through retrofit measures or installed during the construction of buildings, as specified in building regulations.”

EtF notes that significant reductions in residential heat demand have been made in the UK in the last decade. This has been largely as a result of pro–active regulatory policy, notably the energy company obligations and the requirement for condensing boilers at the point of replacement. However, we are less optimistic than the consultation document on the extent to which building fabric and heating systems can continue to be improved at a cost that home-owners will pay without financial incentives. Installing loft insulation in a spacious roof void is relatively straightforward but insulating a Victorian house with dormer windows and a scullery extension at the back is much more difficult.

Solid wall insulation is said to cost from £6,000 to £11,000 to install and can save around £334 per year (see consultation paragraph 1.37). Assuming a 2% discount rate, a loan at the low end of this scale would take 20 years to pay back. Even assuming a 0.5% discount rate, an £11,000 loan is not recouped for 40 years. Homeowners, who may be increasingly insecure about their job prospects and finances in the current economic climate are unlikely to sign up to this sort of deal without a large subsidy. This will make the success of the proposed Green Deal vitally important and given the scheme is yet to be tested, adds a serious degree of uncertainty to achieving the aspirations in the consultation document.

The standard of installation of demand reduction measures is also extremely important: targets set assuming a certain theoretical level of performance can easily be missed when the actual, real-life installed performance, fails to meet expectations. Experience has shown that predicted reductions in energy within the home may not materialise, as shown by UCL's research into low income households in the Warm Front programme[1]. Design, installation, commissioning, ergonomics and feedback and human behaviour all play a part and could be improved upon in many cases.

EtF welcomes the extensive data now being gathered in the Home Energy Efficiency Database and the National Energy Efficiency Data Framework, as well as the more realistic numbers based on monitored savings that are being used in more recent policy assessments.

There is also concern that, while the consultation document is technically persuasive, little is said about the scale of the retrofit issue, particularly with regard to whether the supply chain would be capable of handling a significant increase in demand. A lot is expected of the Green Deal and behavioural change. Based on UK experience of over four decades of energy efficiency and carbon saving campaigns, it seems quite likely that neither will deliver without further incentives, however unattractive this may be to government. However, the introduction of the enabling mechanism for the minimum energy standards in the Energy Act 2011 is already galvanising action in the commercial property sector.

1. Hong, SH and Gilbertson, J and Oreszczyn, T and Green, C and Ridley, I and Warm Front Study Grp, (2009) A field study of thermal comfort in low-income dwellings in England before and after energy efficient refurbishment. BUILD ENVIRON , 44 (6) 1228 – 1236

Q6: Do you have evidence from existing projects to demonstrate the costs and benefits of demand management solutions in reducing emissions?

The CALEBRE project is a four year (2008–2012), £2 million research project, jointly funded by the Research Councils UK Energy Programme and E.ON. Final reporting from the project is due in early 2013. The Principal Investigator is Professor Dennis Loveday of Loughborough University. This project will provide useful information on the prospects for future improvement of "hard to treat" homes.

The UK has a long history of energy efficiency programmes stretching back over 40 years, initially as the Energy Conservation Demonstration scheme and later the EEO programme and CT work. The Post Occupancy Reviews of Building Engineering (PROBE) studies, reported over the years in the CIBSE Journal provide specific demonstrations of effective measures for improving the design and operation of non domestic buildings, coupled with examples of what does not work. The TSB Building Performance Evaluation programme has more recently invested in real monitoring and measurement of the effectiveness of a range of interventions in the energy performance of existing buildings. These all contribute to our knowledge of how to manage buildings for improved energy efficiency.

The costs and benefits of existing policies have been comprehensively assessed in the reviews of CERT for government.

- Lees, E. W. (2006). Evaluation of the Energy Efficiency Commitment 2002-2005. Report to Defra. Eoin Lees Energy.
- Lees, E. W. (2008). Eoin Lees Energy. Evaluation of the Energy Efficiency Commitment 2005-08. Report to the Department of Energy and Climate Change.

These demonstrate the very high cost effectiveness of basic energy efficiency measures.

Q7: If you have been practically involved in managing heat demand in buildings, what lessons can you share?

Experience of members of EtF and in particular CIBSE indicated the following particular lessons:

- Always reduce the demand for heat as much as possible through good building engineering physics applied to the design of the fabric and hot water services. Energy efficient heating should:
    - incorporate the most efficient primary plant to generate heat or hot water;
    - ensure that heat or hot water is distributed (or generated) effectively and efficiently;
    - include effective controls on primary plant and distribution systems to ensure that heat or hot water is only provided when and where needed and at the correct temperature;
    - ensure the plant and controls are installed and commissioned correctly for efficient operation, and maintained effectively thereafter;
    - be responsive to changes in climate, solar gains, occupancy, activity, and internal gains.
- The scale of heat energy saving measures can be difficult to quantify. In many cases fabric, plant and control measures can show very good cost effective savings but these can be masked by additional consumption by users – a well-studied phenomenon known as the rebound effect. This may be a key issue for the Green Deal. It is also an issue when seeking policy measures to reduce demand for heat.
- Sub-metering of heat has become more common for individual buildings on multi–building sites, and is also more prevalent when monitoring CHP and heat pumps. These meters generally measure flow rate and temperature, and are notorious for giving false readings due to poor commissioning, an area where development of industry capability is required.

CIBSE has produced the following relevant guidance which sets out good practice and lessons learnt over many years by engineers who design and operate buildings:

- CIBSE Guide B - Heating, Ventilating, Air Conditioning and Refrigeration

- CIBSE Guide F - Energy Efficiency in Buildings
- KS14 Energy Efficient Heating: an Overview (CIBSE Knowledge Series 14)
- KS10 Biomass Heating (CIBSE Knowledge Series 10)

An Applications Manual on Biomass Heating systems is currently in preparation.

In addition the Royal Academy of Engineering published the *Engineering a low carbon built environment* report which also provides useful material. www.raeng.org.uk/education/vps/pdf/Engineering_a_low_carbon_built_environment.pdf

Q8: What policies should the Government pursue to promote or facilitate improvements in the management of heat use in buildings, both domestic and commercial?

It is important that the measures DECC take are integrated with the work of DCLG in its changes to Part L of the Building Regulations, on which it has consulted recently. The greatest potential for reducing emissions is now well known as being in the existing building stock.

The proposed changes to Part L should be dependent on limits on application remaining those in Regulation 28 in the current Building Regulations. It would also be appropriate to require consequential works when a dwelling is created as a material change of use.

We also believe that the proposals will only be able to deliver the savings set out in the consultation if they are supported by robust compliance and enforcement measures. Unfortunately there is little evidence of such measures in the proposals, nor any significant allowance for the costs of enforcement in the Impact Assessment. We also note that the Impact Assessment for the Green Deal suggests that voluntary take up will be low. If that is so, then this again raises the question as to whether it is at all credible to expect voluntary compliance with a potentially costly requirement for homeowners. We believe that the current proposals will need active measures to promote compliance, involving both Building Control and the Competent Persons likely to undertake much of the consequential improvement (CI) work.

EtF agrees that the measures eligible for use as consequential improvements should be the list in SAP which is used to generate Green Deal assessments and Energy Performance Certificate recommendations and to determine eligibility for the Green Deal. However with the possible exceptions for boiler replacement, where some of the potential CIs may not be listed under this approach. We suggest that the listed measures should be building works as defined in the Building Regulations 2010.

CHAPTER 2: TRANSFORMING BUILDING-LEVEL HEATING

Q9: Do you agree with the barriers and opportunities set out in relation to

heating and cooling solutions in homes and other buildings?

Engineering the Future agrees with the barriers and opportunities as set out in the consultation document.

The general summary of heating (and cooling) technologies laid out in the consultation is reasonably sound. Even with the most modern gas boilers and state-of-the art insulation, we cannot continue to heat so many homes by natural gas and achieve an 80% cut in emissions. We can expect to see a diversity of systems – such as district heating, CHP and heat pumps. It is important that regulations, taxes and subsidies are sufficiently flexible and are directed at the end objectives, such as reducing carbon emissions and stimulating innovation, but are otherwise technologically neutral. At present, the complexity of the regulations and financial incentives risks leading to perverse outcomes.

If electricity is to replace a large proportion of gas in domestic heating, a much more sophisticated control system will be required. The four main objectives of this control system would be:

- To modulate the energy input to millions of heating systems depending on the availability and carbon intensity of the electricity supply and the criticality of individual consumers' needs, using thermal storage where available.
- To limit the current taken through certain substations and other critical parts of the distribution networks to avoid overloads.
- To limit the rate-of-change of aggregate electricity demand, so avoiding sudden increases or decreases in generation demand.
- To balance the loads taken by heating systems with those taken by electric vehicle charging and other time-shiftable electricity demands.

This 'smart grid' will be essential if large-scale electrification is to be achieved.

It is also important to remember what goal we are trying to achieve. Customers are not generally interested in the primary source of energy – they are interested in having homes or businesses heated to a comfortable level. Many studies on domestic energy make the assumption that people want their homes heated to a steady 21°C for most of the day, possibly with a reduction of a few degrees during the night. This may be true for certain groups of people (for example, elderly people in sheltered accommodation) but is not representative of most British households. Recent research on human comfort has shown that optimal individual room temperatures vary throughout the day and can be improved by allowing individual control, but there are few commercialised control systems that implement such a profile or approach. We particularly agree with the statement in the consultation document that 'Government needs to create the right climate for deployment and to build the market, working with industry to improve the affordability, efficiency and reliability of key technologies' (paragraph 2.75).

Research into how lifestyles may affect the optimum type of insulation and heating system for a particular building is in its infancy but existing studies show potential reductions of up to 50% compared to business as usual[1]. More research is needed in these areas if rational decisions are to be made.

The consultation document does not consider the effects of better insulation and air leakage reduction in new buildings. Neither does it consider the effect of incidental heating contributors such as radiated heat from distribution pipework, lighting, personal computers, large screen televisions or people themselves.

Thermal modelling of multi occupancy residential buildings currently in the design phase shows areas of overheating due to the contribution of heat from distribution pipework and solar radiation. This has led to suggestions of introducing cooling in such buildings which would be counter-productive. Consideration needs to be given to relaxing the requirements of Building Regulations Part L in England and Wales for certain types of buildings if energy reduction is to be achieved. The current set of recommendations for either domestic or non domestic premises is too generic. Building Regulations Part L 2013 needs to follow the approach set out in the consultation which is to set variable targets for buildings of different types.

[1] Eyre, N., J. Anable, et al. (2010). The way we live from now on: lifestyle and energy consumption. Energy 2050: the transition to a secure low carbon energy system for the UK. P. Ekins, J. Skea and M. Winskel. London, Earthscan.

Q10: Do you have evidence from existing projects to demonstrate the costs and benefits of heating and cooling solutions in reducing emissions in homes and other buildings?

In the course of the Royal Academy of Engineering's study on heat, some individuals reported instances of sub-standard installations of heat pumps which are discussed in the final report. More important than isolated anecdotal reports is the Energy Saving Trust's (EST) heat pump field trial that reported its interim findings in September 2010. The results were very discouraging and showed that, with the present carbon intensity of electricity, all but a dozen of the 75 projects studied were not worth doing. However, it is possible that some of the installations included in the EST study were not correctly sized, leading to adverse impact on the coefficient of performance (CoP), but this requires further careful analysis.

The consultation document makes the assumption that heat pumps will return a CoP of three, which is far greater than all but a few of the cases studied. We recognise that much better results have been achieved in other European countries with better developed heat pump markets. **Priority needs to be given to understanding this difference.** The consultation document also makes the assumption that a heat pump can be used for domestic hot water, which has been shown to be seriously detrimental to the CoP.

A consequence should there be a large deployment of heat pumps that turn out to have a poor CoP is the impact on electricity demand and also electricity networks. Even with a good CoP the impact on the electricity system will be substantial, with a potential increase in maximum demand of around 60%. Electrification of heat would need to be accompanied by full deployment of a smart grid to allow the timing of heat pump use to be managed, and with all sources and uses of electricity to be developed as an integrated system. Even with this, substantial reinforcement of electricity networks is likely to be needed.

Q11: If you have been practically involved in installing heating and cooling solutions, what lessons can you share?

See answer to question 7.

Q12: What policies should the Government pursue to promote or facilitate low carbon heating and cooling solutions in homes and other buildings?

The answer to this question is contained within the other sections of this response. Some of the key issues that need to be addressed include a need to integrate heat and electricity policies. Furthermore the issues raised through the responses to questions eight (building regulations) and 10 (heat pumps) are also relevant.

Q13: What are challenges to skills development and capacity building to significantly increase the number of domestic renewable heating installations?

The systems that are envisaged by the consultation to deliver heat and electricity in the future are complex and can only be successfully implemented if there is a very significant investment in developing the skills and knowledge to deliver them as large scale pervasive systems. In the long term the strategy calls for a major transformation of the domestic heating market from gas fired boilers to alternative technologies. There is a large scale challenge to be met to retrain a significant number of technicians to deliver the systems envisaged in the consultation. This will require a sub-strategy of its own.

Skills shortages will be a serious barrier to decarbonising heating unless addressed effectively. As noted above, the optimisation of systems design to suit individual premises and usages, and the installation of insulation and new technologies such as heat pumps needs to be done to a high standard. This will require better training, especially as heating systems become more complex, requiring a mixture of hardware and control systems suited to individual properties and lifestyles.

A new type of energy use professional will be needed. Recruiting these will compete with the demands of new nuclear power, offshore wind, networks and other energy industries that are already flagging-up staff shortages. In addition, there will be a need for increased understanding of the low carbon agenda and relevant skills amongst the wide variety of trades involved in building refurbishment. Skills shortage will potentially be a serious barrier to decarbonising heating unless addressed effectively.

When condensing boilers were made a requirement for most replacements through the Building Regulations, the Energy Efficiency Best Practice Programme provided training for all plumbers to bring them up to speed. It was a major undertaking and even then the transition was not entirely trouble free. The challenges to skills development and capacity building required by the proposed move to renewable heat are enormous by comparison.

Q14: Do you have evidence on the viability, economics and performance of hydrogen in building heating applications, including distribution through existing gas pipes?

The prospect of using the existing gas distribution system to distribute hydrogen seems remote because hydrogen requires much higher quality sealing to remain within the pipelines as compared to natural gas. If it was desired to supply hydrogen through gas pipelines, solutions such as feeding new piping through the network formed by the existing pipes would have to be considered. Any such solutions would need full engineering and safety risk analysis.

CHAPTER 3: DEVELOPING HEAT NETWORKS IN THE UK

Q15: Do you agree with the barriers and opportunities set out in relation to heat networks?

Section 3.11 in the consultation describes the low take-up of heat networks in the UK in comparison to other regions such as Scandinavia. There are features of British housing and local government that mitigate against communal networks:

- England has a higher proportion of owner-occupation than the European average. There is a strong political driver for competition rather than collaboration. The Scandinavian model of, after a few years, charging residents for the district heating scheme in their street, whether or not they use it, is likely to be politically unacceptable. Urban roads are highly congested and there are strong disincentives against large scale road works to install heat pipes.

- Over 60 years, local authorities have progressively lost much responsibility for institutions such as schools, hospitals and social housing. Their ability to act as the focus for district heating schemes has therefore become severely restricted in comparison with their previous level of control or those of other countries.

Paragraph 3.18 recognises that “developers therefore need a high degree of certainty that they will continue to have a sufficient customer base for the long term to assure a return on the investment. One way of ensuring this customer base is for heat suppliers to seek long-term contracts with their customers. Consequently, networks are often best developed by starting with low risk customers who can commit to long term contracts, such as public sector buildings, social housing and some commercial and industrial buildings." This may have been a credible strategy in the 1970s, when Sheffield and Leeds schemes (quoted in the consultation) were initially developed. It is unlikely to be a practicable proposition in current circumstances.

The viability of heat networks is negatively impacted by reducing the heat demands of buildings. The interaction between low energy refurbishment and heat networks needs to be better understood, but is likely to mean that the attractiveness of this solution is reduced where loads are less concentrated, such as in suburban areas of low housing density.

We agree with the technical aspects of the proposal, however the costs and behavioural barriers are not to be underestimated and the history of pursuing CHP and district heating in the Energy Efficiency Best Practice Programme provides plenty of evidence of just how difficult it will be without major central investment and push.

Q16: Do you have evidence from existing projects to demonstrate the costs and benefits of heat networks in reducing emissions, alleviating fuel poverty or reducing fuel consumption?

There is a wide range of examples of highly successful district heating in the UK including schemes in Pimlico, Southampton, Birmingham, Exeter, Leicester, Nottingham, Newcastle, Woking, Sheffield, Shetland and Edinburgh. There are many more small scale district heating networks on university campuses, multi building hospitals and large housing schemes - case studies are available on the CHPA and their members' web sites.

Q17: If you have been practically involved in setting up heat networks, what lessons can you share?

These lessons will be set out in the forthcoming update to CIBSE AM12 - CHP in Buildings. Also see response to Q2.

Q18: What policies should the Government pursue to promote or facilitate heat networks?

District heating infrastructure is expensive and grant schemes have in the past been needed to contribute significantly to district heating implementation.

District heating requires extensive heat mapping and feasibility work and a subsidy towards this type of work could encourage more such schemes. The Greater London Authority (GLA) has been leading a large number of heat mapping exercises across London and this has identified potential district heating systems that are now moving towards implementation. In this way pockets of cost effective district heating can be installed and will usually grow and interconnect.

Q19: Do you see the need to regulate the supply of heat through heat networks and, if so, how?

Heat networks require substantial investment, and take many years to construct and for the heat load to develop fully. Without some form of support there is a risk that they will not be deployed on the scale required. One approach is to regulate heat networks using a similar approach adopted for other networks such as gas, water and electricity. However, there may be other approaches. We recommend that support for heat networks needs to be thoroughly investigated to ensure that this does not become an obstacle to their deployment.

CHAPTER 4: TRANSFORMING INDUSTRIAL HEAT

Q20: What technical and financial barriers could prevent the switch to low carbon heating technologies on industrial sites?

When considering technical and financial barriers, the drivers of change need to be considered first. Industrial sites will typically move to low carbon solutions to either reduce costs or gain competitive market advantage in line with customer expectations. There is still little incentive outside of these drivers except for legislation. Legislation will expedite change but not necessarily sustain successful paradigm shifts in investment choice In industry.

These types of investments are often decided at plant level, where business units have to demonstrate a payback of between one and three years which is the most fundamental barrier for investment. This issue is often compounded by volatile markets, and limited immediate cash flow availability. One potential solution is for government to engage with business at a more strategic level, to allow a portfolio of energy efficiency investments to be considered more appropriately.

Cost of heat generation is affected by fuel prices as expected but also by exchange rate fluctuations related to capital costs such as raw materials and manufacturing location choice. Operational costs are also unpredictable, resulting in increased yet unknown costs over time. This is exacerbated by a shortage of providers and competitive pricing for lifetime maintenance as well as limited industry learning at this time.

Site location and operations of established industry sites will have a direct influence on feasibility of a low carbon heat technology. For example, biogas generation from municipal sewage requires a minimum waste volume to make this cost effective. Collaboration with adjoining industries may mitigate this issue for some.

Often locations which appear most feasible will be in remote areas making distribution of heat generated unviable financially. Often, local collaboration projects are embraced by industry such as district heating projects across business parks or a share in supply chain needs such as a wood mill providing waste materials to a biomass station in return for free electricity. These collaborations require extensive capital expenditure and the knowledge that all partners will remain operational long term.

UK planning legislation is often stated by investors as a fundamental barrier to low carbon projects. The new Planning Act (2012) will reduce planning consultation time and costs though public opposition is still an issue. It is important that robust long-term review and communication methods are established for all heating projects, supported by transparent technical and financial analysis.

Q21: What scope is there for further reductions in emissions through energy efficiency in industrial processes?

The data and analysis available to answer this question are notoriously out of date. An on–going UKERC project lead by Professor Geoff Hammond at the University of Bath is expected to report in March 2013.

Existing codes and standards do not facilitate improved energy efficiency practice. While certain legislation is being developed, much of the working standards are out–dated.

The government should be seen to be actively supporting cross-sector learning and to publicise case studies for others to learn from. Industry seldom looks over the wall to the hospital, school or housing next door. Government should seek ways to incentivise the provision of industrial heat into the built environment.

Q22: Do you have evidence from existing projects to demonstrate the costs and benefits of approaches to reducing emissions from industrial heat, including combined heat and power?

CHP projects appear to only be viable on a very large scale for individual businesses to support. CHP is often used by larger industrial entities as part of a wider low carbon strategy. The net present value of CHP when compared to equivalent carbon offset investment is often marginal when considering £/tonne CO2 saved at current carbon prices.

Biogas is found to work well for smaller, more remote industrial facilities, particularly if waste from the facility can be used in the process to generate heat. Costs and benefits are obviously dictated by individual sites and the operation levels. Specific success stories so far involve farming industries where organic waste from livestock can be converted cost effectively to fuel for heat used in other farming processes for example dairy processing. This idea has also been considered by the food and drink industry where suitable waste materials are generated such as large brewery operations and the use of spent hops in energy generation.

On–site micro generation projects are rarely cost–effective in light of payback requirements already outlined. This is mostly due to pre-development costs (such as technical development, consultation, planning, site investigation) to establish a business case for the project.

Q23: If you have been practically involved in projects that sought to reduce emissions from industrial heat, what lessons can you share?

The use of heat and energy in industry is typically guided by processes and standards. It should not be forgotten, however, that individuals' behaviour in industries has a signification part to play. It is thought that savings from simple green behavioural change initiatives can result in at least 5% emissions reduction in manufacturing sites. Behavioural change does require strong leadership and an operating strategy that all employees embrace. Incentives are often required but this is most successful when the individual changing their behaviour sees a personal benefit from doing so.

Measuring a baseline is fundamental to any industrial efficiency project brief. For example, smart metering is slowly being implemented across industry because of the added value the information brings in relation to specific processes and their efficiency.

Payback requirements by industry are still an issue when considering which solutions to invest in. It is still rare that industry considers the long term lifecycle impacts of energy projects because of the financial pressures of business. Typically, renewable energy projects will have a payback of at least 10 years. This can be unacceptable in private industries working on maximum three year plans, though it is noteworthy that the same industries will consider investments giving longer returns when contemplating more major capital projects.

Q24: What policies should the Government pursue to promote or facilitate reduction in emissions from industrial heat?

Planning costs and time are deciding factors in capital projects. Recent changes to legislation allow relaxation of these criteria but the government should continue this pace of change. There will be a need to influence legislative decisions at a European level. This should be considered for the benefit of UK industry but should not forget the wider benefit to reducing climate impacts.

We would also encourage systems thinking across energy and across all relevant government departments. The efficient production and use of industrial heat will likely mean developing policies that cross boundaries. An example of this could be industry using high pressure steam produced in a CHP plant belonging to a third party, then exporting lower pressure steam to a different adjacent industry, and that industry

exporting hot water for space heating to a community centre.
Q25: What policies should the Government pursue to promote or facilitate recovery of waste heat from industrial processes?