FULCRUMCONSULTING

BERR HEAT CALL FOR EVIDENCE

FULCRUM CONSULTING RESPONSE

Date	31st March 2008
Author	Compiled by Tessa Parnell, representing the views of Fulcrum Consulting
Main Contributors	Andy Ford, Brian Mark, Chani Leahong, Chris Puttick, Clare Wildfire, Jules Saunderson, Justin Carrell, Tessa Parnell, Tom Randall

Fulcrum Consulting is a leading firm of multi-disciplinary consulting engineers.

We deliver fully integrated design of building services and infrastructure. We also advise on building design and built fabric solutions which ensure minimum environmental impact.

The company was founded in 1984. We have a long-term interest and expertise in low energy and sustainable design of buildings and the built environment. We believe that the rational application of cost, performance and quality drivers leads to reduction in waste and carbon emissions.

Fulcrum Consulting takes a lead in controlled innovation. We research and identify suitable technologies and companies developing them to further our aims. We work in both formal and informal partnerships with such technology suppliers to integrate their products into high quality and exemplar designs.

Fulcrum Consulting are founding members of the UK Green Building Council, which is dedicated to dramatically improving the sustainability of the built environment by radically transforming the way it is planned, designed, constructed, maintained and operated.

Please address any correspondence to:

Tessa Parnell
Fulcrum Consulting
62-68 Rosebery Avenue
London, EC1R 4RR

020 7520 1300
tessap.consultation@fulcrumfirst.com

In order to respond to this consultation we held two in-house discussion sessions regarding the consultation document, and the views expressed within this response emerged from those deliberations and subsequent written responses.

We have arranged our comments against the questions raised in the consultation document, but start with some overarching comments which do not sit within the answer to any one particular question.

Overarching comments

Any policy interventions which come out of this consultation must not be implemented in isolation. A thorough understanding of how new policies will interface with existing policies and drivers must be gained prior to them being implemented. For example, any decisions made regarding heat networks and renewable heat must sit comfortably with existing carbon trading mechanisms, legislation related to electricity generation and supply, and the final definition of 'zero carbon' for homes and non-domestic buildings. Care must be taken for policies not to champion a single technology or fuel; a good mix of technology solutions is required for security of energy supply.

To enable feedback in terms of the effect of policy interventions, any policy must be implemented together with a robust mechanism for measurement of outcomes. Ideally this should include regular reporting to enable any unintended consequences to be picked up and resolved quickly.

The estimated carbon savings from the domestic sector to 2020 quoted in paragraph 33 of the consultation document seem very optimistic. The baseline against which the savings have been calculated is not made clear, and the report from which they are quoted also does not fully explain the origin of the figures; therefore it is very difficult to judge their accuracy.

If the figure for savings from zero carbon homes is calculated against the base of a current building regulations compliant dwelling (which presumably it should be as savings from building regulations are calculated separately), then we believe the carbon savings potential of this measure to be significantly less than the figure quoted. There will be only very few examples of zero carbon dwellings prior to the implementation of legislation requiring all new dwellings to be zero carbon in 2016. Post 2016, there will be an inevitable lag in completions being zero carbon. Experience from implementation of previous changes to building regulations suggests that of new dwellings completed in 2016, 5% will be zero carbon, increasing to 100% in 2020, with 15%, 40% and 70% in the intervening years. Assuming the 240,000 new homes per year quoted in the Housing Green Paper, this equates to perhaps 555,000 new homes being zero carbon by the end of 2020. Assuming that if built to 2006 regulations these dwellings would have been responsible for around $40kgCO_2/m^2$ (including both Part L and appliance energy use), and an average dwelling area of $80m^2$, this would equate to a saving of around 1.7million tonnes CO_2, rather than the 2.9 million tonnes quoted.

The savings quoted for building regulations would also appear to be massively overestimated. The total energy use per household has remained fairly constant since 1970, despite the implementation of successive building regulations (source: DTI). Therefore, although it is true that the energy demand for heating a home has reduced over the years, this has gone hand in hand with increases in electricity use (for example for appliances). Arguably this switch in energy use will have the net effect of increasing rather than decreasing carbon emissions over the period as electricity has a greater carbon intensity than most heating fuels.

Q1 Table 2.1 sets out technological measures for reducing carbon emissions from the heat loads of existing homes, with cost estimates. Do you have any comments about this analysis?

It is not made clear whether the baseline, over which the potential carbon savings are stated, relates to just the heat component of energy supply, or the total energy required in a dwelling (including appliance loads). We assume that it is related just to heat supply, given the emphasis of this consultation, and this is the position taken in the formulation of our comments below. As the table is specific to existing dwellings, we also assume that the measures shown will be complemented by other existing policy drivers which are improving the energy efficiency of dwellings (i.e. the energy demands to be satisfied per dwelling will be on average around 9MW for space heating and 5MW for hot water as quoted in paragraph 35.

We are very concerned about the base data used in the table. The BRE report quoted as the main source for this data looked at the potential carbon savings of different heat-energy supply options for new-build dwellings; the table is related to carbon savings from existing stock. The energy profile of existing dwellings is quite different from that of new-build dwellings, with existing dwellings having a much greater space heating requirement. This difference will affect the quoted typical capital cost per household as well as the magnitude and proportion of the carbon savings.

Additional to these overarching concerns, we have a number of technical comments related to the figures in the table:

- The potential carbon saving for ground source heat pumps could be misleading due to the lower seasonal coefficients of performance achieved when sourcing higher temperature heat requirements such as domestic hot water. From our experience, the very best seasonal efficiencies are achievable only on carefully designed systems, and would be in the order of 3.5 for space heating delivered as low temperature underfloor heating and 2.8 for hot water delivered at 50°C. Most individual domestic solutions would not achieve these levels of efficiency, especially if retrofitted to existing stock where for example delivery of higher temperature heat for a wet radiator based space heating would likely be required. The upper carbon saving of 40% will therefore rarely be achieved as exemplar installations are rare. However, wholesale decarbonisation of the grid will improve this scenario.
- We would expect the potential carbon savings from the use of biomass boilers for both space heating and hot water would equate to around 85%, rather than the 60% quoted.
- We would expect the potential carbon savings from use of solar hot water to equate to around 18%, based on supplying 50% of the yearly hot water demand (which is a reasonable assumption for such an installation), rather than the 10% quoted.
- We assume that the 'CHP district heat' and 'micro CHP' measures relate to gas fired CHP. For both these measures it is unclear how the carbon savings of the CHP have been taken into account – because the CHP produces both heat and electricity. How has this been split to show carbon savings in heat generation only? We are therefore dubious about the carbon saving figures quoted.
- We are unsure why the carbon savings quoted for 'renewable district heat' are any different from those quoted for 'biomass boiler' as both utilise biomass to deliver all heat demands. We would therefore expect the carbon savings from 'renewable district heat' to be around 85%.

- The maximum carbon savings which could be achieved by 'district heat with remote heat supply' would be the same as for 'renewable district heat', which we estimate as being around 85%. In addition, the costs quoted for this technology specifically exclude the district heat network. It is not clear whether the cost of a district heat network has been included in the cost estimates for CHP district heat, renewable district heat, or any other technology which might utilise a district heat supply network.

We would anticipate that the excluded 'grid costs' of de-carbonised electricity for the delivery of heat may be very significant if this measure for heat delivery is applied at a large scale. This is due to the peaks in electrical demand that may be experienced as a result, therefore requiring more significant delivery infrastructure and 'peak demand' power station availability.

The typical capital cost per household of decarbonised electricity is given at £3000 plus grid costs based on a supply cost estimate from the provision of large scale nuclear energy on the basis of 30 billion Euros to provide a 1.6GW output plant. This equates to a plant capital cost of £14 million per megawatt which calculates out to £35,000 per household (based on 2.5kW/household) rather than the £3,000 shown. In addition, the £14million per megawatt for nuclear is considerably above present costs for large scale renewable supply technologies such as onshore wind, offshore wind and biomass. Onshore wind capital cost is approximately £1.5 million per megawatt installed. Taking capacity factors into consideration, this would equate to around £5.4m/MW for onshore wind, and £15.5m/MW for nuclear (assuming capacity factors of 0.28 for onshore wind and 0.9 for nuclear).

Whilst the continuous output abilities of nuclear plants are of use in providing the baseline electrical supply requirement, this could also potentially be provided by aggregating the stored energy assets of biomass and waste which could be scheduled to augment the fluctuating power output from wind-based renewables to provide an equally robust supply scenario at considerably lower. Research into the total availability of biomass and waste, the required storage facilities and other aspects to enable this scenario should be carried out.

Q2 What scope is there for greater use of electrical heating to reduce carbon emissions from heating? In what circumstances is electrical heating best deployed?

There may well be a case for the use of electric heating to reduce carbon emissions where space heating requirements are extremely low; as will be the case in post 2016 'zero carbon' housing. Given that the infrastructure for electric heating is already present and that the heat emitters can use relatively little material, when concepts such as whole life carbon emissions including embodied carbon within infrastructure materials are considered, for buildings with very low heating demands a complex and extensive heat delivery system such as district heating may produce more CO_2 in manufacture, installation, operation and maintenance, than a very simple low material system such as electric heating.

The 'peaky' nature of the electricity demand that may result from the use of de-carbonised grid electricity for space heating and domestic hot water is an issue that would need to be addressed. The increased peaks in demand that are likely to occur will impact on both electricity distribution infrastructure (at local and regional level) and electricity generation provision, in the form of more capital infrastructure and supply capacity. Measures to achieve 'peak lopping' would be important to incorporate as part of any strategic solution. Such measures could include thermal storage within building systems, or underground thermal storage.

The 2020 renewable energy targets required by the EU are likely to require a minimum 45% decarbonisation of the grid by 2020. If this level of decarbonisation is realised and continued in future years, then use of electricity for heat could be a low CO_2 means of satisfying this demand. However, if greater use were to be made of electricity in the delivery of heat, it would be more appropriate to utilise efficient forms of heating (and cooling) such as interseasonal thermal storage (see answer to Q7 for further information on this technology). If these systems were operated on substantially off-peak electricity supply tariffs to serve mixed-use areas with heating and cooling, this may reduce future concerns of the need to increase summer electrical supply capacity to meet the increasing potential summertime cooling load which may otherwise be met by standard electricity consuming air conditioning. Operational energy costs would also be minimised in this situation aiding fuel poverty concerns.

A limitation to the wholesale application of a de-carbonised grid is that electricity generation from power stations results in heat production as a by-product, such that while power stations are being applied as a generation technology, the waste heat from these should be distributed for use wherever possible (i.e. via district heating), thus enabling most efficient use of the primary fuels involved. It would therefore be important to support district heating to at least a proportion of areas, in addition to working towards a decarbonised grid.

Q3 Is it desirable to include emissions from all heat use in a carbon market, even if it is indirectly through the supplier?

We believe that it is important to include emissions from all heat use in a carbon market if this mechanism is to drive down carbon emissions. It is a very complex market to capture and will need investment in both in terms time (research) and money (incentives). It is extremely important that a robust feedback loop is included to make sure the mechanisms are working as desired. This must include the ability to adjust policies in the event of unintended consequences or if appropriate savings are not being achieved.

As for including emissions indirectly through the supplier, this mechanism would be required in the case of domestic emissions from fossil fuel (mainly gas) consumption, unless tradable energy quotas (TEQs) are implemented. Ideally it would be best to treat carbon emissions at the point of creation, and this would be best done through the use of TEQs, where everyone is given a "carbon allowance" and all sources of carbon emissions such as transport are included too. It would be difficult to implement point-of-creation accountability without the use of TEQs, as carbon emissions need to be capped in their entirety. A Supplier Obligation (SO) system incorporating an outcome-based approach would be able to assign some accountability for the carbon emissions from the household sector. This would place some ownership of the carbon emissions with the supplier; however, this also creates the issue that the costs of this would then be reflected directly in the price paid by the consumer, and so effectively create a "carbon tax" to the consumer.

Nevertheless, the concept of a SO has inherent contradictions as the mechanism requires a supplier to reduce their sales of fossil fuels, when in fact the supplier's business model has always been based around selling more. On a small scale, such as in the case of the previous EEC schemes, this would have little overall effect and could be absorbed into the supplier's costs. However, as dramatic reductions in carbon emissions are required, this would directly impact the supplier's business unless the market can be changed to a product service systems (PSS) approach where a customer would pay for a certain level of comfort (heat) – see also Q27.

Q4 Options for including SMEs in the carbon market are broadening the SO or creating an entirely new upstream instrument for SMEs. Which do you prefer and why? What other levers could be used, and what are the advantages and disadvantages of these approaches?

SMEs will not have the resource to dedicate to a complex carbon accounting system, therefore it is necessary to make the system simple or pass on the responsibility in the form of an SO. Again tradable energy quotas (TEQs) would be a possible approach.

Work by the Carbon Trust has suggested that there is a very favourable business case for introducing advanced metering and targeting (aM&T) for most SMEs. The implementation of aM&T strategies will reduce national carbon emissions while saving individual enterprises money. Furthermore, the data acquired through aM&T will significantly reduce the administrative burden associated with including SMEs in carbon-accounting mechanism.

Given that the business case for implementing aM&T strategies is often so attractive, the need for costly financial incentives is reduced. Instead, investment should be focused on ensuring that more organisations are aware of the potential benefits, and high-quality advice is available on implementing effective aM&T strategies.

As well as encouraging SMEs to take-up aM&T to save money and reduce carbon emissions, a clearly stated intention to include SMEs in a carbon accounting scheme in the future could act as a further incentive for aM&T.

Q5 What are your views about the hybrid SO, do you think it would be effective to abate carbon through investment in measures? How else might a hybrid system look or function?

A hybrid system would have some effect if it is ultimately based on outcomes, as this would create the link to the contraction-based mechanism needed to reduce carbon emissions. Allowing the supplier to use certain measures to achieve carbon reduction outcomes would make some sense. Nevertheless, certain areas need to be addressed. For instance the approach of receiving credits based on lifetime savings is not an accurate reflection of the actual carbon reductions and would lead to false accounting; only carbon savings made in a defined period, e.g. a year, should be assigned to a period. The measures employed would need to reflect the scale required, such as insulation improvements to hundreds of thousands of homes and large scale district heating systems linked to CHP plant.

However, in our opinion, CERT will drive the uptake of the more cost effective measures leaving only the more expensive measures, thus forcing up the price of the SO, thus putting negative strain on fuel poverty.

Q6 Would you anticipate significant impacts on fuel poverty as a result of means to limit heat emissions? In what ways might these impacts might be limited?

We do anticipate significant impacts on fuel poverty as a result of any means to limit heat emissions. Due to the deregulated nature of the market, additional costs to suppliers will invariably be passed on to consumers.

The effect can be limited, for example:

- by targeting the fuel poor in terms of providing energy efficient upgrades to the building envelope and the introduction of more energy efficient means of heat supply

- by raising awareness of the role of energy efficiency measures and the subsidies available
- by ensuring that if heat pre-payment meters are installed, the tariffs are not disproportionately high compared to standing order/ direct debit tariffs

Paragraphs 67 – 71 clearly detail the potential significant impacts of increasing fuel poverty as a result of the means taken to limit CO_2 emissions from heat production. The measures necessary to meet the 2020 EU renewables directive and the targets within the Climate Change Bill will also inevitably lead to increases in electricity supply tariffs over and above these concerns. Requirements for energy labelling under the energy performance of buildings directive, if successful, are likely to reduce the value of hard to heat dwellings where 'low hanging fruit' energy improvement measures have either been done or are not financially or practically viable. It is likely that increasingly low income individuals will become marginalised in these lower value properties with high heat energy usage at high energy tariff rates.

If new 'zero carbon' development is capable of providing funding as described below in Q12 and Q16, it may improve, rather than worsen, the fuel poverty prognosis if subsidised waste heat can be provided to existing stock as outlined in the comments. If coupled with further support, such as capital grants, this could minimise any likely increase in fuel poverty. Any additional government expenditure from a capital grant scheme would obviously be shared as an increase in general tax burden, though this would be more equitably shared and would not affect the fuel poor as much as a feed in tariff or renewable heat obligation alternative which would selectively disadvantage occupants of hard to heat housing.

Heritage aspects play a role here too. Currently in many cases for listed buildings or those within conservation areas it can be almost impossible to receive planning permission to carry out works which would improve the energy efficiency of the building. A reasoned debate needs to be had which weighs up the conservation benefits of this policy with those of the wider climate change agenda. It may be the case that for buildings considered worth preserving without the addition of energy efficient building fabric improvements, a heat subsidy could be paid to occupants of such buildings.

Q7 Is our view of these technologies correct? Have we left out any technologies that could make a significant contribution?

Biomass heat

At present biomass heat is seen as one of the most cost effective forms of renewable heat. However, biomass in not an infinite resource, and care must be taken so as not to deplete existing biomass resources in an unsustainable manner, especially woody biomass which has a time period to maturity of 30 years +, depending on species.

Natural habitat and ecosystems need to be protected and large scale monocultures avoided. Plus see answer to Q8 and Q9.

Heat from waste

We believe that heat from waste has a definite part to play in the future fuel mix of the UK. Heat from waste is available in a number of different forms, and some have not been considered in the consultation document as much as we would have hoped. See answer to Q10 for full details.

Microgeneration heat

We believe that heat from microgeneration technologies will have a fairly small part to play in the overall low carbon heat generation strategy for the UK. See answer to Q13 for further details.

Other technologies not covered

There are a couple of technologies which haven't been covered in this section which we believe could make a significant contribution. These are outlined below:

Large scale use of ground/water source heat pumps

Ground and water source heat pumps are not just a microgeneration technology as intimated by the consultation document. The technology can be successfully integrated into multi-building and larger district heat networks to achieve carbon reductions.

Interseasonal thermal storage (ITS)

This is touched upon in para 154, but should also be considered here in the context of the technologies likely to make a significant contribution to renewable/low carbon heat generation.

ITS can be at relatively low temperatures, such as utilised by aquifer thermal energy storage (ATES) or borehole thermal energy storage (BTES), or at slightly higher temperatures such as thermal stores fed by large scale deployment of solar thermal collectors. The Drakes Landing case study mentioned on page 57 demonstrates this aspect of the technology.

ATES and BTES work by storing heat captured in the summer for use in winter, and cold from winter for use in summer. They rely on having large quantities of thermal storage capacity and commonly use heat pumps to step up (or down) the retrieved heat (or coolth) to usable temperatures. The most efficient system would aim to balance these heating and cooling loads over the annual cycle.

ATES is a form of communal heating and cooling that was first developed in Holland. It uses underground aquifers to store heat and coolth. A typical system uses two boreholes (or two groups of boreholes, depending on the size of the scheme). The applicability of this technology for a particular location will depend on the local geology and presence of a suitable aquifer.

The system operates by collecting heat rejected in the summer i.e. by providing cooling, and rejecting the warmed water extracted from the building(s) to one of the two ATES boreholes (or groups of boreholes), which will store the heat in the aquifer at between 15°C and 22°C depending on the time of year. This becomes the 'warm' borehole store. In the winter the flow is reversed and the warmed stored water from summertime is passed through heat pumps which extract and upgrade the heat and utilise it for space heating. The now cooled aquifer water is then rejected into the second borehole (or group of boreholes) giving rise to aquifer storage temperatures of between 7°C and 9°C. This becomes the 'cold' borehole (or set of boreholes). ATES is an open loop system, but there is no net extraction of water from the aquifer.

Many examples exist in Holland such as Eindhoven University where the systems have been retrofitted to serve relatively non heat optimised buildings of the older stock type. These systems could become potentially powerful in large-scale urban mixed-use regeneration projects. Fulcrum was involved in the first application of ATES in the UK on the Westway Housing project, London. Further details can be provided on request.

BTES works on the same principles as ATES but is a closed loop system. BTES can be applied where aquifer conditions are not deemed suitable for ATES.

Although electricity is used to pump water around the system, and to upgrade/downgrade the heat, the coefficient of performance (COP) of these systems is such that the carbon efficiency is extremely good, even with the use of grid electricity. These systems when installed properly are more carbon efficient than standard ground/water source heating or cooling systems.

Lignocellulosic biomass to bioethanol

Anaerobic digestion cannot liberate energy from cellulose or hemi-cellulose which makes up a relatively large proportion of some biomass feed stocks. An early second generation biofuel process known as dilute acid lignocellulosic hydrolysis has been used commercially in America for some time. The downside of this technology is that 60% of the process costs come from energy to produce the process heat necessary to break down the cellulose and hemi-cellulose into simple sugars which is then fermented, with further process heat required for distillation to bioethanol.

Although bioethanol is likely to become primarily a renewable transport fuel to meet the renewable transport fuel obligation (RTFO), by integrating such a process with existing combustion based power stations which reject waste heat because they are remote from heat-requiring buildings, production costs can be reduced significantly and a relatively high energy density fuel which is easy to transport could be produced to serve transport or building needs. This technology works very well on agricultural waste such as straw to turn it from a low energy density low value fuel to a potentially high value fuel without loosing land for food production.

Q8 Is our analysis of potential biomass fuel supply accurate? Do you have evidence relating to the long-term sustainability of biomass supply, or demand pressures from other EU countries?

We expect any available liquid forms of biomass to be used as a transport fuel. This is driven by the EU Renewable Transport Fuel Obligation (RTFO) and must be taken into account when estimating the potential biomass fuel supply for the built environment.

We believe that the only significant form of biomass available as a fuel for the built environment is woody biomass. However, this will only be a proportion of the available resource as some will most likely be used in gasification processes to produce liquid biofuels for use in higher-value applications such as transport fuel.

When assessing the potential of woody biomass, one must take an international view. Timber is a freely traded commodity and indeed Denmark is importing a proportion of the wood fuel they use from the UK. The free market encourages consumption and does not treat resources sensibly. Therefore, legislation must ensure that there isn't an unsustainable 'dash for wood', both in the UK and the rest of the world.

The consultation document does not include an analysis of actual availability of different types of biomass fuel. This analysis is important and as woody biomass is generally a long-cycle fuel, it is essential that the ongoing availability of each type of biomass is considered, and any foreseeable fluctuations factored in.

Clean and unclean biomass must be viewed quite separately, because for smaller-scale generators or biomass boilers it is not financially viable to install the required pollution control measures to clean the flue gases if unclean biomass is used. Therefore the market for unclean biomass (such as waste treated wood) should be for use in large scale generators where appropriate pollution control measures are installed under the EU Waste Incineration Directive.

As with any fuel, there will be cost uncertainty for the future. However, due to the immaturity of biomass supply chain in the UK, this uncertainty is more acute than for other fuel types. One would have thought that this would be affecting the take-up of biomass-fuelled heat generation for the built environment. However, in general our recent experience with medium-scale new-build mixed-use developments suggests that uncertainty of supply and fuel cost does not appear to have too much of a bearing on the uptake of this technology. This is mainly due to the fact that, in general, biomass boilers are one of the least capital cost means of complying with current planning policies requiring a proportion of a development's energy to be met by renewable energy technologies. Often the ongoing cost to the consumer does not play a part in the decision regarding which technology to install to gain planning approval.

For larger scale electrical generators, the cost of fuel is extremely important to the viability of a scheme. For example, Fulcrum are currently involved in the design of 2 No. 50MW electrical output wood to energy schemes, where the business plan showed that reliance on imported wood is considerably cheaper than reliance on locally available wood. These two projects burn an aggregate of approximately 720,000 tonnes of wood per year predicated almost entirely on imported briquetted wood. The same is very likely to be true of the recently consented wood to energy plant in Port Talbot, which at 350MW electrical output is likely to burn over 2.5 million tonnes of wood per year. In the experience gained through the two projects we are involved in, there is considerable competition for overseas wood resource from other European large scale biomass developers.

The issue mentioned in paragraph 96 of the consultation document relating to the 'chicken and egg' situation with respect to the supply vs demand of renewable heat from biomass is interesting. We suspect that in the short-term biomass sourced from outside the UK will play a part in the majority of the biomass heat installations in the UK. This should allow the UK biomass supply chain to mature in response to competition from other countries, whilst not damaging the uptake of biomass fired technologies.

Please also see answers to Q9.

Q9 Do you agree with the assessment of the potential for heat from biomass and the barriers to its deployment? How can these barriers best be tackled? Are there other barriers which should be addressed?

The quality of biomass fuel is a very important issue. There is an urgent need for a quality assurance method which will undoubtedly require the setting up of a regulatory body to oversee the industry in the UK. Paragraph 99 of the consultation document refers to the emerging EU Biomass standards, but it will not be beneficial for the UK to have to wait until post 2010 for this to be agreed. Therefore it is paramount that UK government acts quickly and decisively to set up industry standards for the UK. There are existing standards which have been set up in other EU countries, most notably Austria and Germany, which could be followed.

The issue of maintaining acceptable levels of particulate pollution emissions is particularly interesting as auditable compliance is more likely to be achieved from larger installations where operational conditions are known, than with a proliferation of smaller, particularly individual household installations where exact operational conditions influencing emissions control will be very hard to predict.

The recent AEA Energy & Environment report for London Councils on the potential impact on air quality of increased wood fuelled biomass use in London concluded that increasing the contribution from small-scale wood fuelled biomass combustion may lead to a potentially substantial increase in nitrogen dioxide and particulate matter, and therefore have a detrimental effect air quality. It has to be noted however that the scenario examined in the report anticipated the use of 50,000 domestic wood fuel boilers and 800 biomass CHP plants in London. We believe this to be an unrealistic over-representation, especially in terms of the uptake of individual household scale wood fuel boilers.

There are some existing barriers in terms of available technology at specific scales; for example in relation to sub 1MW electrical output biomass CHP units. Currently in the UK there is only one plant fully supported which is that manufactured by Talbotts. This 100kWe plant is yet to be fully tested in real long-term operational conditions and cannot at present be thought of as robust. Another issue is that the heat-to-power ratio of smaller-scale CHP units is worse than for larger installations.

The policies passed by regional and local planning authorities under PPS 22 require the provision of an element of renewable energy to enable major developments to achieve planning permission. Several planning authorities have also utilised powers confirmed under PPS 22 and PPS 1 to require efficient, low carbon energy production methods such as CHP and CCHP to be a requirement to achieve planning, over and above the requirement for a renewables percentage. This is particularly the case with planning applications decided by the GLA (see the updated London Plan). There is an emerging issue where such policies could create perverse outcomes such as the proliferation of smaller biomass fired combined heat and power installations at the expense of solutions involving more economical and auditable larger systems that may save more carbon. Due to the lack of enforcement resources within planning authorities, including the GLA , (who do not have a remit for post occupation enforcement, passing enforcement responsibilities to the local planning authority) these policies have a real risk of causing inappropriately small biomass CHP installations to be purchased and installed to achieve planning with a high likelihood that they will either not be used or will be used at low capacity as all such installations in practice are also provided with the full back-up gas supply system and full grid connection for electricity supply.

Whilst this issue is not a barrier to the uptake of smaller wood fired heat producing or heat and electricity producing (CHP) plants it may be a barrier to achieving the expected level of production of renewable heat and or electricity until post occupation monitoring and enforcement by planning authorities, overcomes the risk adverse inclination of developers towards embracing new technology in optimal usage.

It is also our experience that developers are acutely aware of the lack of meaningful post-occupation audit by building control or planning departments. Since all correctly engineered biomass fuelled plants serving such developments have full gas (for heat) and grid (for power) backup connections, plant is likely to operate in fossil fuel mode for a significant portion of the time unless robust monitoring processes are put in place.

Please also see answers to Q8.

Q10 Do you agree with this assessment of the potential for heat from waste and the issues restricting deployment? How can these barriers to heat from waste best be tackled? Are there other barriers which we have not identified?

At present in the UK the suggestion that more of our municipal waste should be dealt with via energy generation in incinerators is not met with a great deal of support. The NIMBY nature of the general public and the arguments of environmental groups relating to perceived risk, potential environmental pollution, and the ongoing need for waste as a feedstock needs to be taken into consideration in any strategy aimed at promoting the use of this form of energy from waste (EfW). Whilst recycling is essential in reducing environmental impact, the actual economic benefits as well as carbon benefits should influence decisions concerning the point at which 'best value' recycling is actually to produce energy rather than a recycled product.

Paragraph 106 refers to the government response to the RO banding consultation that energy from waste is likely to be considered as having 50% energy from biomass unless there is reasonable doubt that this is not the case. If the reasonable doubt test is not generally applied, energy from waste CHP plants will therefore receive income support equivalent to 1 ROC for every megawatt of electricity generated. If additional income from LECs and close to end user tariff electricity sale is achieved by the provision of a private wire system, an income of approximately 15.5 pence per kilowatt hour of electricity plus sales of waste heat via a district heating system would make a potentially highly attractive income stream. With the estimate in paragraph 80 that by 2020 25% of England's municipal waste and 6% of commercial and industrial waste will need to be dealt with through energy recovery this introduces a further major income stream from avoided gate fees.

To comply with the Waste Incineration Directive, the emission control systems of waste to energy plants determine that currently only municipal scale plants are feasible; probably at the smallest scale being equivalent to the Chineham plant operated by Veolia at 8MW electrical output, approximately 12MW thermal output. As the provision of renewable electricity and heat is required for post-2016 zero carbon housing, there is a potential to attract funding from new zero carbon housing developments in situations where it is judged that microgeneration options for electricity are limited. At present the technical criteria issued by DCLG governing the attainment of 'zero carbon' homes would make the use of the renewable energy from EfW plants impossible as only 50% renewable energy could be assumed (paragraph 106) and the CO_2 emissions from the hydrocarbon element of the waste would have to be offset by the net grid export of an equivalent amount of renewable electricity offsetting net CO_2 emissions to zero which is difficult to envisage. This barrier could be overcome if the technical definitions for renewable energy allowed 50% of the output of such an EfW plant to be taken as fully renewable to serve 'zero carbon homes', with the remaining 50% available either for sale to the grid or via a private wire scheme to existing building stock or industry. This situation would then be likely to lead to zero carbon housing developers to invest in more waste to energy technology.

Obviously such a plant could also be utilised for co-firing biomass which is an efficient use of plant investment costs attracting a good level of banded ROC support, but to achieve the highest level of ROC income, good quality CHP standard must be achieved which requires the sale of a high proportion of the waste heat generated. Zero carbon housing at low and medium densities is not an ideal candidate for heat supply via district heating as the demand for space heating will be negligible and around 50% of hot water demands can be met from solar thermal panels. As such, the potential for heat sales per metre of installed district heating pipe is low and the financial viability of district heating schemes to new highly-insulated buildings is therefore not good. If the technical standards governing the applicability of zero carbon (waste) heat could be adjusted so that new zero carbon housing delivered after 2016 could benefit from supplying such waste heat to high heat-usage existing stock, then the investment future for district heating will be much improved and zero carbon housing developers would be more likely to invest in district heating networks to serve existing stock. In addition, more research is needed into developing reliable smaller EfW processes (say below 500kW+) utilising the organic Rankine cycle.

The waste hierarchy should be followed, but can throw up some interesting points; for example should waste paper be recycled, or used in an EfW plant? Paper recycling is a very energy, water and chemical intensive process, so if it can be shown that it is more resource efficient to use waste paper as a fuel source (going slightly against the waste hierarchy, but ensuring wider benefits) then policy should allow this. More research is undoubtedly required in this area, but given the drive for large increases in the use of biomass as a fuel, it seems slightly perverse to insist that paper is recycled (downcycled).

Organic waste should be separated from the waste stream, and after separation of dry waste for recycling the (hopefully) small remainder of residual waste should be used to generate energy (including heat). However, it is very important that any planning of such facilities and decisions as to which feedstocks are appropriate is done at a strategic level to ensure that this form of energy generation is not being over-provided in a particular location. Over-provision of such facilities is dangerous as it is likely to discourage waste minimisation and recycling.

The consultation document seems limited in its consideration of the breadth of energy from waste technologies which are available. For example the digestate from anaerobic digestion (AD) can be dried and used as a solid fuel (e.g. for a biomass CHP).

Wastewater treatment plants can be converted to utilise AD technology to produce biogas. There is limited uptake of this at present because current wastewater treatment plants are not designed for energy generation, but as a waste treatment process. The waste is not seen as a resource by the companies who run these plants, and therefore in most cases where AD has been incorporated, the energy generated is used on-site rather than being sold on to others. This mindset is also restricting the efficiency of the AD plant, because the design of the system is not paramount if the technology is viewed as being marginal; for example it is being implemented in above-ground un-insulated vessels. We see this as a barrier to greater deployment of integrated AD plant in wastewater treatment systems.

Local treatment of wastewater is the best way of dealing with it, and enables any energy generated in the process to be utilised by the local community. There are many examples of successful local organic waste utilisation, such as Vastra Hamnen in Malmo, Sweden, and many instances throughout China.

There is limited knowledge of EfW plant and processes in the UK. This needs to be changed if we are to fully utilise waste as a resource.

To encourage the use of all forms of EfW, government must strongly engage with both the public and planning authorities. Mindsets need to be changed to one where the challenges and imperatives of climate change are top of the agenda. This would be helped by calling waste a resource rather than a waste product.

There is a useful book on the subject by Robin Murray entitled 'Creating Wealth from Waste' which we would recommend (viewable online at http://books.google.co.uk/books?id=LEBnsMFuWkcC&dq=creating+wealth+from+waste&pg=PP1&ots=FTQOkf2cBI&sig=C45EiTrQCW5xObsbMlWTV88w_WQ&hl=en&prev=http://www.google.co.uk/search?hl=en&rlz=1T4EGLC_enGB268GB268&q=Creating+Wealth+from+Waste&sa=X&oi=print&ct=title&cad=one-book-with-thumbnail).

Q11 Do you agree with the assessment of the potential for heat from biogas and bio-methane, and the barriers to its deployment? How can these barriers best be tackled? What is the potential contribution from biogas and bio-methane to meeting UK heat demand? Are there particular difficulties with including bio-methane in a renewable heat support mechanism?

- There is an inherent conflict in the two philosophies presented – one which reinforces the business-as-usual case (bio-methane into the gas network), and the other which embraces a new philosophy of heat as a commodity (the large-scale use of district heat networks). We believe that it is very important that the general public and businesses are not lulled into a false sense of security with respect to climate change and fuel use. The amount of bio-methane which could be produced for addition to the existing gas network would only ever be a small fraction of the energy distributed in this way. Use of the gas network is not sustainable in the long term and therefore we believe that there should be no distraction from the facilitation of district heat networks which will enable a future-proofed heat delivery scenario. With a heat network in place, the technologies utilised to produce the heat can respond to changing energy resources and the introduction of new technologies.

Bio-methane is a good quality fuel in its own right and should be used in CHP, power generation, and transport, rather than primarily for heat production via existing boilers in buildings. Therefore we believe that bio-methane should only be included in a renewable heat support mechanism if it is used as renewable heat rather than distributed as a gas.

The mixing of bio-methane into the gas supply network, would increase reliance on a redundant delivery mechanism which:

- cannot support our energy needs in the long term
- reinforces natural gas with its associated carbon emissions
- means a continuing proliferation of individual gas boilers with associated lack of control over maintenance, replacement and operational efficiency.

Q12 Are there any other significant non-financial barriers specific to the deployment of renewable heat technologies as well as those set out at paragraphs 87–115 above? How might Government address them?

The definition of 'zero carbon' domestic and non-domestic new buildings will have a significant effect on the deployment of renewable heat technologies. The current definition of 'zero carbon' homes as defined by the technical guidance in the Code for Sustainable Homes has the potential to drive the deployment of inappropriate technologies and counter-intuitive solutions. For example, English Partnerships have run two competitions based on the requirement for a 'zero carbon' new development consisting mainly of domestic buildings (Gallions Park and Hanham Hall Carbon Challenge). In both cases the winning scheme included biomass CHP solutions which do not comply with the definition of 'good quality CHP' because they were dumping waste heat to atmosphere. The message this sends is inappropriate at best as it means the inefficient use of valuable fuel resources.

If the dumping of heat is used in a central urban setting it may add to the urban heat island effect, contrary to the stipulations of the Planning and Climate Change supplement to PPS1. This may make this inherently inefficient approach to system design unacceptable and for the avoidance of doubt we believe that a legal opinion should be sought.

Fundamentally, the current definition of zero carbon is not commercially replicable in all developments due to the need for relatively large amounts of zero carbon electricity generation. The wasting of heat in the long term is not an appropriate use of resources and the final definition of zero carbon, and any legislation used to encourage deployment of renewable heat technologies must also drive the efficient use of fuel.

A number of local authorities have planning policies which call for new developments to prioritise connection to local district networks in the vicinity of the development to satisfy their heat needs. Current methodologies for complying with building regulations (SAP and SBEM) are not set up to allow for CO_2emissions to be calculated from connection to district heat networks with a large mix of technologies producing a proportion of the heat. It is also unfair to expect one developer to house/provide heat generation equipment for a whole area. Another aspect of this is the fact that if a new development were to be required to connect to an existing nearby heat network, it would inherently make achieving 'zero carbon' status harder as more costly electricity-only renewable generation technologies would have to be employed.

A significant barrier to deployment of renewable heat technologies is the lack of a supportive structure or mechanism to enable different development sites to link to each other to deliver cost-effective renewable heat in the short to medium term, and to help the creation of a district heat infrastructure network in the medium to long term. Although some Local Authorities are now requiring connection to adjacent or nearby heating networks (where feasible) through planning policies, there is little support to equip developers with the legal and technical input to ensure an appropriate solution for linking the two sites is delivered. This is especially important where energy infrastructure may cross a number of existing land ownership boundaries and be navigated around existing utilities infrastructure services. In addition to lack of support to facilitate linking of sites, there is a broader issue that to achieve best results, planning and deployment of district heating infrastructure should be undertaken in a coordinated fashion at a strategic planning level, rather than in a piecemeal way by ad-hoc delivery of sites by individual developers.

There is a clear need to encourage the installation of heat networks, especially to serve existing stock which is generally far less heat efficient than new build. In the current market a potential way to drive the installation of such networks to serve existing stock would be to allow new developments to claim the CO_2 reduction brought about by the connection of existing stock to new district heat mains. This could be facilitated through the planning system as a 'near-site' form of carbon abatement. The developer could either finance the installation of the heat distribution network, or perhaps more effectively they could pay a lump sum into a fund managed by the trustees, which could be the local council or similar authority. The trustees could then coordinate the appropriate spending of that money on carbon abatement measures including the installation of district heat mains and the central plant to serve it.

These types of fund are not new – Milton Keynes Policy D4 and Brighton and Hove council's recently proposed carbon offset scheme are examples. However, there are uncertainties surrounding the legality of such schemes. Through our involvement in the Examination in Public of the London Plan last year as technical panel representatives, we learnt from the Government Office for London (GOL) that such a 'carbon reduction fund' could be viewed as a local tax, and therefore would not be compatible with the regulations governing Section 106 payments; a view shared by the examiner. However, it is our strong belief that the government should consider the introduction of such funds to stimulate investment in municipal scale low carbon heat networks.

Whatever the mechanism, community level coordination of resources will be required, which is very difficult in the current market. An article published in November 2007 entitled 'Six in the City' expands on various issues surrounding zero carbon definitions and outlines some of the potential ideas for linking sites together: http://www.building.co.uk/story.asp?storycode=3100372.

Public perception is another major issue which will need addressing if the full potential of renewable heat technologies and low carbon heat networks are to be realised. There is extreme consumer wariness regarding new technologies and especially where heat is being delivered directly rather than, say, gas to an individual boiler. It is not just the technologies but the other delivery solutions which consumers are wary of – for example underfloor heating. This works very well with some renewable heat technologies which are more efficient at lower flow temperatures, but will only be installed by developers if they do not see the absence of radiators as a detriment to the value or quick sale of a dwelling.

The fragmented nature of the construction industry could also be a significant barrier to the uptake of renewable heat technologies.

Q13 For microgeneration heat technologies, do you agree with the above assessment of their potential, and the barriers to their deployment? How can these barriers best be addressed? Are there other barriers we have not identified?

The use of microgeneration heat technologies are definitely a part of the solution, but quality control is required to prohibit 'technological cowboys' installing renewable heat technologies on individual dwellings which do not interface correctly with heat delivery systems and hence will not achieve the full potential carbon savings for that particular technology.

The interaction between microgeneration solutions and that of a community heat network is interesting and in particular it should be noted that the large scale take-up of microgeneration technologies can reduce the business case for community heat networks.

Dwelling based technologies have a very different business case to those connected to heat networks. The main issue is that cost savings from dwelling based technologies go directly to the householder whereas a revenue stream is available to the owner of the technology if it is connected to a district heat network.

The potential lack of a maintenance regime for microgeneration technologies installed on individual dwellings is a big issue. Proposed figures supporting the ability of microgeneration to achieve a given amount of carbon savings across the UK are based on the theoretical ability of the technologies, assuming efficient and effective operation. However, the reality of microgeneration technology performance in application depends on a human factor in terms of operation and maintenance. This is very likely to mean that far less carbon is actually saved per individual installation compared to theoretical predictions, and could, at its extreme, mean that no carbon savings are achieved.

All microgeneration technologies require maintenance. The existing market for microgeneration technologies is to a small number of niche purchasers who are engaged with the technology and the carbon savings it can bring; i.e. they are more likely to carry out preventative maintenance and notice if reactive maintenance is required. If a much wider take-up of microgeneration technologies occurs then the maintenance burden falls on householders who are liable to be less likely to carry out the correct maintenance regime. Even the relatively niche market dwellings have been observed a number of years later to find that renewable energy systems have been disconnected/switched off/broken due to lack of maintenance or understanding. Indeed, recent anecdotal evidence cites

Future World in Milton Keynes as one example of this lack of system upkeep by dwelling owners.

With microgeneration technologies, there is an issue surrounding land tenure which would present difficulties in achieving maintenance of the systems installed via a management company. With leasehold property, use of a management company is commonplace and householders are used to paying a management fee. Therefore an energy services company (ESCO) or specialist management company could easily be used in conjunction to maintain the microgeneration technologies installed. However, with freehold properties there is currently no facility to ensure maintenance of installed microgeneration technologies by anyone other than a party specifically instructed by the individual householder. There is a benefit to be had if the microgeneration technologies can be managed and maintained by a specialist company on an ongoing basis, particularly in terms of ensuring the technology is performing as designed.

There may be other forms of land tenure arrangement that could be established to meet the ambition of achieving efficient operation and maintenance of renewable energy generation, whilst simultaneously enabling the many advantages of freehold tenure. It is our opinion that there may be scope to expand on the core principles of a 'commonhold' tenure arrangement, to enable centrally managed maintenance and upkeep of microgeneration technologies. Commonhold is itself a newly established tenure arrangement in the UK which enables the central management of 'common parts' of a development under a single Commonhold Association (CA), whilst maintaining individual status for units. A single CA for a community development can hold the common parts for management companies, social landlords and individual dwelling/building owners. Education of the general public about such a relatively novel approach to tenure would be required to ensure successful application. Useful references on commonhold include: Part I of the Commonhold and Leasehold Reform Act 2002 which sets out basic principles. Practical detail is contained in the Commonhold Regulations 2004.

In terms of the technologies mentioned, we would argue that air source heat pumps (ASHPs) should not be counted as a renewable technology, especially if used for domestic hot water production. The performance efficiencies quoted by manufacturers do not appropriately consider the different seasonal conditions under which they will operate, or the temperature of the water required. Efficiencies used in any calculation of potential CO_2 savings should be those which apply to the ASHP when used as part of an integrated system, rather than the COPs quoted by the manufacturer at optimum conditions.

Q14 Do you believe that financial support is essential, desirable, or not essential to achieve a significant increase in the uptake of renewable heat? Is your answer the same for all technologies and fuels?

We believe that financial support is essential to achieve a significant increase in the uptake of renewable heat technologies. Complementary to this could be the mechanism described in our answer to Q12 regarding linking new build developments with improvements in the existing stock via a local 'carbon reduction fund'.

If the government wishes to encourage the installation of these networks then funding for them should be on an equitable footing with the funding which went into the setting up of the gas network. At present there is a huge disconnect between the amount of funding available and that which is being spent on other energy generation technologies (such as nuclear). A paradigm shift in thinking is now required. Previously homes and businesses did not generally have anything to do with their energy generation. It was not something which a developer had to think about or deal with other than connecting up each premises to the electricity and gas grids. Now they are having to take a keen interest in the generation of at least a proportion of a development's energy needs on-site. Similarly, energy supply companies are not used to interfacing with developers other than carrying out network evaluations and collecting network connection charges/upgrade costs.

The cost of district heat networks is an additional upfront capital cost which developers generally find very hard to bear. However, on a scheme-by-scheme basis, barriers to deployment are more about cash-flow rather than the actual capital required. Cash-flow and borrowed finances available to the traditional energy companies are much better than within the construction industry. This makes it very difficult for high upfront cost distribution systems to be installed by developers without additional funding streams or finance options becoming available.

The installation of the actual technologies is generally not the issue, but funding for the means of distributing the heat generated (i.e. the heat network) is desperately needed. We would argue that the strategic funding of district heat networks to serve existing building stock is the most important area where government could quickly and decisively drive the uptake of renewable heat generation in order to achieve reductions in greenhouse gas emissions. Legislative changes to encourage existing buildings to connect to the heat network may be required, and the final definition of 'zero carbon' buildings must also be fully aligned with this strategy.

It is important that any financial support mechanism aimed at renewable heat generating technologies drives only the most appropriate and efficient solutions. For instance, the poor seasonal coefficients of performance of ASHPs in general, and GSHPs when producing high temperature water (e.g. for domestic hot water), should not be supported.

Q15 What level of support would bring on how much of each renewable heat technology? How cost-effective would you judge this to be in relation to other ways of reducing emissions? Can you supply supporting evidence based on the costs of equipment, infrastructure or renewable fuels?

The level of support needs to be set in the context of the support which has previously been afforded to now established technologies, and with the benefits of greater energy security in mind.

In terms of cost of equipment, Fulcrum has been, and are, involved with the design of a number of projects where this information is available. Please contact us if you would like us to provide this information in more detail.

Q16 If you believe a funding mechanism is needed to expand renewable heat, do you have any ideas for a different mechanism to the three set out above? What are your views or preferences between the various options set out here? Do any of the options create particular barriers to certain heat technologies or fuels? Are there particular difficulties with including biomethane in a renewable heat support mechanism?

<u>Capital grants</u>

There is invariably not enough money put in to capital grants, and the uncertainty regarding whether a project will qualify, and the level of funding granted is a major issue. Our experience of applying for capital grants under several different schemes has shown the frustration of this route, and sometimes the difficulty of applying for grants for innovative solutions because of the nature of the funding application form, including the type of questions asked and the detailed qualification criteria. However, the use of capital grants may have a role to play in terms of public engagement, as it is a fairly simple mechanism to understand.

Feed-in Tariff

Opinion was divided over the use of feed-in tariffs, with some people very wary of higher feed-in tariffs for certain technologies creating distortions in the market. The better option was believed to be 'net metering' where the import and export tariff is the same.

Renewable Heat Obligation

We believe that use of a renewable heat obligation has the highest chance of leading to unintended consequences. If this route were taken, it should include existing sources of heat (waste heat) and also low carbon heat solutions such as gas fired CHP; i.e. it should not be so much a 'renewable heat obligation' as a 'low carbon heat obligation'.

Planning policy is currently driving the uptake of gas fired CHP, so it would be unfortunate if the introduction of an RO for heat meant that gas fired CHP fell too quickly out of favour as it is definitely part of the solution for moving towards a lower carbon economy, although will have to be phased out of the equation eventually.

Other comments

Differential support may be useful to protect finite resources such as biomass. In the current market, this appears to be the most capital cost effective solution for providing low carbon heat. However, there are many issues with taking the use of any one technology too far.

Any support mechanism should make it financially advantageous for people to use primary fuel efficiently. It should not reward schemes where energy is being unnecessarily wasted; i.e. heat dumping to atmosphere.

The generation and use of heat covers more areas than just the construction industry, so it is important that a suitable mechanism is provided to allow for this in any support scheme.

See also Q12 & Q14

Other possible mechanisms

An interesting mechanism which could be used in conjunction with the funding mechanisms mentioned in the consultation document is to link delivery of low carbon heat to existing developments to the provision of low or zero carbon new build developments via the concept of planning gain. The requirement for zero carbon new-build housing by 2016 and new build non-domestic buildings by 2019 can be used to facilitate the installation of district heat networks to existing buildings. This could be done by fostering a hierarchy of solutions along the lines of: energy efficiency; on-site low and zero carbon technologies; near-site low and zero carbon technologies; off-site low and zero carbon technologies. The developer would be required to do all he can to economically produce a zero carbon development by first maximising energy efficiency and then utilising on-site low and zero carbon technologies. Then if the development does not achieve 'zero carbon', the potential for near-site solutions such as the installation of a district heat network to serve adjacent existing stock could be investigated. The carbon reduction benefit from such installations would be allocated to the new-build development. Then if near-site opportunities did not exist, off-site installations could be utilised to provide low and zero carbon electricity generation via the grid to count towards national carbon emissions reductions.

In order to facilitate the near-site and off-site installations where needed, the local authority could administer a 'carbon reduction fund' (see Q12) with the monies spent on local initiatives to reduce the carbon emissions of the existing built stock. This would include the installation of district heat networks. The rules must be set so that this option is only available as a very last resort, and that the cost is high enough to incentivise innovation to achieve the highest possible reductions in resultant carbon emissions. This could be achieved by setting the 'buy-out' price at such a level that greater CO_2 savings would be facilitated than if the development was actually able to provide for 'zero carbon' on-site.

This could also encourage large scale new 'zero carbon' development to provide efficient CHP plant (biomass or waste fuel), which must be on a municipal scale to achieve the best economies of scale. The new development would benefit from the low carbon electricity produced by such plant, but the heat output is likely to be far greater than that required by the new development (due to being built to high energy efficiency standards). Therefore, by allowing CO_2 emissions reductions from connection to nearby existing stock to count towards the new development's 'zero carbon' status, the installation of district heat mains will be facilitated in the local area. This would enable the cost efficient provision of district heating to serve existing industry and homes which have high heat demands.

Q17 Is it reasonable to assume that heat meters can be installed to enable a support mechanism linked to heat produced?

Yes, we believe it is reasonable to assume that heat meters can be installed. In fact it is very important that they are installed so that appropriate feedback loops can be established.

To drive efficiency in limiting heat loss from heat distribution systems, it would be preferential to aggregate the overall support from data collected from consumer end heat meters rather than a supply end heat meter. Modern meter installations are invariably of the digital type to enable remote collection of billing information. If this type of meter were to be integrated into heat supply, it would enable a relatively straightforward audit of useful heat actually supplied and this information could be linked into an appropriate support mechanism.

Q18 Are there any additional problems that you foresee with any of the options? If so, what are they?

No comment.

Q19 Do you have any information about the scale of surplus heat vented into the environment by industry? Are there any process reasons why it is necessary to discard the heat?

No comment.

Q20 What features of the electricity/gas regulatory framework would be important to assist the development of a competitive heat market? Are there any other features that should also be incorporated?

Features of the electricity/ gas regulatory framework that we believe should be incorporated include:

- Quality assurance methods
- Compensation mechanisms for consumers
- Creation of level playing field for suppliers and distributers

Any regulatory framework developed must be open and accessible to organisations of any scale wishing to contribute to a heat network. If it is only viable for the larger scale players this could have the potential effect of distorting the uptake of certain technologies.

The terms of reference used in the set up of a heat market will be very important to its success and must consider wider issues such as the inherent link between electricity and heat networks from the use of CHP and the utilisation of waste heat from existing power stations. Indeed there is a case to suggest that the same regulator should be looking after both the electricity and heat markets due to this interrelationship. Potentially this could be achieved by a comprehensive overhall of OFGEM, including adding 'lowest carbon' to their 'best value' remit.

There are a number of existing heat providers in the UK, and any regulatory framework will need to develop a means of including these pioneers without jeopardising their existing business case. For example grandfather rights could be extended to existing ESCOs providing heat over a network.

The use of dynamic metering (i.e. the variation of price of heat across the day) could become a useful mechanism to reduce the carbon burden of heat generation by reducing the total capacity required and ensuring that running times are altered to match supply and demand. Any regulatory framework should be set up so as not to restrict such innovative techniques.

Some heat networks are based on low temperature heat storage and supply networks (e.g. ATES and BTES, see Q7), and there are also cooling networks in existence. Any regulatory framework should cover all forms of heat supply network.

In addition these low temperature heat storage technologies require a regulatory support system to guarantee that only the most efficient systems are allowed and to protect the underground interseasonal heat stores in existing installations from the actions of neighbours that may affect their continued efficient operation. Such a regulatory support system has been active for many years in Holland where, for example, optimal system efficiencies are maintained by a monitoring and enforcement approach guaranteeing that over a two year period all such installations are in thermal balance i.e. that the quantum of heat extracted equals the heat introduced and stored.

Extra low temperature heating networks of this type are utilised extensively in Holland (partly due to developer confidence from the regulatory support system) and typically do not require insulated distribution pipework systems, significantly reducing district heating and cooling installation capital costs.

Overall, the regulatory framework needs to drive efficiency of heat supply in the context of reducing carbon emissions whilst ensuring that the rights of consumers are protected.

Q21 Do you agree with this account of the technical aspects of heat networks and storage? Have we missed out any important information that you feel we should have included? If you have been practically involved in heat networks, either in the UK or elsewhere, do you have any practical examples which will inform the Government's understanding?

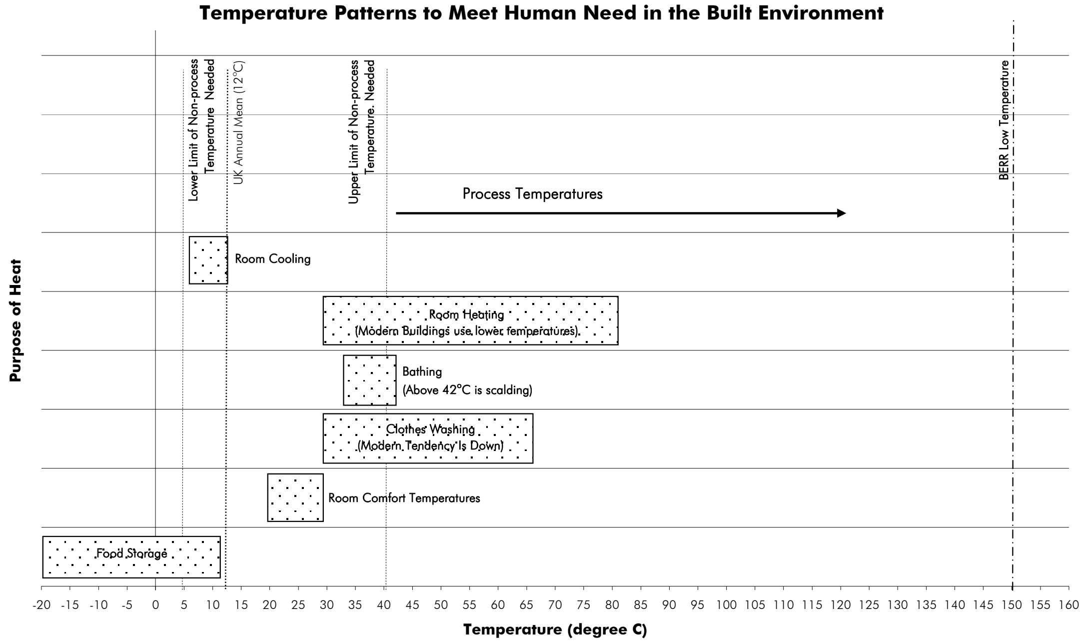
We have several issues with the definition of the different grades of heat given in the consultation document (para 151). Usable heat for the built environment is generally at the lower end of the scale.

'Low grade' heat as defined in the consultation encompasses steam (generally thought of as water over 95°C) as well as hot water. It is extremely important mainly for safety reasons that the steam portion is thought of separately. There are rightly many regulations governing the use of steam, and there are very few steam engineers left in the UK, leaving a skills shortage in this area for the foreseeable future. There should be an industry-wide definition of the relative temperature ranges, and we would advise consultation with the

Chartered Institute of Building Services Engineers (CIBSE) with respect to this. A partial definition is already to be found in CIBSE Guide B1.

To all intents and purposes, useful heat for the built environment can generally be thought of in the range 40°C to 95°C, however very low temperature applications below this level (as in the case of interseasonal heat storage) are also very much applicable. Therefore greater granularity of temperature ranges are required below the 150°C quoted in the consultation document. We include a graph below which gives indicative ranges for heat required by the built environment.

Temperature Patterns to Meet Human Need in the Built Environment



As noted in the consultation document, a lot of Swedish and Danish central primary networks can run at around 120°C flow and pressures over 10bar. If a similar approach were to be taken in the UK (i.e. higher temperature primary networks feeding potentially lower temperature secondary networks) there would be acute difficulties in the short term in terms of availability of skilled personnel to undertake the design and installation of such networks. However, this skills shortage should only be a short term problem as demand will facilitate supply, and expertise can be transferred from Europe.

Also there has to be a requirement for lowering return temperatures thus allowing the maximum use of heat available and a reduction in pumping overheads. Danish systems, for example, have an obligation on the user to return below certain temperatures.

Fulcrum have been practically involved in the design of development-scale heat networks in the UK, and we would indicate that the important aspects to consider are:

- carbon content of heat, and how this is attributed to users of the heat network, e.g. for building regulations compliance calculations, ‘zero carbon’ status, EPCs/DECs etc.
- capital cost of installing the network, and how this might be facilitated by any funding mechanism
- technical and practical aspects of the installation of heat networks, including the skills required for successful delivery
- safety issues, for example pertaining to the treatment of steam

- heat storage – not just seasonally (as in interseasonal thermal storage), but daily and hourly as well
- maintainability
- system governance and management – this should ensure that the system is operated to minimise carbon emissions and end use costs

If a new network is created then the opportunity could be taken to implement a real time, or at least more time variable, pricing system so that heat is cheap when over-supplied and expensive when under-supplied. This would encourage load matching (for example, an industrial plant adjusting time of operation to enable the use of cheaper heat when there is over supply) and storage (for example, when there is oversupply buildings could be heated to the upper band of there temperature range or if absorption chillers are used refrigeration equipment could chill to the lower end of operating temperature ranges). This form of dynamic pricing and metering to encourage load matching and storage would help flatten out the demand curve for heat; improving efficiencies and reducing carbon emissions.

Fulcrum has also been practically involved in the provision of low temperature heat networks and we have designed the first operational Aquifer Thermal Energy Storage interseasonal thermal storage system in the UK, which is the Westway Beacons project in London. We have a partnering arrangement with IF Technology, a leading specialist engineering consultancy in Holland dealing with this technology and can supply data on numerous Dutch, American and other international installations of this sort including data on the Westway Beacons project itself. Please contact us for further information.

An issue found when implementing the Westway Beacons project is that current Building Regulations compliance methods (SAP and SBEM) are not set up to be able to model the benefits of interseasonal heat storage technologies, thus creating a barrier to greater up-take of this technology in the UK.

Specific issues arise in connection with heating and cooling networks that use underground thermal energy storage such as ATES and BTES as described in Q7. The technology works at its best where there is a mix of building load profiles, matching cooling and heating demands of different building types over a year. It is particularly useful where existing buildings with a higher heating demand can be connected to buildings that have a net excess of heat over a year. Fulcrum are involved in the investigation of the technology as part of the carbon reduction programme being implemented across the South Kensington Cultural and Academic Estate (1851 Commission), part funded by DCMS.

The implications of this technology include the possibility of 'heat planning', whereby the possibility for buildings to work together to balance heating and cooling demands over a year can influence the planning of the built environment, by encouraging mixed use and heat contribution by new commercial heat-exporting buildings to existing buildings.

One essential part of this technology is the need to model and control the heat flows in the 'underground' thermal resource. This is relatively simple to do and is common practice in countries where the resource has been successfully exploited as part of a low carbon heating and cooling infrastructure, such as Holland. The UK Government needs to determine how this will best be managed, e.g. through EA, Local Authorities, etc.

The use of underground thermal energy storage should also be considered as part of a 'tri-generation' strategy. The South Kensington Cultural and Academic Estate study is carrying out research into the potential use of this technology in conjunction with CHP as a local heating/cooling/electricity supply network to maximise carbon emissions reductions. This study is being supported by the London Climate Change Agency.

Q22 To what extent will carbon pricing signals provided by future phases of EU ETS, the Carbon Reduction Commitment and other policy measures be sufficient in encouraging the supply and use of surplus heat including CHP? If insufficient, which other measures may be desirable and what is the case for them?

The EU ETS treatment of CHP, especially incorporating it into existing sites, is very complex, and the method of benchmarking used for CHP is quite crude. Understanding the impacts of CHP in the ETS is very complicated. The EU ETS deals with carbon emissions from fossil fuel consumption. Although the ETS has a specific sector for CHP, it is most useful for large electricity producers that are intending to either convert existing sites or open new sites. It is much more complex to understand the implications of adding CHP to sites in sectors other than large electricity producers. In particular, the inclusion of fossil fuelled CHP will lead to higher on site fossil fuel consumption, as now part of the site's electricity consumption which was generated offsite (and not included in the sites allocation) is now generated onsite. The ETS does not directly account for this carbon reduction in the manner used in Part L of the Building Regulations. Instead a portion of the site's allocation would be moved to the CHP sector. Recent correspondence with the CHPA shows that even the experts feel it is incredibly complex.

In terms of price signals, the current price of Phase II allocations of around €20/t is still only a fraction of the fuels sales price and has only a small impact compared to other variations in fuel and electricity prices. An industrial scheme recently analysed by Fulcrum Consulting comprising a 1.8MW CHP unit fully installed at around £1M could save allocations of around 1,000t/yr and could payback in around 5 years with current energy prices. The current price of €20/t only represents about 8% of the savings attributed to the "spark gap" difference between electricity and gas prices. To finance this installation on a carbon basis alone, a carbon price of around €256/t would be needed. It is important to note that predictions of spark gap savings are very difficult to make and given the experience with NETA in the early years of this decade, where the spark gap closed so considerably that many operating and proposed CHP schemes became uneconomic, many parties are naturally wary of embracing CHP without further support from other areas. In the example given above even if the carbon price doubled to €40/t it would still only represent 16% of the savings, leaving the rest to the risk of spark gap variations. It is worth noting that the Part L methodology would attribute carbon emissions reductions in the region of 3,000t/yr, compared to the 1,000t/yr from the ETS method. The ETS methodology does not truly reflect the carbon saved from the electricity production in the CHP system.

It can be seen from the expected failure to meet the Government's target of 10GW of CHP by 2010 that the current methods of CHP incentivisation are not satisfactory. In recent years the main incentive for CHP installation is the "spark gap", other incentives such as Enhanced Capital Allowances are only really cash flow related and do not greatly aid the business case of CHP. The most recent driver in the building sector is planning legislation and whilst this might force the use of CHP, it still does not assist its uptake financially. In particular most CHP schemes will also require investment in heat distribution networks, which are very capital intensive. The ETS does not have any allowances for this.

The termination of the Community Energy Programme in 2006 killed off the potential of many community scale schemes which could have realised considerable emission reductions compared to spending the equivalent money on other technologies. The only financial incentive currently driving community scale heat network schemes with CHP is the sale of electricity over private wire via Energy Services Companies (ESCOs). Whilst this can assist in the finance of new build schemes, there is still a very high cost to the developer and it is rarely helpful when addressing existing buildings where taking over electricity networks is very difficult. To really enable the uptake of CHP in areas requiring investment in heat distribution, a funding mechanism similar to the Community Energy Programme needs to be considered.

Q23 Is it appropriate to use the regulatory mechanisms such as Climate Change Agreements and Pollution Prevention and Control regulation to stimulate industrial demand for surplus heat? How could this be implemented? What other existing mechanism might be used?

No comment.

Q24 What additional data should the Government collate relating to surplus heat from the power and industrial sectors? How do you suggest that Government could go about capturing information on surplus heat from these sectors for use in statistics?

No comment.

Q25 If you have been practically involved in setting up heat supply networks what lessons can you share? How can Government make it easier for firms to create heat networks? What information can you provide on the costs of heat infrastructure either in the UK or overseas? What barriers have you encountered? Are any of these unique to the heat market?

Where CHP heat networks serving housing are linked to private wire electricity supply networks, barriers have been found involving the Landlord and Tenants Act. Whilst communal heating networks are not regulated under the Landlord and Tenants Act, the supply of electricity is, in that a tenant cannot be bound to accept an electricity supply solely offered by the freeholder unless it is of 'demonstrable value'; i.e. is cheaper than available alternative supplies. This potential legal barrier should be fully investigated.

There is a perceived barrier by developers to the utilisation of ESCO services from companies which are not amongst the 'big six' energy suppliers which is limiting uptake of more innovative, low carbon commercial approaches to ESCO procurement. This perception is also limiting the potential advantages of smaller ESCO company entries into the energy market improving competition. Currently there are also high legal costs to be borne by companies involved due to the bespoke nature of ESCO contracts to date. These issues must be considered fully, especially where a governing body is set up to deal with heat suppliers and distributors.

Please refer to Q21 and elsewhere.

Q26 What useful role might public bodies play in coordinating information between different industrial sectors, above what is already being done? Should central and/or local government play a part in helping to normalise/standardise heat transactions between suppliers and customers? If so, in what way?

The energy supply market has given the onus to companies who make energy, not those who need to use it. The role of a public body could be to help facilitate the setting up of 'heat collaborations' from a much more consumer orientated point of view, and could provide useful guidance to all parties if the public bodies can attract people with the correct skills base. However, any role of public bodies with a local focus to their activities must not act as a barrier to strategic thinking.

The potential for leverage of investment funding in district heating networks from zero carbon developments potentially augmented by low carbon planning gain funding creates an opportunity for local government to use such funding to achieve partial equity ownership in community ESCO energy supply networks. By achieving equity ownership without the need to raise capital, local government would be privy to all information concerning the community ESCO allowing it to play a role in normalising and standardising heat transactions between the ESCO and the consumer.

We are currently aware of several ESCOs which are part-owned by public bodies, and in some cases this is driving inappropriate solutions, in both technical and competition terms. The promotion of use of a particular ESCO for a development must not be at the expense of due planning process.

Q27 Should government consider setting up a regulatory regime for the heat market? What would be the key features of any guidance or regulatory regime?

Yes, we believe government should consider setting up a regulatory regime for the heat market. A regulatory regime for the heat market is essential in terms of guaranteeing expectations of an agreed level of service and an accessible compensation route for non-performance, to avoid negative effects on the market value of any housing served via such heat networks.

Care should be taken in the marketing of heat as a commodity. Any regulatory regime should avoid incentivising the sale of more and more heat to individual consumers because overall the encouragement first and foremost should be for increasing the energy efficiency of the built environment (i.e. requiring less heat per building). If consumers were to pay to have their homes/offices heated to a particular level rather than pay directly for the quantum of heat supplied, the onus would be shifted to the supply companies to produce and deliver heat in the most efficient way as a means of increasing their profits.

Please also see answer to Q20.

Q28 What role, if any, do you believe that district heating has in reducing greenhouse gas emissions from communities?

We believe that district heating has an essential role in reducing green house gas emissions from the existing stock. Interseasonal thermal storage/heat pump based extra low temperature district heating and cooling systems also have an essential role in reducing CO_2 emissions from mixed use communities. We also believe that the role of district heating provision in 'zero carbon' housing communities is limited to high density developments only, due to the very low heat demand of these new developments.

Fulcrum have undertaken pre-planning investigation of a 50MW electrical output biomass power station which showed that the provision of subsidised waste heat via a district heating network to an adjacent industrial park could allow tenancies from industries otherwise leaving the area due to rising heat energy costs (in this case cheese making). The provision of subsidised waste heat to nearby industrial parks could retain employment in industries otherwise leaving the UK due to rising energy prices, which will have wider benefits for the UK economy.

With a community share in equity ownership of district heating networks, there is a driver for the inherent data collection systems from heat meters to be upgraded to high grade data services networks to provide a community intranet system thereby enabling another potential income stream for the community from sale of data and telephony services. This community intranet system is capable of achieving greenhouse gas emission reductions from communities by providing education on sustainable lifestyles, managing car pool systems remotely, potentially providing guaranteed locally grown food to the front door, etc.

Please also see comments to many questions above.

Q29 Do you have evidence from real projects to demonstrate the cost-effectiveness or otherwise of district heating in reducing emissions?

Fulcrum has been involved in a number of projects which have included district heat networks. Please contact us if you would like further information.

Q30 What policies could the government pursue to promote or facilitate district heating?

Please see answers to Q12, Q16, and others above, especially in relation to:

- the introduction of funding streams to promote district heat networks, especially in relation to the installation of district heating pipework
- the setting up of a 'carbon reduction fund' to facilitate investment via new developments
- the setting up of an appropriate regulatory regime for a heat market, to protect consumers from potential local heat monopolies

In putting together policies, government must consider the interrelationship with the electricity markets for CHP based heat generation. The government could promote district heating by setting up demonstration projects to existing stock by involving the government estate.

In addition, funding for district heating installations could be achieved from CERT funding to which could be added additional income for electricity sales from CHP under the proposed ROC banding arrangements. Our idea is that the municipality negotiates with the commercial ESCO partner to recognise that the likely additional 0.5 ROC income achieved from CHP derived biomass to electricity (rather than biomass to electricity only) should be considered as an income stream enabled by the municipality itself (along with an element of the heat sales).

This funding could be applied to meet some of the initial high capital costs of providing the district heating network and could also be utilised by the municipality to achieve an equity ownership share of the municipal ESCO special purpose vehicle.

Q31 Are there reasons to accelerate the development of district heating (such as missed opportunities) or should other technologies be given priority?

Fundamentally we believe that district heating has a very important role to play in our energy future, and therefore its uptake should be strongly promoted. There are currently very few substantial district heat networks in the UK, and it could be argued that this is due to the current regulatory regime related to electricity and gas markets and planning policy. Countries such as Denmark have much higher penetration of district heat networks, partially due to the municipal ownership of networks and the ability, within a framework, to oblige buildings to connect to the heat network.

The setting up of district heat networks really needs municipal level coordination. In the UK there have been many missed opportunities to utilise waste heat from power stations. A case in point is the South East London Combined Heat and Power (SELCHP) energy from waste plant. Despite its name, no heat from the plant has ever been delivered to consumers – the regulatory regime to allow this to happen has simply not been place.

To prevent travesties such as SELCHP from reoccurring there should be an absolute requirement from government that all new power stations should be connected up to district heating to prevent the wasting of heat. For instance, the proposed coal power station at Kingsnorth in Kent, which given the carbon intensity of coal is highly questionable in the first place, should not be given planning consent without the requirement to provide 'waste' heat to nearby developments. Similarly, the recently consented Port Talbot renewable energy power station should be a CHP plant rather than just a power provider. The existing gas power station in Barking, London, also has enormous potential to supply heat to areas very close by.

Another example is the money spent on liquefied natural gas (LNG) infrastructure to handle the importation from producers in the Middle East and other locations. A special terminal in Milford Haven has been constructed at a cost of approximately £6bn and a further £1bn has been spent on a pipeline to transport this gas to the National Gas Transmission System in Gloucestershire. The logic of this expenditure is highly questionable as a similar sum spent on district heat networks to utilise 'waste' heat from existing power stations would have reduced the need for gas and given low carbon heating to tens of thousands of homes. We believe this to be a missed opportunity which therefore adds to the case for government intervention to accelerate the deployment of district heating.

Q32 What role, if any, should central or government, developers and energy companies play in the development of district heating?

See comments throughout.

All parties mentioned are likely to have a role in the delivery and facilitation of district heating in the UK, with potentially interesting partnering arrangements possible.

Q33 Who should deliver district heating? Specific purpose ESCOs, major energy suppliers or other utilities, local government, other. Please expand.

Any of these parties could within the correct policy framework deliver district heating. In our experience, the current fledgling market is being delivered by ESCOs, at an individual development level. We feel that local authorities will need to be involved in the facilitation of larger-scale heat networks, as strategic decisions will need to be made.

Public ownership of energy networks is also an option, especially if carbon emission reductions are the major driver for encouraging an alternative view of energy supply.

See also comments throughout.

Q34 Should government consider setting up a Good Quality accreditation scheme for district heating networks to ensure standards and perhaps enable targeted support?

Yes, we believe this would be an essential element to promote confidence amongst consumers and hopefully prevent the possibility of a negative consumer perception of the value of properties served by district heat networks.

Q35 What forms of regulatory support would be required for operators of district heating schemes?

District heating schemes and renewable heat are inexorably linked. Therefore, please refer to comments throughout.