*Re: Heat Call for Evidence Coordinator, Energy Group, The Department for Business, Enterprise and Regulatory Reform (BERR)*

**Evidence prepared by AECB – the sustainable building association**

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*1. Introduction*

The proportion of UK delivered energy used for heat has been about 65% for several decades. Much of it is for space and water heating. Some, however, is for industrial processes at a temperature of above 100 degC - sometimes far above 100 degC, as with steel-, glass- and cement-making.

*2. Reduce consumption*

The government should be seeking to reduce the consumption of heat. The means to achieve this in buildings have been known for decades, comprising thermal insulation, draughtproofing, very advanced window designs and other technologies, but some of the technology has been dramatically refined over the last 15 years, especially with the rise of the Passivhaus Standard. The trend is led by Germany and Austria, where 8000 domestic and non-domestic buildings met the Passivhaus standard by 2007.

The requirement for useful space heating in a Passivhaus building is 10-15 kWh/m$^2$yr. The requirement for space heating energy in a well-heated UK building is 200-300 kWh/m$^2$yr; the national average is 150-200 kWh/m$^2$yr, because not all buildings are by any means fully-heated.

A few exceptional buildings such as the Elizabeth Fry Building at UEA have recorded figures of 30-40 kWh/m$^2$yr. So far, no UK projects have been documented which perform as well as the requirement of the Passivhaus Standard.

In Austria, 8% of new building construction meets the Passivhaus Standard. In the UK, by contrast, at least 40% of new construction fails to meet Part L of the Building Regulations.

*3. Utilise reject heat*

More heat is thrown away from UK power generation than the quantity of natural gas which is used to heat UK buildings - a gas usage which depleted the entire North Sea in the space of barely 35 years.

This has been the picture for several decades. The government's Energy Paper 20 analysed the economics of the situation in 1980 and they were encouraging even then - long before the present concern re climate change.

Also some industrial processes produce waste heat which can be utilised to heat buildings - so long as a heat distribution system exists. For instance, in Gothenburg, Sweden waste heat from an oil refinery is used to heat part of the city (in future, no doubt, as we move from petroleum fuels to biological fuels, heat from bio-refineries could be used likewise).

Denmark has developed CHP/DH to the point where 65% of buildings are heated this way. Heat and gas mains co-exist, although more gas is now used in CHP plants than in individual boilers in homes. Danish technology for heat distribution to buildings is generally considered to be a world leader even versus other Scandinavian countries. It becomes economic to lay heat mains in districts of detached and semi-detached houses, whereas the UK at the time of Energy Paper 20 only considered connecting flats and row houses.

The alleged trade-off between heat distribution and efficient use of heat has been overstated. Many Danish and German low-energy buildings have been successfully connected to heat distribution systems; e.g. the Low Energy and Passivhaus development at Kronsberg, Hanover is heated from a gas-fired CHP plant. A Passivhaus residential block for 286 students in Vienna is connected to the district heating system.

To date, the UK has wrongly analysed the $CO_2$ savings from CHP. The savings are on the thermal side, not on the electrical side - in line with the second law of thermodynamics. Accordingly, the CO2 savings from using waste heat to heat buildings are larger than the government has allowed for, and the CO2 savings on the electricity side from CHP operation are smaller than the government has allowed for.

Heat mains offer long term-flexibility, because they can utilise any source of low-grade heat. Gas mains can only use gas and electricity distribution systems and resistance wires can only use electricity, which is a very expensive form of energy to generate and transmit.

The Danish CHP system is being successfully used to balance the varying output from windpower, using large scale heat storage on the heat distribution systems. The same could happen in the UK, if more windpower is to be used.

Denmark plans to provide 50% of its heat in around 2030 from stored solar heat, using existing or new district heating infrastructure. Large-scale solar thermal systems produce heat at roughly *one-fifth* the cost of heat from systems on individual house roofs. This transforms the economics of solar heat from debatable to quite attractive. In fact, Denmark finds solar systems of 250 $m^2$ upwards to be viable today without subsidies. What other renewable source of heat is equally viable? See for example;
http://www.solarge.org/uploads/media/9_DENMARK_Runager.pdf esp. slide 14.
And;
www.solarge.org/uploads/media/CSTS_Market_Development_Denmark_RAMBOLL_Steffensen.pdf.

*4. Solid biofuels*

There has been quite a widespread UK conclusion that, to save $CO_2$, solid biofuels should be burned in single-house heating systems. Significant problems arise from this decision.

Older wood-burning appliances often emit more greenhouse gases, per kWh of heat, than an oil boiler. The general public and buiding design teams seem to be unaware of such pitfalls. So does part of the UK government and its agencies.

The exhaust emissions from wood are more troublesome than the emissions from burning today's heating fuels; i.e., gas in urban areas and oil and LPG in rural areas. (Not even the most expensive wood pellet boilers yet have emissions level with an average oil-fired boiler.)

Large combustion plants burning solid fuels; e.g., wood- or straw-fired CHP stations, *are* generally able to clean up their exhaust gases to the standards expected by an advanced 21st. century society. This is because they can afford expensive flue gas cleaning equipment. They also make more efficient use of the fuel than small CHP plants or heat-only boilers; it is inefficient to burn very high-grade energy to produce low-grade heat, in line with the second law of thermodynamics.

We feel that a revival in small-scale solid fuel combustion is an unwelcome prospect as the adverse effects on public health could be worse than the hoped-for climate change benefits. Government subsidy for activity which could increase the levels of particulates, polycyclic aromatic hydrocarbons and related pollutants should have been carefully considered beforehand, to evaluate the harm to public health and compare this to the supposed benefits from reduced CO2 emissions. We see no evidence that such an assessment was ever made.

The sustainable potential for biomass has been put at c10% of present EU energy use, or c.2500 TWh/yr for the entire EU-27. After considering high-value uses for biofuels such as chemical feedstocks, transport, cooking (in lieu of LPG or mains gas), glassmaking, steelmaking, CHP plant, etc, the amount left over and which could be justifiably devoted to providing low-grade heat may be severely limited.

*5. Electric Heat Pumps*

We question the validity of treating different kWh from the national grid as “green” or “brown”. All electricity taken from the national grid at a particular time is broadly equivalent in its $CO_2$ intensity. Renewable electricity exported into the national grid at a particular time benefits electricity consumers as a whole, not so much the owners of the individual solar, wind or hydro generating plant.

In recent years the proportion of electricity from renewables has not actually met the legal minimum percentage set by government. In 2007 the legal mandate was 7% but the actual amount produced was 5%.

To treat green electricity as though it is in surplus and can be considered for optional uses such as space and water heating strikes us as at least 40-50 years’ premature. Today, the marginal plant installed in response to a sustained increase in UK demand for electricity is coal-fired; it is not gas-fired or renewable.

The users of electric space heating, including heat pumps, are heavily dependent on coal-fired plant, which serves the winter peaks. The notion that if such users produce as many kWh of electricity from wind or PV as their annual consumption in kWh, their electric space heating is clean and green is a fantasy.

We think that it would be a tough task to produce enough electricity from renewables (hydro, tidal, wind, solar, geothermal and biomass) in 2050 to meet all the “essential” uses of electricity; e.g., lights, PCs, ventilation fans, pumps and appliances. So even in 2050, the marginal plant to consider in such analyses will not be renewable; it will be fossil-fuelled.

Present labelling of electric heat pumps as “renewable energy” is highly misleading. Coefficients of performance from plant that has been monitored are not as high as the manufacturers state, with as much $CO_2$ being emitted as a result of the electricity being used to run them as is being ‘saved’ by using the heat pump as a heat source. A highly efficient gas, LPG or oil boiler would usually emit less $CO_2$. It is open to further challenge but we hope that the government will abandon this wording as soon as possible.

Belief that heat pumps are a form of "renewable energy" has already caused some people who live in towns to install a heating system which costs three to four times more to install and emits more $CO_2$ than the gas boiler it replaces. A serious misallocation of resources has been subsidised from public funds.

*6. Active solar, single buildings*

We refer to our comments at the end of section (2). If central solar collectors produce heat for one-fifth of the cost of heat from collectors on individual roofs, and if moreover, such heat can be stored from summer to winter, taking advantage of the economies of scale, it is perverse to install solar collectors on single buildings - except on buildings in the countryside.

Given that rural buildings using active solar will usually need some backup fuel, priority should be given to producing clean-burning liquid or gaseous biofuels from solid raw materials such as miscanthus and forestry wastes. Biomass replacements for LPG and oil, such as bio-dimethyl ether and bio-diesel, could be burned in condensing LPG- and oil-fired boilers with minimal redesign. Some biodiesel is already being burned in oil boilers especially in the USA.

If such buildings are retrofitted to high levels of insulation and airtightness - as per the current German policy of bringing-up buildings to at least their current Building Regulations, and sometimes to Passivhaus, by 2025 - then a combination of active solar and biofuel offers a viable method to provide their space and water heating. The fuel use of a typical large detached house, in litres/yr, may drop from 3000-5000 (30,000-50,000 kWh/yr) to 200-500 (1,000-4,000 kWh/yr). EU climate change policy published in January 2008 proposes that all new buildings in Europe from 2011 be designed to the Passivhaus standard.

*7. Areas for action*

Attention should be paid to the above areas (2) and (3) before considering the relatively expensive renewable sources of heat in (4), (5) and (6) (although (6) is necessary in rural areas). The technologies covered in (2-3) can be successful at current energy prices; the ones in (4-6) are at best marginal.

All in all, the UK has lacked any kind of strategic planning in the energy field. Other regions recognise the need for this. See http://www.californiaenergyefficiency.com/index.shtml and http://www.californiaenergyefficiency.com/docs/plancomments/DRAFT%20CEESP--FOR%20SERVING%2002-08-08.pdf.
With space heating, we think it would be necessary to follow the lead of Denmark, which has had a Heat Plan since 1979 which brings some order to the situation and enables the most effective methods of heating buildings to be used in different areas.

The government must rectify the incorrect methods which have been used to assess the $CO_2$ savings from using reject heat from thermal electricity generating plant. These errors are indefensible. They have distorted public policy, by understating the benefits from using CHP plant for space and water heating.

There is no UK grant aid for floor insulation or solid wall insulation in existing buildings, nor is aid available for installing extremely high levels of insulation and airtightness - on a par with Passivhaus standards - in new buildings. Nor does passive solar design receive incentives. Nor does CHP. Yet such steps save $CO_2$ for fewer £/tonne than other measures which do receive grant aid; e.g., solar water heating, and are profitable once a mature market is achieved (in fact, passive solar design and CHP are profitable now if institutional and political barriers are removed).

Grant aid for heat pumps should be suspended until all more profitable $CO_2$ -saving measures in the supply or saving of heat receive commensurate grant aid. These include CHP from existing power stations and biomass-fired power stations and extremely high levels of insulation and airtightness - often on the Passivhaus scale - applied to new and existing buildings. Heat pumps should not normally be subsidised in cases where they replace a heating system which has *lower* CO2 emissions. There should also be a thorough review of the design and installation errors in LCBP-supported heat pumps. These have reportedly led to widespread COPs of less than 2.0.

The profitability or otherwise of different $CO_2$-saving measures available to the UK should be analysed on the basis of life-cycle costing, in £ per tonne, using the real interest rates in the Treasury Green Book and using correct $CO_2$ emissions coefficients for different forms of energy. Until this is done, there is no rational basis for action to support one potential area of investment versus another and the UK will continue to lag behind its continental neighbours. Germany expects to reduce its $CO_2$ emissions by 36% by 2020; on existing trends, the UK will have difficulty in reducing its $CO_2$ emissions by 20%.

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