Heat and the City

Exploring affordable, low carbon community heating in cold climate cities

www.heatandthecity.org.uk

Research Team:

Janette Webb (Principal Investigator)
David Hawkey (Research Fellow)
Mags Tingey (Research Officer)
Andy Kerr
Heather Lovell
David McCrone
Mark Winskel (Co-Investigators)

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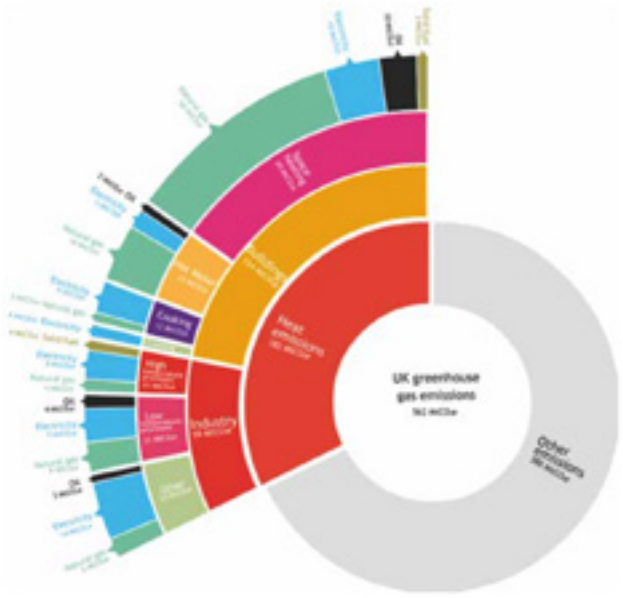
Energy

'By 2050, all buildings will need to have an emissions footprint close to zero' (UK Government, Carbon Plan 2011, p.5)

In the UK, buildings account for 37% of UK greenhouse gas emissions and 45% of these are due to use of heat from fossil fuels. National and devolved governments have set goals for all energy used in buildings to be low or zero carbon as part of the radical 80% emissions reduction target embodied in Climate Change legislation.

Old and new buildings are predominantly in densely populated cities and urban areas where as much as 80% of final energy demand is concentrated. Currently the UK wastes a lot of heat, much of which we pay for, from leaky buildings and industry. Heat produced by industry and in power generation could instead be captured and used to provide district heating, as in many parts of Europe. Currently around 2% of heat is delivered by district heating, and only 1-2% of heat is from renewable sources (UK Government Department of Energy and Climate Change (DECC), 2013).

Much of UK policy targets either large- or small-scale intervention ignoring advantages of area-based solutions. At the large scale policies focus on low carbon electricity. At the small scale policies focus on individual buildings, and behaviours. Our research addresses 'the missing middle'– city-scale action for sustainable energy.



UK Greenhouse Gas Emissions. Source: DECC (2012)

Collaborative research methodology

Our data focus on the multiple perspectives on developing district heating in the UK in comparison with Netherlands and Norway. We have conducted:

- Interviews with 159 legal, finance and engineering experts, supply chain businesses, local and central governments and agencies
- Ethnography of policy processes and project developments
- Household surveys of experiences of district heating retrofit in a low income area
- Documentary analysis
- Secondary analysis of public datasets

We have engaged in knowledge exchange with district heating practitioners across the UK and Europe

- Working with a community energy practitioner, we have developed the UK District Energy Vanguards Network
- We ran four workshops on leadership, finance and policy options
- Vanguard members include 62 UK local authorities, 10 Registered Social Landlords, 5 University estates, UK and Scottish Government representatives, as well as energy utilities and investors
- For more information on the network visit www.heatandthecity.org.uk/vanguards

The Heat and the City project has led to further research and knowledge exchange

- European Stratego project www.heatandthecity.org.uk/stratego (funded by Intelligent Energy Europe)
- Local Engagement with UK Energy Systems (co-funded by the UK Energy Research Centre and the Energy Technologies Institute)
- Reframing Energy Demand: Innovation for Sustainable Heat (funded by the Engineering and Physical Sciences Research Council – working with the Centre on Innovation and Energy Demand)

Thermal Imaging of Sheffield Town Hall. Copyright Dr Grant Wilson, The University of Sheffield

District heating – the technology

District heating trench work and pipes in Glasgow (left) and Edinburgh (right)

Heat networks

District heating uses insulated underground pipes to deliver heat from any 'waste heat', low carbon and renewable sources to multiple buildings. For example, in Islington the council is exploring using heat from the London Underground in a heat network. In Danish cities such as Copenhagen large heat networks create competitive markets for heat providers.

Justification of the high level of capital investment in infrastructure usually requires long term commitments from a stable user base to provide guaranteed revenues. Speculative investment is unlikely. In Scandinavian countries in the twentieth century, regulation and municipal planning helped secure local user bases.

Heat sources

In the UK, most urban projects use small scale gas combined heat and power (CHP). This is affordable at the scale of many heat network projects. Gas CHP produces a moderate carbon saving in the short term by displacing electricity on the national grid. As the grid is decarbonised however, the carbon savings of gas CHP will reduce, so government policy envisages replacement with lower carbon sources such as large heat pumps, geothermal or industrial surplus heat. Periodic policy discussions consider regulation to encourage thermal power generators to supply heat, but UK requirements on the industry have remained weak. For example, the EU Energy Efficiency Directive proposal stipulating that all new power stations should make use of residual heat was weakened to require only the conduct of a cost benefit analysis. This reduced the energy saving by a third (Services of the European Commission, 2012). The UK Environment Agency guidance recommends use of a 16% rate of return on capital for such cost-benefit analysis, which is far higher than heat networks (or other infrastructures) typically achieve.

> *'these plants (Energy from Waste) … they could produce more electricity and less heat, they could produce more heat and less electricity but as things stand at the moment the money is in the electricity. So they'll tend to produce as much electricity as they can, as little heat as they can, but still meet their efficiency standards. Because there's just not that impetus for heat use…'* (Environmental officer for a City-Region waste partnership)

Impacts of heat networks on the energy system

By bringing electricity and heat generation and supply closer to end users, localised energy could reduce or defer some of the estimated £200bn+ investment needed in renewal of UK energy infrastructure. By enabling different heat sources they increase options for the future.

Heat networks can also contribute to balancing the electricity system. Distributed generation from CHP reduces the need for investment in (high carbon) 'stand-by' plant and network infrastructure, because it can operate flexibly as short-term operating reserve, plugging gaps when demand outstrips supply. Conversely, converting electricity into heat can make use of power that otherwise would be wasted. This is more significant with increasing levels of intermittent renewable energy and nuclear power, both of which are difficult to modulate in response to demand.

Network economies mean large scale systems are more effective in addressing energy policy objectives than an equivalent number of small systems (Woods et al. 2005).

Our Findings. District heating and low income households

Residents described the old heating system in their own words.

There was a transformation of views under the new district heating system.

We interviewed 10% of households on a Glasgow estate where old electric storage heating was replaced with a heat network and the buildings were insulated. This was the first significant energy upgrade on the estate since it was constructed in the 1960s. The housing association negotiated a long term concession contract with a major utility to design, construct and operate the system.

Before the upgrade, most households complained of being cold all or most of the time in winter. Many were spending 25% or more of their income on electricity, yet were still too cold. The new system has resulted in a major increase in satisfaction with heating: this has leapt from 31% reporting satisfaction before the upgrade to 78% now. Furthermore, 80% now say they were never cold during winter, compared with only 8% the previous year.

The cost of keeping homes warm is now lower, but on average energy bills have not fallen. Households have taken the increase in affordability in heating in warmer homes rather than lower bills. While average bills remained roughly the same, we found that households whose energy bills had been high before the new system made savings, whereas those with low energy usage in the past were now paying more.

The transition to new systems of heat metering, billing and payment has caused problems for some residents. Households now pay two standing charges where they previously paid one, and the system of payment combines elements of credit metering with prepayment metering. Residents found it difficult to understand the connection between how much heat and hot water they were using over what period, and how much they needed to pay.

District heating can improve people's quality of life, while reducing carbon emissions, but more work is needed to address affordability for all.

www.heatandthecity.org.uk/wyndford

Tower blocks in Glasgow being fitted with external insulation.

Wyndford energy centre

The view from central government

'The heat challenge is a "systems problem" and can be addressed at different levels … it cannot be fully solved by considering one part of the solution in isolation' (UK DECC, 2013, p.8)

Our research finds that although the parameters of UK sustainable heat policy are now developing, it remains unclear how any transition will be brought about. Under growing pressure on carbon budgets and changing estimates of different technologies' price and performance, policy has shifted from envisaging universal electrification of heat, via heat pumps in each building, to encompassing more diverse technologies (UK Committee on Climate Change, 2012; 2013).

The UK DECC 2013 heat strategy envisages three key elements for future supply: heat networks for urban areas, renewable heating for rural areas, and more efficient use of gas in suburbs. But where does responsibility lie for driving such radical change? The UK Government Carbon Plan (2011) is optimistic about market competition in the long run, while in the short term central government support focuses on equipping local authorities to develop niche opportunities.

Positioning local government

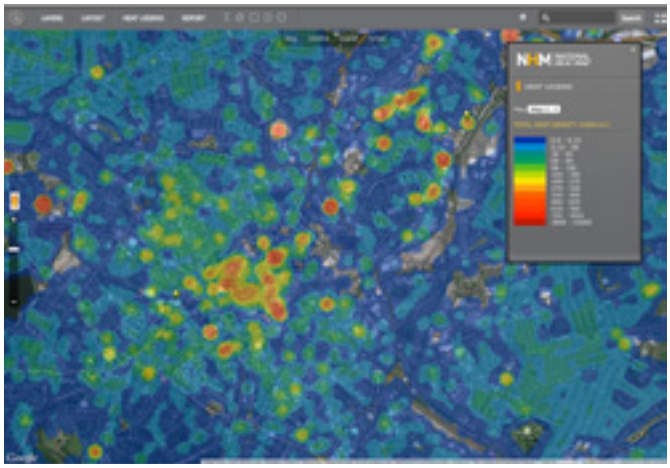
Local authorities have historically been critical to developing district heating elsewhere in Europe. Neoliberal policies have led to unbundling of both energy and local government. Nonetheless we found local authorities remain important actors in European countries such as Denmark, Norway and the Netherlands. UK policies, as well as most stakeholders, also position local government as a key actor in future development of urban district heating.

UK local authorities have few powers over energy, and lack capacity and resources, but they are using the available central government resources:

- Heat maps show location of intensive heat users and nearby sources of heat
- Generic advice and consultancy is being procured with assistance from the Heat Networks Delivery Unit (England and Wales) and the Heat Network Partnership (Scotland)

Public funds to invest are however restricted by political-economic policy. The UK Green Investment Bank for example does not offer low cost finance. Instead it aims to "crowd private capital in" to create a new financial market for investment. Taken together this policy package tends to position local authorities as organising financial opportunities for the private sector to exploit.

Strategic Framework for Low Carbon Heating in Buildings. Source: DECC (2013)



National Heat Map - Birmingham. Source: DECC

Scottish Heat Map – Glasgow. Source: Scottish Government

Our Findings. Local authority engagement with energy systems

How do local authorities see their role in energy system change? They are increasingly active in low carbon energy planning and investment: heat and energy saving projects are most common, though many leading authorities combine multiple approaches.

We developed a metric of local authority engagement with energy on the basis of two key indicators

- Strategic energy and/or carbon planning by local authorities
- Number of projects for which the authority has secured investment

Planning is more common than action: two thirds of authorities have plans but only one third have secured investment

We categorised all 434 UK local authorities as

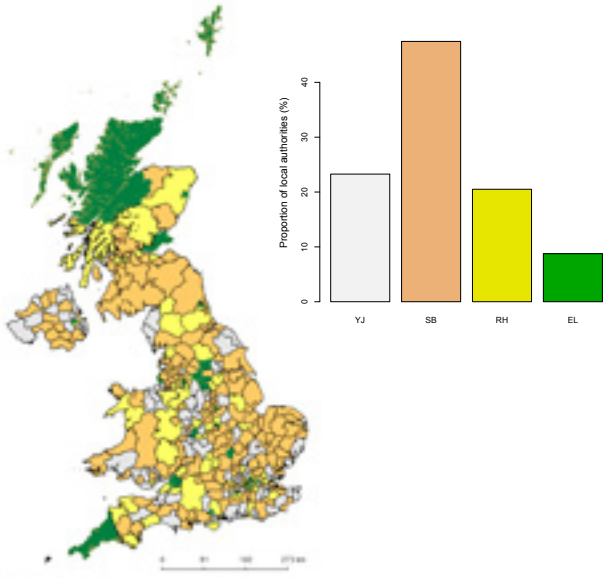
- Energy leaders (9%): successfully mobilised investment for three or more initiatives. The majority of these authorities also had energy and carbon plans.
- Running hard (21%): investment in one or two initiatives, accompanied by an energy/carbon plan
- At the starting blocks (47%): either investment in one or two initaitives, or an energy/carbon plan
- Yet to join (23%): no evidence of either investment or energy/carbon planning

www.heatandthecity.org.uk/LEUKES_pilot

When local authorities develop community energy and district heating, they act on the basis of multiple rationales

- Economic regeneration
- Housing stock upgrades to improve revenues
- Affordable warmth
- Energy from waste
- Avoided costs

Authorities vary in the extent to which they seek to invest in their own projects and retain control, or mobilise private capital and support commercial approaches.



Map of Local Authority Engagement in Energy Systems. Contains Crown Copyright and Database Right (2013; 2013).
Proportion of Local Authorities in Each Category of Engagement.
(Green=energy leaders, yellow=running hard, orange=at the starting blocks, grey=yet to join).

Local heat network development in practice
Local authority project teams comprise 'coalitions of the willing' often going beyond statutory responsibilities but struggling against local inertia:

> *'energy as even a theme isn't given a huge emphasis within local plans or even within a lot of the strategy development that local councils do…. you don't get energy seen in any strategic context… there's no joining up of it'* (City Council Economic Development officer seconded to government)

> *'The concept of a city being an energy manager, setting up an ESCo, was … remote from both senior director and political party interests'* (former City Council officer)

Their efforts are often frustrated by a perceived lack of clarity in who should "own" responsibility for district heating, and what their role should be in comparison with other public and private sector interests:

> *'I think there's a feeling that all the ducks are in the duck pond, but nothing's quite lined up'* (City Council officer responsible for low carbon projects)

Time horizons for financial support initiatives are typically short and previous funding programmes have had a stop-start character:

> *'Clock is ticking, usual government criteria is 'here's a lot of money and the key criteria is you need to spend it by a deadline' – it's the reality of public sector funding.'* (University carbon and energy manager, case study city retrofit)

Development is driven by opportunities that arise at particular times, but which can be hard to corral, particularly where multiple organisations are involved; the emerging development pattern is fragmented and incremental.

Various business models are in use, and they distribute risk and control between actors in different ways. Schemes tend to be packaged as bounded projects with finance shaping objectives and delivery vehicles tailored to the characteristics of specific groups of users. Projects are small scale and piecemeal, particularly in comparison with the city-wide systems achieved in Scandinavia. Reminiscent of fragmentation in early development of UK gas and electricity systems, this pattern may create barriers to interconnecting or scaling up envisaged for the future.

Our Conclusions. Ways forward for district heating in the UK

UK liberalised governance: is it hampering progress?
Heat networks are social as well as technical: they require coordinated action among different organisations to finance the infrastructure and manage the long-term interdependencies entailed.

However, the means of collaboration are elusive in a liberalised market:

> *'There's no real need for us to interact with the city council. There's no need for us to really interact with [university A] and even less with [West City Housing Association]. So, you know, we don't naturally sit together and all meet every week, if you know what I mean. So somebody has to bind all those people together, and you have to bind them together, […] first of all you have to force them to work together, and once you give them a common purpose, I think it will work, but it won't work naturally. We won't all come together.'* (Estates manager, university B)

Central government is broadly committed to market solutions and sees the regulatory and Treasury roles as centred on 'dismantling market barriers' for low carbon projects geared to commercial rates of return. Large investors (utilities, institutional investors) in principle can accept low returns over long periods but do not find district heating in the UK attractive because

- The scale of each project is too small
- Securing and growing a user base is perceived as uncertain

Instead policy commitments to commercial finance push projects towards off-balance sheet models of project finance, designed to limit local authority financial exposure but requiring high returns. Many city councils are wary of the private finance model, suspecting that it may not secure benefits for the locality.

UK challenges for decarbonising heat in cities

- Policy increasingly positions heat as a systems problem
- But current patterns of development are fragmented rather than systemic – small systems do not achieve economies of scale
- Even those local actors wanting to 'think big' end up 'acting small' because
  - They end up organising financial opportunities in a technocratic framework, rather than systems of collective consumption
  - There is no clarity over lead responsibility for co-ordination of multiple parties
  - Knowledge and expertise is fragmented
- The incremental character of current heat network developments is in tension with the much larger scale of much energy investment driven by
  - Centralised energy markets, incentives and regulation
  - Utilities' objectives, sunk investments, business models
- How can the regulatory framework change to integrate long term public goods of social and environmental sustainability into the short-term cost-benefit equation?

We conclude that local government leadership for UK urban scale sustainable heat would require new central government policy measures. These include raising the standards of energy efficiency required for producers of waste heat, underwriting long term loans for infrastructure, regulation to support long-term expansion of local heat markets and to control heat prices, and the option of non-profit business models and mutual enterprises (Hawkey and Webb, 2014).

Long Term Private Concession Contract

Local Authority Led

Community Mutual Non-Profit

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CONTACT:

Professor Janette Webb and Dr David Hawkey
University of Edinburgh
School of Social and Political Science
Institute of Governance
Chisholm House, High School Yards
Edinburgh EH1 1LZ
UK

+44 (0)131 650 3987/2841

jan.webb@ed.ac.uk
dave.hawkey@ed.ac.uk

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Forthcoming book:
David Hawkey, Janette Webb, Heather Lovell, David McCrone, Mags Tingey and Mark Winskel, 2015.
Sustainable Urban Energy Policy: Heat and the City London: Routledge.