Research Councils UK (RC UK) Energy Programme: *Heat and the City* Project www.heatandthecity.org.uk

Submission to UK Parliament Energy and Climate Change Committee in response to its call for evidence on heat.

Written evidence submitted by Dr David Hawkey on behalf of the RC UK *Heat and the City* project. *Heat and the City* is a four year collaborative project between the Universities of Edinburgh and Strathclyde which explores sustainable heating in UK cities. The project is funded by the UK Research Councils, and incorporates case studies, over 100 interviews with policy makers and practitioners, 200 interviews with households receiving district heating, and knowledge exchange workshops with the UK District Energy Vanguards Network. More information on the project can be found at www.heatandthecity.org.uk.

This response focuses on the committee's question "Why is community heating / CHP not more common in the UK?"

Summary

- Neglect of district heating and combined heat and power in the UK has a complex history; some key past challenges persist or have parallels today.
- Contemporary developments are generally oriented to specific niche opportunities. This has potential to create physical, organisational and commercial obstacles to future expansion and interconnection.
- Local government has a key role to play in development of heat networks, particularly in ensuring systems are developed strategically. Pressure on budgets, limited expertise and perceived lack of clarity in central government's expectations of local government (in the context of the localism agenda) are restricting their capacity to act strategically.
- DECC's Heat Networks Delivery Unit has potential to help overcome some project development barriers, though challenges in mobilising finance remain.

Submitted evidence

1) District heating (DH) in the UK is commonly used in conjunction with combined heat and power (CHP) generation. In densely populated urban areas, these technologies can, in the short term, provide affordable heat (particularly where it replaces electric resistive heating), as well as carbon and primary energy saving. In the right places, CHP/DH contributes to local economic regeneration and public welfare. While small gas CHP often stabilises the business model of new DH systems, over the longer term the technologies should decouple, leaving DH infrastructure which would afford key benefits to the UK's energy system: building in flexibility to respond to changing patterns of energy resource availability and heat technology performance, provide balancing services to an increasingly inflexible electricity system, and enabling a transition away from unabated use of gas for heating in dense areas.[i] The existence of heat

networks in Sweden and Denmark is a significant factor in the high renewables penetration in those countries.[ii]

2) Systematic uncertainties across energy systems make it difficult to estimate an optimum level of DH in the UK. DECC estimates[iii] range from 14% to 50% of space and hot water demand, considerably greater than the current figure of under 2%. Therefore, while the appropriate deployment of DH in the UK is not clear, it is likely to be *at least* seven times the current level.

Historical reasons why DH is not more common

3) Many of the manifold historical reasons for limited use of DH in the UK have parallels with current (and possibly future) challenges to development of urban sustainable heat systems. DH with CHP was positioned as a central component in energy policy in two distinct periods (immediately following the Second World War, and towards the end of the 1970s). However, development was limited for various reasons including:

   - Separation between electricity supply industry (organised on a national scale) and organisations (usually local authorities) seeking to develop heat networks. In European countries with high levels of DH, development was usually undertaken by municipal enterprises that operated both local electricity and heat systems and could integrate development. The post-war nationalised electricity industry pursued greater electrical efficiency via centralised generators. Distributed generation from CHP was marginalised as it did not fit the industry's preferred investment or operational models. Attempts by other organisations to develop CHP stations connected to the public electricity system were thwarted, sometimes by active resistance, sometimes by unfavourable conditions (connection costs and tariffs) created by the centralised system.[iv]

   - Limitations on the autonomy of local government frustrated development. For example under the UK's unusual *ultra vires* principal, post-war local authorities had to promote Local Bills in parliament to secure powers to generate heat and electricity until parliament granted these powers to local government in 1976.

   - European DH systems were often integrated into local government development and service activities, allowing for extensive cross subsidisation of DH with other investments, justified by reference to social objectives including: energy savings, affordable heating, regeneration of local industry and employment opportunities.[v] In contrast, local authorities in the UK were required by Local Bills to adopt strictly separate accounting procedures. The second phase of policy interest at the end of the 1970s coincided with plans to privatise the energy system, leading central government to withdraw from commitments to schemes identified in the Lead Cities programme and from establishment of the proposed Heat Board. Instead DH / CHP was treated as a test case for private investment. Rather than being appraised in terms of social objectives, DH systems were required to

generate financial returns attractive to private investors – a challenging task for long-term infrastructure projects, particularly as investors interpreted withdrawal of government investment as general withdrawal of support.

- Consequently many schemes originally conceived as city-wide were either abandoned or developed into much smaller systems whose performance was disappointing.

4) In the intervening period (1960s and early 1970s), small community heating systems were installed in new housing developments. Energy saving was not a strong priority. The coal and oil industries competed to offer packaged heating systems to capture shares of the heating market. Cost cutting and limited experience contributed to poor performance, and DH developed a poor reputation. Competition with then cheap North Sea gas meant economic viability was often challenging, and systems were operated by organisations for whom DH was not a core activity, exacerbating operational problems.

5) The above summary does not exhaust the historical reasons why CHP / DH is not more common in the UK, further evidence is cited in endnotes.[vi]

DH Niche Project Development

6) While DH is a conceptually simple technology it admits of a wide variety of configurations. This applies to technical components (pipe work, different heat sources), to variety of users connected, to different financing and business models, to different delivery and operational vehicles, and to different strategies for expansion (including no expansion).

7) UK development is following a liberal model, with policy open to a wide range of configurations. While this allows for innovative exploration, it also leads to DH initiatives characteristically structured as small scale, piecemeal, bounded projects. This contrasts markedly with most municipal infrastructure (including European DH systems) developed strategically in the twentieth century on an integrated, comprehensive area wide basis. A number of interrelated factors contribute to the small scale focus

   - In the absence of strategic planning, to identify areas where DH offers the most efficient solution to low carbon heating, users have to be individually recruited to an unfamiliar technology. This is commonly done on an *ad hoc* basis (with no formal or regularised procedures for coordination) and is likely to be feasible only during brief windows of opportunity (e.g. created by scheduled replacement of heating equipment), and such schedules may not coincide with those of other potential users. Subscribers are also required to make long term commitments to use the system, in the absence of regulatory and consumer protection standards. Therefore UK DH systems generally exist in small niches where a range of technical, economic, cognitive and social factors have aligned, rather than in the larger areas over which they would achieve cost and carbon savings.[vii]

- The range of possible business and organisational configurations around DH systems also contributes uncertainty. Local authority and housing association developers often feel they are starting from scratch. Exploration requires resources, and the absence of standard solution exacerbates perceived risk.

- In line with earlier UK development , finance and accounting conventions require projects to achieve stand-alone financial viability. However, DH systems commonly exhibit increasing returns to scale (the economic characteristic which renders a network a natural monopoly).[viii] The early phases of development usually have poorer overall financial performance than later stages. These "first phase" disadvantages are compounded by the concentration of perceived risk in establishment of a new local energy supply proposition.

8) The exploitation of niche opportunities presents challenges for future-proofing systems for expansion and interconnection. Some technical aspects of future proofing can be addressed by local adoption of technical standards (such as the GLA's District Heating Manual for London). Other engineering aspects (particularly sizing systems to accommodate additional load) add cost. Justification of this additional investment to future-proof systems is challenging due to uncertainty over future connections in the absence of requirements on building owners or developers to connect.

9) Expanding or interconnecting networks also poses future commercial challenges. There is little empirical evidence that piecemeal networks operated by different organisations can be integrated into a coherent system.[ix] Organisational challenges and transaction costs associated with a "link up later" approach to isolated developments have received much less attention than the engineering challenges.

10) The degree to which a heat network is controlled by the local authority impacts on its future trajectory. Differences between public sector goals and commercial owner/operator priorities have, in some instances, led to frustration over expansion (both to new heat users and new heat sources). There is a risk in the current piecemeal approach that lucrative opportunities (large public sector heat users in close proximity) will be cherry-picked rather than used to leverage bigger systems with greater overall benefit.

11) Norwegian DH development is an important example for the UK.[x] A centrally administered licensing system establishes concession areas within which developers (public or private) obtain exclusive rights to operate DH, provided they can demonstrate (against a standard appraisal methodology) the integrated social, economic and environmental benefits in comparison with realistic alternatives. This approach builds legitimacy and confidence among subscribers and investors and facilitates a strategic approach. A standardised appraisal methodology imposes some restrictions on the scope for innovation, but delivers reduced transaction costs, strategic development, and public oversight of decisions with long term consequences. Without this, commercial imperatives *have the potential* to lead to DH systems which fail to address policy concerns, paralleling

1960s and 1970s problems (for example, a developer may judge that the savings associated with low-cost pipe insulation outweigh the costs of energy loss, but such an outcome would undermine energy policy aims).

Role of local government

12) Statutory functions of local authorities (LAs) (as planning authorities and service providers) mean they play a pivotal intermediary role in strategic development and expansion of networks. In addition, the heat demands of LA estates can provide the basis for long-term contracts for heat and power supply, which stabilise business revenues. LA prudential borrowing powers provide access to affordable finance; they can act as guarantor to reduce costs of long term loan finance; they can ensure that heat tariffs are fair and transparent; and they can assist in developing consumer protections and service standards. DH configuration is particular to localities, and needs actors with long-term commitment to the area; this requires local knowledge about opportunities, their timing, and potential for integrated developments. Commercial DH developers regard LA commitment as equally important to area technical characteristics when considering where to invest.

13) However, energy services are not a statutory activity for LAs. DH development competes with other priorities, and budget pressures make a strategic approach uncommon. The ability to develop DH is strongly influenced by the clarity of policy direction from other levels of government. The loss of planning guidance in England, along with the transfer of planning functions away from local government under the "localism" agenda, are perceived by LAs as creating significant challenges to DH. Central government's determination to cut red tape (particularly by reducing reporting requirements which thereby reduces inter-authority visibility) and to reduce directive guidance to local authorities has the effect of isolating them from each other and from other levels of government. This is detrimental to DH development which requires a coordinated planning framework.

14) The LA capacity to engage with the consultancy and design market is limited by lack of experience. Difficulties in acting as an "informed client" mean that feasibility studies may be under-specified and outputs inadequately challenged, opening the potential for low quality work. The extent to which DECC's Heat Networks Delivery Unit (HNDU) builds capacity, and the extent to which HNDU-supported projects are future proofed, will be crucial to transformational change.

Central government policy

15) In the early 2000s, DH was identified as a crucial component of the UK's energy policy[xi], and was supported by the Community Energy Programme. While that programme stimulated many of the recent DH successes, and created networks of expertise, LAs perceive limited policy progress since: as DECC's 2013 Heat Strategy acknowledges, DH is influenced by a wide range of energy policies and programmes, none of which are specific to it. Over the last decade, policy focus and funding have had a stop-start character[xii], making long-term planning and investment difficult, and creating intermittent spikes in demand for consultancy and contractors,

raising costs and lengthening lead times. LAs most successful in responding to funding opportunities have typically committed resources to development, at their own risk, before central government support has been announced. However, the risks of this kind of speculative approach are piecemeal and sub-optimal systems, and projects which fail to progress.

16) HNDU will focus on the early project development stages. While this is a crucial contribution to establishing projects and building LA capacity, there is no capital investment budget (either as grants or underwriting). Systemic risks remain, therefore, that first-phase disadvantages and the costs of future-proofing systems, coupled with the potential for patchworks of technically or commercially incompatible systems to emerge without strategic oversight, lead to stunted DH development.

Financing DH systems

17) Financial models are highly sensitive to the valuation of future benefits – i.e. the rate of return required of investment. In comparison with regulated gas and electricity networks where returns on sunk investment are protected, DH investments are exposed to greater risks, raising the costs of capital and reducing viability. In common with other investments, a public-sector led approach can accommodate lower rates of return (and lower borrowing costs), but implies risk is taken on by the public sector.

18) DH networks face challenges in mobilising finance. Banks are less willing to offer long term commercial finance in the wake of the financial crisis. The Green Investment Bank (GIB) targets district heating under its Non-Domestic Energy Efficiency theme. Some practitioners have questioned whether the requirement that the GIB must lend on market terms to crowd in investment will adequately address the challenges faced by first-stage projects in mobilising long term and low cost finance .

19) Institutional investors (such as pension funds and sovereign wealth funds) are potentially suited (in terms of time scale and returns) to refinancing DH once higher risk development stages have been passed. However, the minimum investment considered is generally much larger than the niche opportunities which are currently the focus of UK activity.

20) Ensuring network subscribers remain connected, require heat over the lifetime of the business model, and are financially sound, are crucial dimensions of risk perceptions. This is mitigated through low risk subscribers (such as public sector organisations). There are differences in opinion as to how significant heat off-take risk actually is to business models; some consider it a "red herring" since subscribers can be replaced.[xiii] However, given limited DH experience, lenders are unable to quantify such mitigation options and instead assess projects on the basis of "bankable" heat supply contracts.

21) At present the balance of key incentives (particularly the Renewables Obligation and Renewable Heat Incentive) skew business models towards electricity production. This enforces business model preference for electricity, where the established network mitigates volume risks arising from the need to recruit users. While electricity sales are often crucial to

financial viability of DH initiatives, distributed generators are disadvantaged by the physical and institutional legacies of the centralised electricity system. These include difficulties dealing with DNOs,[xiv] the impact of the Citiworks case on private wire models,[xv] the slow and uncertain development of License Light opportunities, and barriers to small entrants engaging with wholesale markets.[xvi]

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[i] DECC (2013) *The future of heating: Meeting the challenge.* https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge

[ii] Ericson, K. (2009) *Introduction and development of the Swedish district heating systems: Critical factors and lessons learned* http://www.res-h-policy.eu/downloads/Swedish_district_heating_case-study_(D5)_final.pdf. Euroheat & Power (2011) *District Heating Cooling: Country by Country 2011 Survey*. Belgium, Euroheat & Power.

[iii] DECC (2013) *The future of heating: Meeting the challenge.* https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge

[iv] Russell, S. (1993) *Writing Energy History: Explaining the Neglect of CHP/DH in Britain*. British Journal for the History of Science, 26 (1), pp.33–54.

[v] *Ibid.*

[vi] Heat and the City (2011) *History of CHP and district heating in the UK (to the mid 1990s)* http://www.heatandthecity.org.uk/__data/assets/pdf_file/0004/62419/HatC_history_paper_SR.pdf; Russell, S. (1996) *At the Margin: British Electricity Generation after Nationalisation and Privatisation, and the Fortunes of Combined Heat and Power*. In: SHOT '96 (proceedings of the Society for the History of Technology Annual Meeting) London; Weber, K.M. (2003) *Transforming Large Socio-technical Systems towards Sustainability: On the Role of Users and Future Visions for the Uptake of City Logistics and Combined Heat and Power Generation*. Innovation: The European Journal of Social Science Research, 16 (2), pp.155–175.

[vii] IEA (2005) *A Comparison of distributed CHP/DH with large-scale CHP/DH.*

[viii] IEA (2005) *A Comparison of distributed CHP/DH with large-scale CHP/DH*. IEA District Heating and Cooling Project. Netherlands, SenterNovem.

[ix] The history of development of electricity networks in the UK (particularly in London) suggests such a patchwork can be just as difficult to bring together in more efficient systems as incompatible engineering standards: Hughes, T.P. (1983) *Networks of power: Electrification in Western society 1880–1930*. Baltimore, Johns Hopkins University Press.

[x] Heat and the City (2011) *Case study – district heating in Bergen* http://www.heatandthecity.org.uk/__data/assets/pdf_file/0003/124428/Norway_Bergen_DH_Case.pdf; NVE (2009) *Veileder i utforming av konsesjonssøknad for fjernvarmeanlegg (Guidance on the design of a license application for district heating).* Norwegian Water Resources and Energy Directorate http://nve.no/Global/Konsesjoner/Fjernvarme/Fjernvarmeveileder2009.pdf

[xi] DTI (2003) *Our energy future*. Department of Trade and Industry. http://webarchive.nationalarchives.gov.uk/+/http://www.berr.gov.uk/files/file10719.pdf

[xii] Earlier policy consultations and papers include DTI (2003) *Our energy future*; DTI (2007) *Meeting the Energy Challenge: A White Paper on Energy* http://www.berr.gov.uk/files/file39387.pdf; BERR (2008) *Heat — Call for Evidence* http://www.bis.gov.uk/files/file43609.pdf; DECC and DCLG (2009) *Heat and Energy Saving Strategy* http://hes.decc.gov.uk; DECC (2010) *Warm homes, greener homes: an enabling framework for district heating*. Earlier programmes include the Community Energy Programme (£50m, 2002-2005), Low Carbon Infrastructure Fund (£25m, 2009).

[xiii] BRE (2013) *Research into barriers to deployment of district heating networks*. https://www.gov.uk/government/publications/the-future-of-heating-meeting-the-challenge

[xiv] Ofgem (2011) *High Level Summary of DG Forum Responses*. http://www.ofgem.gov.uk/Networks/ElecDist/Policy/DistGen/Documents1/high%20level%20summary%20of%20DG%20Forum_published.pdf

[xv] European Court of Justice (2008) *Case C-439/06: Energy Management Proceedings Citiworks AG. Summary of the Judgement*. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:62006J0439:EN:HTML

[xvi] Toke, D. & Fragaki, A. (2008) *Do liberalised electricity markets help or hinder CHP and district heating? The case of the UK*. Energy Policy, 36 (4), pp.1448–1456.