

## **Evaluating Urban Energy Systems in the UK – the Implications for Financing Heat Networks**

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### **Abstract**

UK energy policies position urban heat networks as components of a resilient low carbon, affordable system, but, as Stewart Russell's work showed, such technologies have never been integrated into UK provision. This paper takes Russell's legacy forward by examining prospects for urban district heating and combined heat and power development in the context of the *financial*, rather than technological, innovations shaped by liberalised energy and financial markets. Drawing on sociology of markets and social studies of finance, the paper examines the resulting evaluation practices. Findings indicate that such district energy infrastructure does not conform to the investment calculus, making a business case hard to establish. Bridging the value gap between liberalised finance and district energy requires actors willing to devise improvised solutions. In spite of the established sustainability credentials of the technology therefore, significant deployment in the UK (and similar countries) will depend on political leadership and new fiscal policy.

*Keywords:* energy, financial markets, sociology

## Introduction

...our goal is to make sure that investable projects across our priority sectors can obtain finance in the market place (quote from research interview with UK Government Officer, Low Carbon Investment Team, 2012).

Contemporary energy policies and scenarios project a future of low energy consumption in a secure, affordable low carbon system (UK Government Department of Energy and Climate Change (UK DECC), 2011a; 2011b; European Commission (EC), 2011). Behind the aspirations however lie contested, and uncertain, models for how any transformation may be brought about, by whom, using what resources and with what implications for shares of costs and benefits. Such uncertainty and contestation are for example embedded in the terms of UK Green Investments, which received £3bn capitalisation from the UK Treasury in 2012 to address the lack of investment in low carbon technologies, on the condition that it operates on the same market terms identified as responsible for the current failure to invest.

This paper focuses on prospects for investment in meso-scale district energy<sup>i</sup> and heat network infrastructures, which are defined in UK Government strategy as a key aspect of sustainable energy (UK DECC, 2013), and are targeted in UK Green Investment Bank (GIB) energy efficiency strategy (UK GIB, 2014). Investment in district energy in the UK remains, however, very limited (UK DECC, 2013). The paper uses a sociological perspective on markets and social studies of finance (Beckert, 2009; Callon, 1998; Carruthers & Kim, 2011; MacKenzie, 2009) to explore the reasons for apparent mismatch between the sustainability value attributed to such technologies in policy and their low valuation as an investment proposition in practice. It uses ethnographic research to assess the strategies of public and private sector organisations engaged in ‘making the finances stack up’ to secure ‘the investable project’. Rather than treating market valuations of energy technologies as economic objects subject to universal laws of supply and demand which exist outside societal processes, the sociological perspective used here examines the socially-embedded production of value. The perspective is derived from classical sociological theory exemplified in Max Weber’s (2000 [1894]) analysis of the centrality of politics and power relationships in financial markets, and Karl Polanyi’s (1957 [1944]) appraisal of the embedding of economic exchange in social networks where political beliefs and ideologies inform value attribution. Recent scholarship has extended these foundations through examination of the processes of producing and reinforcing, or sometimes undermining, market facts, which are critical to market operation and attributions of value (Callon, 1998; MacKenzie, 2009). Such facts and metrics, such as rates of return on invested capital, are interpreted as a socio-technical accomplishment which brings particular kinds of economy, economic actors, and material outcomes into being (Caliskan & Callon, 2009). The sociology of markets and social studies of finance have however been relatively neglected in analyses of transitions to sustainable energy, where most attention has focused on the study of innovations in technology ‘hardware’. This paper suggests that recent innovations in finance, using economic theory and mathematical knowledge, are reshaping market facts and the production of value (MacKenzie, 2009), with significant consequences for energy infrastructure and the characteristics of transition to a low carbon energy

system.

The UK is a significant case study for questions relating to the evaluation and financing of low carbon energy infrastructure. On the one hand UK and Scottish Government climate change legislation has set ambitious targets and timetables for energy decarbonisation and demand reduction. On the other hand, in the liberalised energy system, solutions are expected to derive less from co-ordinated planning than from financial markets, where the discovery of viable commercial returns on private investment governs the prioritising and configuring of any low carbon provision. UK energy policy has recognised the failures of current market structures to deliver investment in secure and affordable low carbon energy, but envisages adjustments to the existing regulatory frame, rather than systemic reform (UK DECC, 2011a). Rather than holistic appraisal of optimal routes to energy systems decarbonisation, policy development has focused on electricity. Heat has remained marginal until very recently, even though more energy is used for heating than for the generation of electricity. For example in the UK, almost half (46 per cent) of the final energy used is for heat; a further 41 per cent is used for transport, while only 8 per cent is used to provide electricity (UK DECC, 2012: 10). Around three quarters of the heat is used in domestic, commercial and public buildings; the remainder is used in industrial processes. In 2012, the UK government published a heat strategy, which concluded that climate change mitigation targets necessitate radical change to reduce energy used for heating, and to use low carbon or renewable sources to meet remaining requirements. Policy frameworks (UK DECC, 2013; Scottish Government, 2013) envisage a combination of solutions, including building insulation, electrification of heat and changes to the content of the gas grid. They also attribute value to low carbon heat networks in circumstances where development is justified by density and diversity of heat demand, and by the likely availability of local heat sources which would otherwise be wasted. These documents begin to incorporate a systemic model of energy, identifying the potential of heat networks to reduce the total costs, and improve the resilience, of a low carbon energy system, over and above their local value: ‘the capacity of networks to store heat helps to tackle system balancing issues, and diverse heat sources will also reduce pressure on peak grid demand’ (UK DECC, 2013: 45). By virtue of their territorial powers, knowledge and resources, local authorities are expected to be critical intermediaries in such developments.

### **The UK Historical Trajectory of Heat Networks and their Contested Value**

Energy generated close to its point of use, at the meso scale, is recognised as having social, economic and environmental value in relation to carbon saving and affordable heat, and having potential to re-localise inter-relations of use, ownership and control (Kelly and Pollitt, 2010; UK Committee on Climate Change, 2010). Such district energy technologies, delivering heat, hot water and sometimes cooling, via an area-based network of underground pipes, or thermal grids, are well-established in Europe, but provide only around 2% of UK space and water heating. Stewart Russell’s (1986; 1993; 1996; 2010) work examined the failure to integrate district energy (combined heat and power (CHP) and district heating (DH) or heat networks) into UK energy provisions, despite periodic policy advocacy and on-going improvements in technology. His work, examining CHP/DH up to the period following energy privatisation, concluded that such developments that have occurred have always

required some form of state intervention to counteract the short-term economics of the energy sector. This was the case under both state and private ownership of energy generation and supply, indicating that limited development is not the result of system ownership *per se*. Russell argued instead that it is the result of the wider UK economy and polity, which have produced an energy sector geared to commercial economies of scale, and avoidance of social obligations. An increasingly specialised and segmented energy supply chain has limited capability to capture the integrated energy productivity of district energy which requires coordinated, predictable long-term planning. Post-privatisation, the more complex regulatory structure of the industry made the prospects for CHP/DH more unpredictable:

To the extent that CHP did show an upturn in the early 1990s ... particularly in large industrial installations and in packaged mini-cogeneration units, it could not be argued convincingly that this came about because of the form of the restructured sector, but still rather in most respects in spite of it; in many ways the fundamental problems were reinforced and exacerbated, it still had to fit as best it could into a system that has not been designed to suit it, and there were no evident incentives or commitment towards energy efficiency built into the new arrangements. (Russell, 2010: 6.)

The historical absence of a focus on heat (as opposed to gas and electricity) provision resulted in the lack of a directly responsible UK policy-making and regulatory authority. Investment decisions were framed by short-term cost logics, even when the initial objectives of periodic investigation were long-term social and environmental benefits. Russell concluded that the economics of meso-scale CHP and DH have been constituted as marginal not because of their inherent lack of societal value, but because their evaluation was always embedded in the political-economic institutions, and physical infrastructures, of an energy sector increasingly modelled on the scale economies of centralised, large scale, generation of electricity, and gas grids.

The potential of district energy and heat networks to contribute to energy productivity and to reduce the total costs of a resilient low carbon energy system has again been raised in the context of climate change risks. The feasibility of an all-electric solution to decarbonisation of heat, with very large seasonal variation in demand and consequent need for (probably high carbon) expensive stand-by plant and grid reinforcement, is subject to scrutiny (Spiers et al., 2010). The low source fuel conversion efficiencies of large scale thermal power generation without heat capture, and with energy lost through long distance transmission, have also returned to the agenda. The costs and benefits of district energy, as a component of a low carbon system, are however contested, given the sunk investment in centralised electricity and gas grids. Risk assessment centres on the capital cost of heat grid infrastructure, and the lag between initial investment and revenues, combined with the lack of an existing regulatory framework for heat and the associated difficulty of securing a long-term revenue stream in the absence of an existing customer base. The UK also lacks supply chains, skills and business models. All of these factors tend to increase attributed risk, and hence the cost, of development, relative to European countries with established heat networks (Pöyry, 2009), militating against straightforward demonstration of *financial* value of investment.

A number of local authorities have however proceeded to develop district energy projects, using criteria of value derived from energy and carbon saving, provision of affordable heating and regeneration of urban centres; raising the necessary finance is however a key area of difficulty (BRE et al., 2013). The conventional principles used in configuring project finance are exemplified in Appendix 1. This is extracted from an Ernst and Young presentation to a district energy finance workshop<sup>ii</sup>, and shows a financial model devised from various combinations of debt and equity. Debt is considered to be cheaper than equity, so debt finance is expected to form the largest proportion. Public sector debt can usually be raised at lower cost than private finance; some local authorities may therefore borrow to finance investment, managing the risks through a variety of governance and contractual structures, including arms length organisations and joint ventures. Other authorities may be reluctant, or unable, to accept the risk of borrowing in order to finance energy infrastructure, when they have no statutory duty to do so, and they may regard themselves as lacking the required knowledge and capacity. A claimed lack of capacity may stem from the underlying financial position of certain local authorities, where existing Private Finance or Public Private Partnership projects result in a high proportion of revenues being committed to servicing existing debt. In the absence of any change in financial regulations, such authorities may have little option but to pursue a commercial model, transferring risk to private contractors to develop, own and operate the system, under a long-term concession contract for heat and power supply. The costs of such an energy services contract are set against revenue rather than capital budgets; over the long term the total financial cost is likely to be higher, but there is no immediate addition to total borrowing. Urban heat network development is hence challenging, not only because of the physical disruption entailed in embedding new infrastructure in a densely populated place, but also because of the demands of assembling a locally feasible and legitimate financial calculus which is acceptable to local authority political leaders and executive officers, as well as other parties.

### **The Sociological Perspective on Evaluation Practices in Financial Markets**

What is little publicly debated, however, and indeed is frequently ‘naturalised’, is why, when evidence of the wider environmental, social and energy saving value of district energy technologies is accepted, their measured financial value remains low, and the risk calculus is generally unfavourable to investment. Social science research on innovations in financial engineering suggests that these instruments have significantly reshaped financial markets, with material impacts on value creation (Knorr-Cetina & Preda, 2012; MacKenzie, 2009). Contemporary political-economic commitment to the attributed efficiency of liberalised markets shapes the field of possibilities, situating finance as a significant dimension of socio-technical innovation. Questions about the non-financialised public value to be derived from different forms of, and routes to, sustainable energy for urban settings, become marginalised.

The powerful neo-liberal discourse of the last 30 years has claimed that financial innovation, particularly complex instruments for securitisation of assets and accelerated capital recycling, is a major contributor to risk management for socio-technical innovation and market expansion in advanced capitalist economies (Engelen et al., 2010). The resulting financialisation of advanced economies (Erturk et al.,

2008) is visible in corporate restructuring to prioritise financial value as the core performance indicator, and in the widespread legitimising of discourses of shareholder value (Crouch, 2011; Preda, 2009). Value is framed within a techno-economic policy model, which asserts that markets are rational-instrumental means of resource allocation, generating economic value by allocating capital efficiently according to its calculated productivity. The role of government in this model is restricted to removal of 'market barriers' by for example using restricted public finance to mobilise significant private capital investment. An efficient market is expected to allocate resources to technological development, because its value will be captured in financial returns to investors. The problems of creating an investable project are conceived as amenable to financial engineering, which is constituted as a means of de-risking investment. Financial metrics are increasingly applied to decisions governing investment in essential infrastructures, resulting in the treatment of infrastructure as a standardised component of an asset portfolio, tradeable in a global market to maximise returns to private shareholders (Torrance, 2008). The underlying epistemology informing such evaluation methodologies, and what is included or excluded as a relevant factor in investment decisions, remains outside the frame and largely unexamined. There are however critical questions about whether such instruments are fit for purpose in relation to the long-term public interest in, and wider social value of, a sustainable, affordable and resilient energy system.

Sociology problematises this naturalising of financial evaluation, and argues that financial market instruments can instead be studied as a problem in the sociology of knowledge, an area of research which investigates empirically the social production of scientific, or expert, knowledge in the context of its institutional structures and cultural and political processes (Bloor, 2004; Shapin, 1995). Knowledge is understood as a form of shared belief, which may or may not be justified in practice, but which has attained the status of factual knowledge through the technologically mediated work of expert practitioner communities. Recent research has brought concepts from the sociology of scientific knowledge to the analysis of knowledge claims and processes in financial markets, where the facticity of market numbers is typically a prerequisite for a functioning market (Carruthers & Stinchcombe, 1999; MacKenzie, 2006; 2009). In the related tradition of actor network theory, the economy is treated not as an independent object, but as a societal phenomenon itself constituted by theories of economics and finance, which become enmeshed in practices of market formation (Callon, 1998; 2007). Associated questions about authority, power relations, and knowledge are the subject of renewed sociological focus through the analysis of *evaluation* techniques as a means of understanding the social production of material value (Beckert, 2009), and of different 'orders of worth' (Boltanski & Thevenot, 2007), which are central to the coordinated production of markets, including energy markets. The boundaries, differential qualities, and the relative value of resources to be transacted all have to be negotiated in order to constitute a market. Such structured power relations are amenable to analysis through study of the distributed knowledge of complex corporate and government actors, and the rules and instruments of markets. Knowledge formations, and their embodiment in 'soft' as well as 'hard' technologies, are conceptualised as the, at least partial, fixing of outcomes of struggles for power. Economic models in these terms are not derived from empirical observation of a fixed economic reality, but contribute to bringing the attributed phenomena of a particular market rationality into being, through the provision of behavioural scripts and algorithms (Callon, 1998; MacKenzie, 2006).

Social studies of finance and the sociology of markets seek to avoid a functionalist analysis of market mechanisms of risk and value calculation in order to reveal the underlying contests and conflicts of interest, and the ultimately precarious qualities of market facts (MacKenzie, 2009). In the context of energy markets, the sociology of knowledge offers insights into the processes of evaluation which inform business investment. The following discussion examines such processes and their implications for assessments of value in district energy projects.

## **Methodology and Data**

Drawn from a larger research project, qualitative data are used to explore the perspectives applied by finance practitioners and energy utilities to the evaluation of meso-scale energy project developments. These data focus on the context-bound, interaction-oriented aspects of financial practices. The aim is to gain insight into the actor's perspective, while seeking to avoid assumptions about the pre-given, normal or taken for granted qualities of the processes explored.

Analysis is based on the following data:

- Semi-structured interviews with nine finance experts (two representatives of a UK government low carbon investment team; three environmental finance specialists - two employed by a transnational finance and accounting corporation and one partner in an independent consultancy; two finance consultants with long-term expertise in UK privatisation of public infrastructure, development of Private Finance Initiative and Public Private Partnership instruments, private equity fund management and infrastructure procurement; two representatives of corporate banking with responsibility for lending to renewable energy and energy efficiency sectors); and five community energy market managers from two of the six large scale gas and electricity utilities which supply the UK<sup>iii</sup>.
- Presentations and discussions from a one-day workshop on financing district energy, organised by the research team in collaboration with a district energy practitioner. The Workshop was attended by 25 local authority representatives and a mix of finance experts, consulting engineers and district energy suppliers.
- Interaction with the UK government Department of Energy and Climate Change (UK DECC) through analysis of heat policy documents and attendance at a workshop on market barriers to district heating.
- A data set of forty-four case studies of district heating projects developed in the last ten years (BRE et al., 2013<sup>iv</sup>). Interviews included a key section on finance. The research findings were a component of evidence used in formulation of heat policy (UK DECC, 2013).
- Interaction with the Scottish government energy team to investigate policy instruments to accelerate delivery of low carbon and renewable heat<sup>v</sup>.
- Interaction with the trade association, UK CHPA, to gain insight into their strategic position on urban heat network policy instruments and financing.
- Interaction with senior managers and non-executive chair of a large-scale energy utility at an invited meeting of a stakeholder forum to consider city scale low carbon investment strategy.

## **Evaluating Urban Energy Investment**

### ***The Dominant Frame: 'Constrained Public Finances' and Risk in a Centralised, Regulated Energy Market***

...and we all recognise that there's a finite pool of public funding out there. So if we are limited to that sort of funding to invest in the green space, that is going to severely constrain the base investment (Quote from research interview with UK government officer, Low Carbon Investment team, 2012).

Two interlocking narratives stemming from neo-liberal political-economy provide the dominant frame for evaluating the viability of urban energy developments. The first is illustrated in the above quote, which situates constrained public sector finance for low carbon investment as unavoidable, rather than as a matter of political decision. The second narrative, which is the necessary counterpart to the first, denotes the continuing commitment, post-financial crash, to financial market innovation to stimulate new private investment in energy infrastructure particularly in the unfamiliar urban scale energy efficiency technologies:

... the sort of ultimate, if you could create a model where public sector sort of stands behind investment, and then the business model is proven, that can then be refinanced by private capital, and then that capital can be recycled (UK government officer, Low Carbon Investments team).

Investment in energy infrastructure has been progressively redirected away from the financial logics of national systems of energy production, and innovation, to those of internationalising capital markets, technology and fuel supply chains (Winskel, 2002). In a market context structured by large corporations, where the main performance indicator is shareholder value, long-term investment programmes have been displaced by an emphasis on 'asset sweating' and short-term investment horizons. The major utilities built strong balance sheets, with 'deep pools of capital for utility type risk' (UK government officer, Low Carbon Investments team). The UK energy market regulatory framework has also guaranteed predictable returns on large-scale investment in generation and transmission, and in electricity and gas distribution networks. Available capital has been deployed by the utilities in line with the established procurement models for centralised energy infrastructure, enabling them to 'satisfy their investors on the basis that they can provide predictable returns... through a regulatory environment...' (UK government officer, Low Carbon Investment team). For energy infrastructure, high value is therefore placed on large-scale de-contextualised, standardised technologies suited to the economics of liberalised markets. In this framework, the utilities 'know exactly what they're building; they know exactly how to do it... The actual projects themselves are large scale, economically viable, generation schemes' (Asset Management Consultant), and they are able to use their 'strong lobbying ability with government' (Asset Management Consultant) to protect incumbent interests:

'Frankly we have a cartel within the electricity supply, and the government is unwilling to break it until it's solved the generation problem, because the big six suppliers, oops they're the big six generators... By and large the generators and suppliers are the same people... But the real problem is that the market has not in fact been opened' (Financial Investment Consultant).



External investors similarly rely on the application of standardised risk assessment instruments to identify easily replicable investment opportunities, producing reliable returns:

A: If you're a bank ... you want the lowest risk, the best return that can be churned out like a sausage machine.

B: And it's systematised; they've done it before and they'll carry on doing it again... Cookie cutter.

A: It was. That's a good phrase: cookie cutter. This [district energy] is exactly the opposite of that.

(Environmental Finance Specialists A and B).

In standardising evaluation around the criteria of maximising predictable financial returns, such templates de-contextualise and delocalise investment decisions, obscuring any local benefits. For example the energy utility stakeholder forum observed by the author addressed the topic of future energy investments at city scale. The post-privatisation withdrawal of the business from customised locality-based energy planning, despite its public benefit, was acknowledged:

'[Utility] has for a long time ignored its cities and turned to the international agenda. We used to have DH in [X City] because it was proved that it reduced the maintenance costs of buildings' (Utility Senior Manager, energy networks).

The main business of the meeting examined the socio-economic rationale for re-engagement and collaboration between the utility and urban authorities. Joint benefits derived from synergies between political, economic and social goals of localities, and utility business goals were identified. Business benefits were cited as: reduced costs of electricity network investment associated with distributed generation, delivering mandated carbon savings and new revenues from innovation in energy services. The projected UK market for such developments was estimated as in excess of £100 billion, with near-term opportunities of around £2 billion, as well as potential to meet energy company obligations for carbon reduction and affordable warmth. Two thirds of the value of decentralised energy opportunities was expected to derive from CHP/DH.

Liberalised financial markets, however, have resulted in corporate structures geared to a central performance metric of share price, and the maximising of shareholder value, in relation to a global asset portfolio. Finance experts have progressively displaced engineers as chief executives (Fligstein & Dauter, 2007; Krippner, 2005; Zorn et al., 2005), as in this case where the corporate director of the utility's UK operations joined the company from a career in investment finance. He in turn must recommend any proposed UK investment to a transnational parent company board, and in this instance concluded that there was no business case which could succeed at board level, given the availability of secure, regulated returns through other routes. An idealised market model asserts that limited resources are rationally allocated according to laws of capital productivity. In advanced capitalist economies however the rules of resource allocation, and even the scale of resources available, are contingent on politically-informed negotiation between state and market actors, with results embodied in regulatory frames governing property rights and rules of trade (Fligstein & Dauter, 2007). In relation to electricity and gas transmission and distribution, for example, the UK's regulated asset base model guarantees a secure,

predictable return on capital investment in networks through a periodically reviewed price control formula (Ofgem, 2013). This logic of value marginalises localised spatial and energy planning for integrated heat and power, however, despite policy recognition of likely benefits to system efficiencies and reduced network reinforcement costs.

The economics of locally customised meso-scale CHP and urban heat networks are hence constituted as marginal in the context of a state regulatory framework which rewards investment in a centralised system, where incumbent corporations are oriented to short-term financial performance in global markets. The initial capital investment and the long-term uncertainties of payback associated with particularities of place result in perceived risk to capital, increasing the cost of loans, and limiting the financial viability of projects:

‘... go and talk to Drax and they’ll say ‘we’re very happy to talk about... replacing a big power station, but what on earth would we want to go and invest what would be ten times the amount of staff to do probably a hundred times as many, little, individual CHP schemes dotted around. Where on earth is the economics behind that?’ ... And you compare everything there is opposite to CHP: small scale, relatively ad-hoc procurement, disparate interested parties. They’ve got to get through all the planning bureaucracies of doing development in the middle of big cities; regulatory risk; policy uncertainty; lack of clarity over revenue risks and who is taking which risks; promoted by small industry players, who, you know, you can’t blame them for trying, but they just don’t have the same lobbying ear that the big six have. And that’s really the conundrum isn’t it?’ (Asset Management Consultant)

Standardised risk assessment tools put a correspondingly high cost on alternatives to business as usual: ‘The issue is risk, perceived risk’ (Finance Investment Consultant). In relation to urban heat networks:

‘Unfortunately with heat, the key risk and the key downside is... you haven’t got a heat grid, so you come back to, again and again, [to] the bankability of that heat and the credit worthiness of the heat off-takers’ (Environmental Finance Specialist B).

‘The big challenge is how do you de-risk them [heat networks] in such a way that you can attract the pools of low cost finance’ (UK Government Officer, Low Carbon Investment Team).

During periods of policy uncertainty, such as those relating to electricity market reform, however, all energy investments were regarded by market actors contributing to this research as risky. The state, rather than business, was considered responsible for ‘the investment fundamentals’ of stable, secure and predictable cash flows: the ‘private sector won’t invest speculatively... Large industrial players ... will invest once policy certainty and detail are established... CHP requires industrial and political sponsors’ (Asset Management Consultant). The constitution of market reform, including guaranteed strike prices for electricity, is for example under development between government and utilities in relation to a proposed new generation of nuclear power stations:

‘They’re saying that they’ll only be funded if the power companies are prepared to actually take the risks of producing and generating the electricity off them. But that is disingenuous, because the disposal of the nuclear waste, they’re saying ‘don’t worry about that, we’ll sort that out.’ Well hang on a minute, you know, the infrastructure involved in disposing of nuclear waste is going to be enormous, not just in terms of engineering, but in terms of cost...But... there are very strong backers within government for nuclear power’ (Asset Management Consultant).

Conversely district energy was perceived as lacking the government sponsorship and covenants embodied in the financial innovations introduced through the Private Finance Initiative and Public Private Partnerships. The main ‘risk’ in investment in local energy systems stems therefore not so much from its *price* per se, or lack of capital for investment, as from the constitution of its economic value relative to established markets and the interests of incumbents, where ‘developers are developers, councils are councils, utility companies are utility companies, and district heating doesn’t fit any of them’ (Finance Investment Consultant). The lack of fit for meso-scale CHP and DH with the established high value placed on centralised energy markets, and large-scale, decontextualised technology investment structured around guaranteed rates of return on capital, means that their substantive benefits remain elusive in the financial calculus.

### ***Making the Market Work for Low Carbon Investment***

‘The holy grail is this model which enables both to be done in an intelligent manner, combining both public and private finance’ (Quote from research interview with UK Government Officer, Low Carbon Investment Team, 2012)

A powerful theme in the evolving narrative of a liberalised energy market is that the role of government is to address attributed ‘market failure’ in areas where private investment is lacking, despite other dimensions of value such as carbon saving or local economic regeneration. A key instrument of government policy is the quasi-autonomous UK Green Investment Bank, which is required to apply market rules for allocation of public finance to projects. In relation to financial innovation oriented to formatting an energy efficiency market, its remit is confined to debt financing in what is construed as the ‘narrow space’ between projects which already attract private capital, and those which are substantively uneconomic. It is charged with ‘crowding capital in’ by deploying public funds into the private sector in order to ‘help the market to generate deal flows’ (UK Government Officer, Low Carbon Investment Team) in targeted areas. It is not allowed to provide start-up equity, low cost loans or financial guarantees. The model thus relies on use of bounded public finance to invest on commercial terms, and to incentivise the rapid recycling of capital through for example the creation of a new energy efficiency asset class which can be securitised:

‘We have to focus on commercially viable investments and we’re about leveraging private capital into the market... Additionality and leverage is really important to our mission... If we can demonstrate to the market that you can make good money in these sectors, then private capital will follow in large volumes’ (UK Government Officer, Low Carbon Investment Team).

Addressing the need to constitute a market where investors perceive little or no value entails building legitimacy to create and sustain shared belief that financial returns can be reliably achieved in such disregarded sectors. Legitimacy is consciously courted through the selection of officers who ‘understand how the City works’ (Finance Investment Consultant). Fund manager partners must not only have a track record for efficiency and reliability in allocating and managing funds and project portfolios, but also pass ‘the reputation smell-test’ or ‘the Sunday Mail test’ (UK Government Officer, Low Carbon Investment Team), indicating that cultural dimensions of evaluation practices are expected to be a significant factor in making low carbon energy and energy efficiency markets work. The UK GIB is positioned as a market intermediary channelling information about the trustworthiness of trading partners through social networks; the resulting reputational capital, anchored in shared beliefs about reliability and trustworthiness, is expected to resolve uncertainties over the value of the products traded (Granovetter, 1985; Podolny, 2001; White, 2002).

The stance taken by the UK Government in specifying that UK green investment lending must be solely on commercial terms is contested by other market actors, who suggest that ‘rethinking the problem, and doing it a different way’ (Finance Investment Consultant) might be more productive in achieving the overall objectives of a low carbon energy system. One informant noted that the model was likely to have the perverse result of increasing the overall cost of local energy infrastructure finance:

‘And one of the problems... rather than moving commercial debt to prudential rates, which is the French model, UK GI is saying: well we’re going to move prudential rates on to commercial levels, because we’re not prepared to lend unless the banks do... because it’s not on market terms’ (Asset Management Consultant).

Such rules are in practice however expected to evolve in operation, and in negotiation over European sanctions against state aid:

‘It would be interesting to see when they’ve got a throughput of projects how many of them have been on true market terms... I mean they’re under immense pressure to push capital into the market place... I don’t think they’ve had a great deal of success on that front to date’ (Investment Manager, corporate banking).

The market finance model is thus more precariously established, less singular and more susceptible to contestation than its formalistic definition as a mechanism of efficient resource allocation implies. Making the market work for low carbon investment may consequently have more scope for improvisation than acknowledged in public statements of policy.

### ***The Risk to Public Value?***

That there is public value in district energy investments, both in terms of cost and carbon savings, seems little disputed:

‘What I would say for district heating is almost the nice thing about it is it stacks up from a pure economics perspective...so particularly within a landscape where you have such a poor state of energy structure within the local authority and public sector user, the introduction of a retrofit gas fired CHP, plus pipework, plus boilers, plus the associated energy efficiency measures to provide guaranteed savings, would reduce carbon emissions by 20 per cent. It would save the local authority or NHS or a public sector user X hundred thousand pounds per annum’ (Investment Manager, corporate banking).

As this manager went on to comment, such investments in ‘non-core’ energy services would also return finance to core public services by reducing energy costs over the life cycle, thus creating further public benefit.

Contemporary evaluation frameworks have however limited the pace and scale of urban CHP and DH projects: ‘It’s very much sort of only the gold plated, de-risked projects that are actually going forward with private sector funding in them’ (Environmental Finance Specialist B). Development has taken place mainly where profitability for private investors is secured by some form of public guarantee or risk underwriting; this may include more than long term contracts with secure revenues, and extend to factors such as the anticipated reputational or ‘brand’ value of investment in prestige developments. In relation to Olympic Park district energy investment for example, ‘I think they’re banking on the fact that it’s probably the highest profile development site in the country, and if it turns into a white elephant it’ll be a national embarrassment’ (Environmental Finance Specialist B). Such projects may however function primarily as a showcase for capital (Hodson & Marvin, 2010), without ensuring commensurate public benefits. Long term private finance contracts governing prestige projects are positive in demonstrating the potential structures for private public partnerships, and access to private finance, but such long term concession contracts for energy supply should theoretically show the added public benefits resulting from increased total project cost of private finance. In practice, private sector operators exercise significant control over their future direction, making long-term public value creation uncertain: ‘effectively the public sector needs to package something up, hand it over and keep their fingers crossed that they will be able to somehow influence the private sector going forward’ (Environmental Finance Specialist B).

Most urban areas also lack ‘that sort of brand’ (Environmental Finance Specialist A) associated with public investment in high profile developments such as the Olympic Park ‘where we know it’s going to happen’ (Environmental Finance Specialist A). Hence to attract investment at sufficiently low cost of capital for a project to proceed, ‘somebody within that circle has got to absorb a higher degree of risk. Now in the deals that we’ve done to date that has ... been predominantly the public sector end user that, because of lack of capital, has commercially taken the view that they’ll accept that risk provision’ (Investment Manager, Corporate Banking). The ultimate risk, and its cost, remains with the public sector. This may mean that other towns and cities will be experimental sites for market testing a privately-financed ‘green development’ model, where standard risk instruments do not adequately incorporate the future substantive risks to the locality of their contribution to guaranteeing private

returns. Private finance is legally accountable to shareholders; local accountability and wider public value may prove difficult to secure.

### ***Bricolage and Alternative Hierarchies of Value***

When technical devices such as those of liberalised finance are legitimised by government regulation, and established as authoritative in evaluating energy investments, then interpretative flexibility has been restricted, and the value of some technological trajectories has been given relatively fixed, durable meaning (Clegg, 1989). But such configurations of power are not monolithic. During periods of major political economic uncertainty, as at present, any model of a singular stable and self-regulating market under-recognises the tensions within and among institutions, or the potential for a plurality of ‘partial’ market and non-market investment schema to be in operation, with different goals and assumptions. Such tensions may work as catalysts to innovation and change, as suggested by sociological analyses of the productivity of intra- and inter-organisational dissonance, and discrepancy in assumptions and understandings between different groups (Boltanski & Thevenot, 2007; Stark, 2009). Research interviews and ethnographic data provide evidence of such dissonances and of the recognised need for new variants of situated financial innovation. This is innovation of an improvisatory kind, characteristic of the bricolage responses of financial actors to changing circumstances (Beunza & Stark, 2003), but guided by a continuing dominant theory (MacKenzie, 2013) of the laws of private finance:

‘I guess what you have to try and do is work with what you have inside the system, and then tweak it rather than require a fundamental new idea to introduce, because the more dramatic the change, then the longer it’s going to take, the more painful it’s going to be for it to happen’ (UK Government Officer, Low Carbon Investment Team).

Such bricolage, Engelen et al. (2010: 56) argue, may work to reformat markets by turning the ‘nodal possibility into a profitable position by using whatever instruments are to hand to create a business model’. This seems to characterise the position of UK GI, charged by UK government with discovery of profit-making potential in low carbon energy and energy efficiency investments, while remaining conscious of the need to demonstrate public benefits from the higher costs of private capital. This does not however recognise that bricolage may also embody subordinated knowledge of alternative social and cultural hierarchies of value which could be brought into play:

B: It would be interesting if someone carved out three or four hundred million, and they said ‘okay, London, with parts of Birmingham, Manchester, Glasgow, Edinburgh, here we go, thirty/forty million pounds each; go and develop your scheme.’ But that’s very much going back to the nineteen thirties; it’s New Deal, it goes against the culture of where we are... and I don’t see that happening.

...

Interviewer: Do you think that will be forthcoming though?

A: Probably not, because ... it's not in the ethos or the culture of how the government wants to deal with energy. It doesn't really want to step in and be a big planner.

B: Yes, you could float the argument really: leaving it all to the market, actually, what are you doing? You're really just abdicating your responsibilities and side-stepping.

(Environmental Finance Specialists A and B).

The speculation by finance experts on the tenets of contemporary financial models echoes the sociology of knowledge argument that knowledge is a matter of shared belief which may or may not be true (Bloor, 2004). A core tenet of the current energy project finance model for example is that debt is cheaper than equity (Appendix 1). This may have increased the risk aversion of urban authorities to equity investment in heat network development. In private enterprise, state regulation allows interest paid on debt financing to be set against tax, making equity more expensive in the short term. Given the different tax status of local authorities, however, an equity stake in energy infrastructure confers some advantages; equity overcomes the problem of the time lag between infrastructure investment and revenues, and confers control over strategic direction. Even in private enterprise, the belief that debt finance is always preferable because of its lower cost has been challenged by formal financial economics; the Modigliani-Miller theorem shows that, over the long term, the balance between equity and debt in an enterprise makes no difference to the overall cost of capital (MacKenzie, 2013). There is controversy over the conditions under which this may apply, but the point to be highlighted here is that current financial models are not inviolable. The financial innovations characterising the contemporary mode of capital accumulation, which prioritise debt financing through market instruments, may be working to the detriment of a more sustainable, secure and affordable energy system. Bricolage activity identifies the dissonances which limit current investment in sustainable urban energy, but has not yet resulted in coherent development of alternatives suited to the creation of a sequence of viable projects.

## Conclusions

We keep using the phrase 'the best is the enemy of the good', and you've got to go out there and make some of it happen, because if nothing happens because we're all paranoid about doing something, then that's the worst outcome of all I think. (Quote from research interview with UK Government Officer, Low Carbon Investment Team, 2012).

Attempts to reconfigure financial evaluations of urban energy infrastructure represent a moment where large-scale energy and financial market interests encounter questions about their future trajectory, and the future qualities, costs and control of energy provision. What is observable in these interviews, in policy meetings and trade forums are the attempts of actors to discover potential solutions, while securing relative socio-economic advantage from such improvised means. The current neo-liberal economic orthodoxy, which prioritises use of financial mechanisms to incentivise private investment in energy infrastructure, shapes decision-making to rule in, and rule out, options. Expert practitioners engage in critical deconstruction of the orthodoxy, but they are unlikely to pursue radically different models, given their judgement that, in the present political-economic settlement, adjustment to

mainstream finance models is more likely to prove productive. The ‘sunk investment’ in knowledge of financial instruments and markets, as well as in material infrastructure, the lobbying power of large corporations and the disempowerment of local levels of government mean that the search for solutions centres on minor adaptations to the dominant private finance model, referred to by one practitioner as ‘son of PFI’ and by another as ‘taking the things that worked from PFI, and applying it here’.

At the level of localities, bridging the gap between liberalised finance and local political and economic interests in urban energy projects requires considerable governance capacity, and has high transaction costs for the local authorities who are positioned as critical intermediaries. Faced with declining resources, local authority politicians and directors of housing, finance and economic regeneration perceive few benefits from the struggle to assemble finances for low carbon energy projects. Centralised state control over their finances and reduced budgets are shrinking their role, as well as the material assets they have available in negotiating with private developers. Significant urban leadership for meso-scale CHP and DH as a component of a low carbon energy system would require greater budgetary autonomy for local government in a regulatory framework which re-values social and environmental benefits of local economic regeneration. These conclusions are in line with the work of Stewart Russell which found that earlier district energy projects were stalled by a UK economy and polity oriented to commercial economies of scale and weak social obligations. The paper extends his legacy by adding a new dimension, derived from the inter-related work on the sociology of knowledge, markets and social studies of finance, to his theoretical account. This work demonstrates the potential for critical insight into the restructuring of energy systems to be gained from a focus on the financial innovations which have dominated political economy for the last three decades. It suggests the societal value of a research agenda to develop social studies of energy markets and energy economics. Such research would in turn strengthen the conceptual basis of the sociology of markets through new insight into the interaction of the economic sciences with political struggle over definitions of legitimate value, interests and market rules. This paper has sought to contribute to such a programme of work.

In relation to policy, there is scope for alternative district energy evaluation models to counter-balance technical-economic assessments of risk and value with questions of substantive risk and value in relation to public goods of ecology, economy and society. For the first time in the UK, there is an indication that new valuation models may be taking shape, at least in elementary form, through embryonic development of institutional authorities directly responsible for heat. The 2013 Heat Policy (UK DECC) established a Heat Networks Delivery Unit to contribute to early stage project development; government is also working with the industry to develop consumer protection and technical standards. The Scottish Government District Heating action plan and heat network partnership is also oriented to increasing development, with funding under the Renewable Energy Investment, Warm Homes and District Heating Loan funds, in a regional development model.

It may be that financial innovation through the mainstream of de-risked investable projects and structured asset classes is the eventual trajectory for low carbon heat developments, but this can be achieved under a variety of governance structures,



some providing more public accountability, transparency and checks on unearned profit than others. There are also alternatives to the current private sector energy utility model, which prioritises short-term maximisation of shareholder value in a global energy market. These are the many subordinated variants of public or community ownership, mutual enterprises, partnerships or consumer cooperatives in a less centralised, distributed energy system. One alternative to the complex financial engineering and costs of the private finance model is the non-profit model, where energy provision is governed by a community interest company, mutual enterprise or company limited by guarantee: ‘The not for profit model is more suited for where there is in effect a demand guarantee, which was the Aberdeen context. And was indeed the Wembley context as well effectively, okay, because the projects have got to be developed anyway. So there wasn’t this risk problem to be solved. So retrofit ... the, sort of, community interest company approach does fit that very well’ (Finance Investment Consultant). Around 30% of UK municipal authorities are developing a variety of ownership and governance models for urban energy projects. In the most advanced projects, these include consideration of mutual enterprise structures, where heat supply is owned and controlled by its users, as well as non-profit generation and supply companies, for-profit companies, and joint ventures between energy utilities and public bodies. In the current political-economic settlement, these are typically projects developed through the determination of ‘wilful individuals’<sup>vi</sup> (Local Authority Officer) who continue to believe that local government has a broadly specified responsibility for public welfare, and who persist in finding resourceful means to work within technical, financial and political constraints. A democratic commitment to reasoned consideration of routes to affordable, sustainable energy provisions in urban centres requires such options to be explicitly and actively maintained on the public agenda. Such a shift in the political framing of the energy debate would require changes in fiscal policy to direct long-term affordable investment into low carbon infrastructure responsive to regional social and economic benefits.

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## Appendix 1

### **Figure 1 Financing principles – urban heat networks**

- ▶ Financing made up of Debt, Equity, or a combination.
- ▶ Debt is traditionally cheaper, so idea is to include as much as possible, traditionally project financed waste or social infrastructure projects made up of c.80% debt, c.20% equity, based on project risk profile.
- ▶ Equity normally provided by shareholders in equal proportions to shareholding. Public sector needs to fund its equity requirement, from reserves, PWLB<sup>vii</sup>, grants etc. Drivers may be more than financial returns, so social and economic outcomes.
- ▶ Financial model takes account of funding approach and costs, project revenues need to support cost inputs – IRR (return requirement) will decide the funding route taken.
- ▶ Private sector return requirements (10%+) higher than public sector (5-6%).
- ▶ Reducing risk will increase IRR – robust electricity and heat off takes, easier with electricity, heat often seen as not bankable.

Source: Extract from Ernst and Young Presentation to Financing District Heating Workshop, London, April 2012.

### Note

There is ambiguity in the final point of the extract, which states that reducing risk will increase IRR (or the rate of return required on project lending). Reducing risk should reduce costs of lending. The point is that secure long-term heat and electricity supply contracts improve cash flow and business revenues, reducing risk of investment in CHP/DH.

## Appendix 2 – Interviewees Cited in Text

1. Finance Investment Consultant - former civil service economist with responsibility for development of UK government privatisation instruments; former Director of a firm of Consulting Engineers; currently independent.
2. Officer of UK government green investment team and former Director of a firm of Consulting Engineers.
3. Environmental Finance Specialist A, Transnational Finance and Accounting Corporation.

4. Environmental Finance Specialist B, Transnational Finance and Accounting Corporation.
5. Asset Management Consultant and former consulting engineer; construction industry specialist; former director of private equity fund in a major bank; currently independent.
6. Corporate Banking Investment Manager, responsible for investments in energy efficiency in the built environment, including district energy infrastructure.
7. Utility Senior Manager, energy networks - professional engineer with leadership and operational expertise in gas and electricity infrastructure. International experience of energy market restructuring.
8. Local Authority Officer – team leader in sustainable development and energy in an English Borough Council; developer of a financial model to analyse options for local energy investments, and participant in the UK District Energy Vanguard network.

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<sup>i</sup> Defined here as ranging from a Combined Heat and Power (CHP) engine, or heat-only boiler, to supply a small number of inter-connected buildings, such as housing estates &/or public and commercial buildings, up to inner city scale with an area-wide network connecting multiple heat producers and mixed public, commercial and residential users.

<sup>ii</sup> The Workshop is one of a series of knowledge exchange events organised as a collaborative venture between the research team and a district energy practitioner. Details from [www.heatandthecity.org.uk](http://www.heatandthecity.org.uk)

<sup>iii</sup> See Appendix 2 for description of interviewees directly quoted

<sup>iv</sup> The author was a member of the research consortium led by BRE and reporting to UK DECC

<sup>v</sup> The author is a member of the Scottish Government Expert Commission on District Heating

<sup>vi</sup> In English, the term *wilful* has ambiguous connotations, signalling intentional, determined and stubborn action, which defies established rules of conduct. For public sector officers or politicians, this risks reputational damage, and harm to career prospects or re-election. In this context, it also has connotations of the initiative, enterprise and determinism required by the minority of local officers and politicians who advocate development of urban energy services, against conventional beliefs and practice.

<sup>vii</sup> Public Works Loan Board