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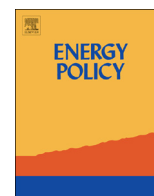
Realising local government visions for developing district heating: Experiences from a learning country

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HIGHLIGHTS

- Local governments are key to the development of district heating (DH).
- Local government-led visions of DH seek to deliver complex value.
- In the UK development is led by funding and commercial factors and is not strategic.
- To enable DH, national policy must align with the vision of local actors.
- Social and environmental criteria must be incorporated in decision-making.

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ABSTRACT

District heating (DH) has an important role to play in enabling cities to transition to low-carbon heating. Although schemes are commonplace in some countries, in 'learning countries' where building-level technologies make up the majority of heating systems there are numerous barriers to introducing DH. Local governments are seen as key actors in helping to create a 'shared vision' for DH amongst stakeholders.

This study uses interviews with stakeholders from a range of sectors in the UK (an example of a learning country) to examine the visions of local actors for developing DH and the types of national policy that would support local implementation of these visions.

The analysis shows that in engaging with DH development local governments seek multiple types of value. Realising this value will most likely happen by taking a long-term, planned approach to development. In contrast, national government policy is geared towards techno-economic criteria and may lead to only a minority of potential sites being developed, without realisation of wider social or environmental benefits aligned to local visions.

The work highlights the importance of local strategic planning, enabled by aligned national policy, in realising the full economic, environmental and social benefits of DH.

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1. Introduction

Heat demand accounts for more than half of the world's final energy consumption (Eisentraut and Brown, 2014). In 2008, two thirds of heat demand for residential and service sector buildings in the EU27 countries was met through the burning of fossil fuels in household-level heating technologies and only 12% by district heating (DH) (Fig. 1). As Connolly et al. (2014) point out, although improvements in energy efficiency and electrification of heating will play an important role in reaching decarbonisation targets, greater use of DH in appropriate areas could offer a scenario that is cheaper and easier to implement than expensive building retrofits to improve energy efficiency. It also offers flexibility to the wider energy system through thermal storage opportunities.

A DH network consists of a heat source coupled to highly insulated pipes that transport heat to multiple buildings using hot
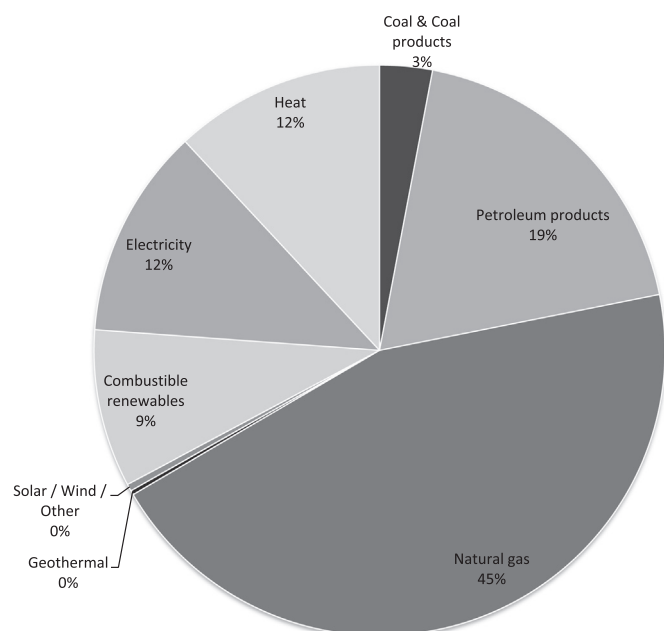
Fig. 1. Origin of heat supply for heat demands in residential and service sector buildings from EU27 countries during 2008. 'Heat' refers to 'heat from district heating systems'. Data sources: IEA energy balances for 2008 'complemented with external estimation' (As redrawn from Connolly et al., 2012). Total heat supply was 11.5 EJ, not including indirect heat supplied from indoor electricity use.

Table 1
Percentage of citizens served by district heating in countries of high DH and low DH installed capacity (Euroheat & Power, 2013).

Percentage of citizens served by district heating (%)			
High DH countries		**Low DH countries**	
Lithuania	67	Germany	12
Latvia	64	Croatia	10
Denmark	61	The Netherlands	5
Estonia	54	Italy	5
Finland	50	UK	1
Sweden	48	Norway	1

water or steam. Networks are best suited to areas of high heat and population density on the basis that a high overall heat density for an area will likely mean a network is more economically feasible (Davies and Woods, 2009). The technological advantages include the potential for high efficiency (e.g. through the use of combined heat and power), the ability to use different input fuels for heat generation (including those from renewable sources) and the option to capture and make use of excess heat from industrial processes that currently is wasted. In addition some heat technologies are simply not relevant for individual dwellings, as scale and size prohibits them e.g. geothermal heat, meaning that DH offers the only alternative to individual gas boilers. Large systems tend to use a variety of heat sources and can also be combined with storage of heat. DH can therefore enable carbon emission reductions, cost savings, and enhanced energy security through diversity and system flexibility.

There is a significant potential for growth in DH across Europe; an estimated 81% of heat demand in the EU is located in the same region (at NUTS3 level[1]) as activities with excess heat (Persson et al., 2014). Despite this, the level of uptake of DH varies significantly across different European countries. Table 1 highlights examples of countries with high installed capacity and countries with low installed capacity of DH in 2011. These differences can be substantially explained by the differing historical contexts (including political, economic, regulatory, climate and cultural factors) of each country's energy system (see, for example, van der Vleuten and Raven, 2006, Russell, 1993; Ericsson, 2009, Lehtonen and Nye, 2009).

Here we use the term 'learning countries' for those that currently have a low uptake of DH, and have stated a national strategy or ambition to increase heat provision through DH.

[1] The NUTS regulation lays down a threshold range of 150,000 and 800,000 for the average population size of a NUTS3 region. For the UK, a NUTS3 area broadly equates to a local authority area.

2. Context and literature review

2.1. European and national-level policy

After many years during which little attention was paid to DH at an EU level, there is now a growing recognition that heat needs to be addressed explicitly within low-carbon energy policy (European Commission, 2015). Article 14 of the Energy Efficiency directive (2012/27/EU) (EU, 2012) requires Member States to carry out a comprehensive assessment of their potential for efficiency in heating and cooling. Article 22 (3) of the EU Directive on Energy from Renewable Sources (2009/28/EC) (EU, 2009) also calls for Member States to identify specific locations for the establishment of renewable DH.

At the national level, countries with an established DH market are looking for opportunities to decarbonise their systems and improve efficiency (Bryntse and Mattison, 2010; Danish Energy Agency, 2012; Ericsson, 2009). Countries with little or no heat delivered via district heating ('learning countries') are beginning to encourage development through various support mechanisms and the introduction of regulations (Hawkey and Webb, 2014). However, many of these learning countries face significant barriers to expanding the deployment of DH, including a need to compete with established and wide-spread gas infrastructure provision and markets, low levels of local strategic energy planning and uncertainty in long-term energy policies (IEA, 2014).

2.2. The role of local government

Across Europe, local governments are increasingly being looked to by national government for leadership in developing local aspects of the energy system. Local government activities range from encouraging uptake of energy-efficiency measures in buildings to strategic coordination of the deployment of new low carbon technologies such as solar PV, solar thermal, and district heating networks (e.g. Bulkeley and Kern, 2006; Hawkey et al., 2013). For district heating development, the case for involvement of local governments is particularly strong, given their connections to local actors, wide-ranging local responsibilities such as social housing provision, and commitments to wider social and environmental concerns such as fuel poverty and air quality. For context, it is estimated that there were 2.35 million households in fuel poverty in England in 2013 (equivalent to approximately 10.4% of all households) (Department of Energy and Climate Change, 2015). Experiences from countries with a high provision of heat through networks, such as Sweden and Denmark, highlight the importance of actively engaging a wide range of actors to realign the energy system in favour of DH (Di Lucia and Ericsson, 2014) and the value of local strategic planning exercises, supported by national-level policy, for enabling the expansion of schemes beyond isolated, small-scale projects (Chittum and Østergaard, 2014). However, for countries where DH is not already established, such as the UK, this is a new role for local governments.

Centralisation of energy supply over the last 50 years has led to energy suppliers, often linked to international companies, leading energy system investments rather than being led at the municipal level (Hawkey, 2012; Roelich and Bale, 2014; Russell, 1993).

Most UK local governments are still in the early stages of learning how to develop DH and they face multiple barriers, particularly for retrofitting schemes into existing buildings where the possibility of commercial returns is not always present (BRE et al., 2013). Where schemes have been developed successfully, they are often the result of a convergence of local political agendas, funding opportunities, and the determination of key individuals who have challenged the traditional way of doing things (Hawkey et al., 2013; Hawkey, 2012; Webb, 2015). For example, a study by Webb (2015) on a DH scheme in the city of Aberdeen, Scotland, showed how the scheme only became possible because the scheme developers were able to redefine the local government's understanding of 'best value' within its cost-benefit analysis of the scheme. The long payback period for investments on many DH infrastructure investments is driving interest in alternative business models that enable leverage of finance into the projects.

Further to the complexities of DH development itself, local authorities face broader constraints on resources and capacity that make taking on a new role within the energy system challenging. In the UK at least, local authority budgets and staffing levels have suffered significant cuts in recent years and they face constraints in terms of knowledge, experience, and staff time. As a result, their financial resources are limited for procuring much-needed feasibility studies and other consultancy services, legal advice, and providing the significant upfront capital costs of networks (BRE et al., 2013). Bale et al. (2012) also point out that local authorities in the UK face financial and structural barriers that prevent them taking on a role in strategic energy planning, including the need to work across multiple departments (planning, waste, finance, legal, and procurement) simultaneously, contrary to the way their governance systems usually function.

2.3. The UK context as a case study of a learning country

In common with a number of other learning countries, the UK has recently seen increased interest in DH from local authorities and associated stakeholders and has introduced a number of new policy support measures. The publication of the UK Strategic Heat Framework (DECC, 2012) recognised that a mix of technologies will be needed to meet future demand for low-carbon heating. DH is seen as a key technology within this mix, particularly in cities. An action plan for heat, published a year later, estimated that 14–40% of heat demand could be supplied through district heating by 2050 (DECC, 2013b). Even the lower end of this scale signifies large-scale change from the current UK energy regime, in which district heating makes up only 2% of the total heat supply (DECC, 2012) and natural gas boilers are used by 91% of households (figures from 2011).

The number of local authorities that are actively considering options for DH is growing steadily and Government has introduced a number of initiatives to try and help them to overcome some of the challenges of taking on a new role in energy system development. A key initiative in England and Wales is the Heat Network Delivery Unit (HNDU), which was formed within the Department for Energy and Climate Change (DECC) in summer 2013. This unit seeks to tackle the issues of 'capability and capacity' faced by local authorities by offering guidance, support and funding to commission studies by consultants to feed expertise into local authorities (DECC, 2014). A distinct programme of support exists in Scotland through the Scottish Heat Network Partnership which offers local authorities access to expertise from existing Scottish organisations including commercial, legal and

technical advice. These support mechanisms are beginning to encourage the use of heat maps, energy master-planning and stakeholder engagement to overcome the early hurdles of DH project development.

In addition, the main policy support measures for heating technologies are the Renewable Heat Incentive (RHI) and the Energy Company Obligation (ECO). The non-domestic Renewable Heat Incentive (RHI) (Ofgem, 2015), introduced in 2011, is designed primarily to incentivise renewable heat uptake in the industrial, commercial and public sectors, but is also applicable to DH for domestic properties. The Energy Company Obligation (ECO) has a broad remit and includes support for DH connections and plant (DECC, 2013a).

There is currently no regulation of the heat market, although very recently a voluntary industry standards scheme was launched by the Chartered Institution of Building Services Engineers and the Association for Decentralised Energy (CIBSE and ADE, 2016).

2.4. Theoretical basis for analysis

The existing literature (e.g. Hawkey and Webb, 2014; Nilsson and Mårtensson, 2003; Sperling et al., 2011 among others) highlights the crucial role of local government in countries that have successfully developed DH. This often means fulfilling a new role, either taking on the risk of development themselves, or creating a local policy framework and institutional infrastructure to facilitate others to make investments. In the context of a highly centralised energy system, the entrance of new local actors brings with it a new set of drivers and perspectives that do not necessarily align with the existing energy regime.

Here, we draw on the transitions-management literature to consider approaches for increasing uptake of DH in learning countries. The energy system is considered as a socio-technical 'regime' whose evolution is influenced by the complex interaction of numerous dimensions including incumbent technologies, institutional and market setups, policy regimes and social practices (Geels, 2002). This body of literature explores how a transition to a new socio-technical regime can be 'managed' through the creation of niche spaces where technological innovations can be developed and demonstrated (Kemp et al., 1998; Smith and Raven, 2012). Niche creation can be supported through activities including government policy support to protect or incentivise innovations and the development of resource and capacity of key actors to enable delivery.

Creation of a 'shared vision' between niche and regime actors is argued to be a critical part of transition management, which enables decisions on short-term actions, within the framework of a long-term goal (Hamann and April, 2013; Hodson and Marvin, 2010; Kemp and Loorbach, 2005; Schot and Geels, 2008). The process of defining a vision depends on who is involved in the process and the value that they perceive in the new technology. In their study of urban transitions, Hodson and Marvin (p. 481, 2010) describe vision creation as "An important participatory process used to engage, inspire and mobilise a wide variety of different social actors, but involves negotiation and struggle".

Likewise, Schot and Geels (2008), drawing on a range of literature from different perspectives, identify the articulation of visions and expectations as one of three key processes necessary for successful niche development, alongside the building of social networks and learning processes at multiple dimensions. They argue that these visions and expectations can provide "direction to learning processes, attract attention, and legitimate (continuing) protection and nurturing".

Through this theoretical framing we explore the visions of local actors and how these may influence a transition from niche to mainstream DH.

2.5. Research questions

In this work we extend the empirical evidence on the topic of DH development by exploring the range of visions and value perceptions articulated by key local actors involved in DH niche creation, using the UK as a case study of a learning country. Specifically, we examine the motivations and drivers that influence the vision formation for a range of stakeholders.

These visions are compared to the decision criteria the actors use to prioritise their activities in support of implementing the vision. In addition, we consider the institutional frameworks that might support local actors in adopting DH. We highlight some of the specific challenges that come with creating a shared vision for DH with new energy system actors working at the local level, and make policy recommendations for national level government to support this process.

We draw on evidence from interviews and public documents to answer four questions:

1) What are local actors' visions for DH development in the UK?
2) What decision criteria are used to prioritise activities for achieving these visions in the UK?
3) What roles do other actors play in supporting the vision for local-government led DH schemes?
4) How can UK national-level policy better support increased uptake of DH?

Using the empirical evidence from the UK experience, we examine the wider policy implications for learning countries and propose recommendations.

The remainder of the paper is structured as follows: Section 3 outlines the data collection methods; Section 4 contains the empirical results; the wider implications of these are discussed in Section 5; Section 6 then concludes the paper.

3. Method

Our method is based on the collection and analysis of empirical data. In order to address the research questions set out in Section 2.4, a series of 14 semi-structured interviews were conducted with key stakeholders involved in DH development in the north of England and Scotland including local governments, central government and industry, between May 2013 and September 2014. The largest proportion of the interviews (6 out of 14) was conducted with local governments to reflect their critical role in facilitating and enabling DH projects. Local governments can either (i) seek to develop a scheme themselves or (ii) enable others to develop schemes. Therefore we also consider data from other key actors involved in DH development either as developers, operators or key anchor loads, as a means of exploring their role in the creation of a shared vision.

Interviewees were selected based upon the extent of the organisations' activities in district heating development, and through recommendations from experts in the field (snowball sampling). Interviews were structured around identifying local actors' long-term visions and decision criteria for action. They were recorded and transcribed for analysis, with the exception of two central government meetings where a formal interview did not take place. Additional information was gathered from policy documents and government reports to support analysis of the interviews. A summary of the interviews can be found in Table 3.

Thematic analysis (Braun and Clarke, 2006) was carried out using the qualitative data analysis software NVivo. The transcripts were coded using the categories shown in Table 2; however, additional themes were explored as they emerged. Where new

Table 2
Coding categories for the interview transcripts.

Main categories	Sub-categories
Visions and perceived value of DH	Economic
	Environmental
	Social
Decision criteria for actions	Economic
	Environmental
	Social
Actors involved in DH development	–
Barriers to DH development	–

themes were mentioned they were noted.

4. Results

In this section we address the research questions in turn, using evidence from the thematic analysis. Table 3 summarises the analysis of the interviews and provides evidence in support of the results discussed in this section.

4.1. Local governments' visions for DH development

We examined the data for the motivations and drivers articulated by the six local government actors in order to understand the vision creation process. The analysis showed that local authorities were aiming to achieve multiple forms of value with DH, particularly recognising the social benefits of the technology as well as the economic and environmental benefits. This differs from what would be expected from traditional UK energy system actors within the private sector, who would require commercial rates of return for their activities. Local authority priorities varied across different geographic areas, suggesting that they were influenced by local context and circumstances. It is often recognised that DH, as a decentralised energy technology, needs to adapt to the local physical and technical context, but these differences in local social and economic circumstances are not commonly considered in the development process. The following quotes provide illustrative examples of the range of values articulated.

Some drivers clearly spanned the coding categories of economic, social and environmental value. For example, achieving reduced heating costs for all of the scheme's customers (both domestic and non-domestic), so reducing their annual energy expenditures, delivers economic value but can also bring social benefits to residential customers in terms of the increased health and wellbeing benefits of providing an affordable way for people to heat their homes.

"We want to have tenants living in good quality accommodation and they can afford to live there and it's affordable to pay their fuel bills." [LA2]

Social criteria were also important, in terms of the drive to reduce fuel poverty, but also as part of a wider aim to regenerate council-owned housing stock. District heating was seen as a solution for improving the living conditions of residents in social housing as well as meeting regulatory requirements for social housing standards. This was seen as a way to reduce the costs of heating and maintenance for residents and the local government, respectively, especially where capital funding was available.

"Probably first pass we are looking at other investment priorities. So there are certain areas that the council wants to regenerate." [LA2]

The evidence from the interviews demonstrates how local governments see district heating as bringing benefits for tackling

Table 3

Summary of thematic analysis of the interviews including motivations, development approaches and challenges to DH development. Note this does not capture the full analysis and due to the commercial sensitivity of the topic, full transcripts and analysis cannot be made available.

Organisation	Main motivation	Secondary motivations	Development approach	Barriers to taking a 'mixed approach'
Scottish Local Authority	Housing standards *"That is what drives the capital programme; it's achieving the Scottish Housing Quality Standards".*	Fuel poverty and CO_2. *"We've always had, from previous single outcome agreements, the desire to reduce fuel poverty, the desire to improve energy efficiency, the desire to bring people out of poverty."* Single Outcome Agreements (setting the agenda of work for local authorities in Scotland) include an environmental target: *"An example for an environment one is the higher level indicator one of them for the environment is on CO_2 emission in [City X]."*	Funding driven *"It is really the opportunities where funding becomes available and if the funding packages stack up then it makes them more attractive."* *"I think the projects have probably just evolved as and when funding has become available."* *"We were speaking to the utilities at the time and could talk to [private company] and we said, is there anything you could do to help us here through the CESP programme? And that is basically how it evolved. And they said, well what about district heating? "*	Making the economic case for switching from natural gas boilers in the domestic sector: *"I suspect that once this scheme is finished district heating may grind to a halt in [City X] in the domestic sector because it is cheaper to put in just conventional gas systems. The capital costs of conventional gas systems is cheaper to us and gas is reasonably available and at a reasonable cost."*
English Local Authority 1	Regeneration *"It has huge revenue benefits in the sense that we don't have to put gas boilers in and take them out every 5 years, depending on the warranty agreement it is much easier to maintain it all. District heating is a whole lot easier for us to do that. So that's why we are going down that route."* "regeneration opportunity"	Strategic vision, CO_2 *"We are going to establish ourselves as an energy city and to achieve our carbon reduction targets we are going to do this through our district heating network."* *"The energy [theme] around energy production, energy efficiency and energy security. [...] Within that there are a number of projects that were identifies for taking forward which are the green ports and that's linked to the off-shore manufacturing plants, onshore wind turbines down the eastern edge of the city, district heating, biomass..."*	Funding driven *"There is no way we could deliver this without ECO funding."*	Knowledge and experience *"There just isn't the technical knowledge both in terms of finance, in terms of legal, in terms of the technical stuff of actually designing and developing a heat network. So it is primarily the local authority bringing in external expertise in to do the work because they don't have that. "* *"The issue for us is understanding what the governance of the business model should be for it. We're thinking to apply for an ESCo and for us it is understanding how we make the whole process attractive, what stake we want within it."*
English Local Authority 2	Regeneration and fuel poverty *"Probably first pass we are looking at other investment priorities. So there are certain areas that the council wants to regenerate."* *"We want to have tenants living in good quality accommodation and they can afford to live there and it's affordable to pay their fuel bills."*	Strategic vision, CO_2 *"It's not particularly windy, or there is no great hydro as energy, so district heating is a big strategic move for the city."* *"I think carbon would come as an underpinning to all of it.*	Funding driven internally, with link to commercial development approach through the LEP *"When you do your detailed analysis for each actual site you would try and get a feel for what's the carbon saving for each one. Particularly because that then directly links to how much funding we get through from the energy companies through ECO."* *"we're very keen to have a stake in whatever we build so we're looking to invest in it"*	Knowledge and experience *"The things we are looking for are examples from other local authorities, what they've done." (Local Authority 1)* Resource *"I do understand for the really early stages and the very specific bits of work that you want to work with consultants who know how heat networks operate but we just want to use our project management team to project manage this so that we've got a) the project management expertise from [English Local Authority 2] and the understanding of where our procurement rules are but also to build that expertise that would then allow us to do more in the future."*

English Local Authority 3	CO$_2$, Commercial	Fuel poverty	Mixed approach	Budget cuts/staff change
	"The whole premise behind it was that commercially and heat load wise we always thought the city centre would be the most attractive area. But the council was very much predicated on fuel poverty and things like that so we want to drive that forward as well."	"We've got other strategic aims to try and develop a network maybe to some of the less commercial wards."	"The council is currently very keen to invest in something like this to obviously generate revenue so we can maintain our level of governance around how it is developed in the future. We don't want to just give it away to a developer who just wants to cherry-pick."	"The city council is undergoing major changes in terms of budget cuts and senior management. They're restructuring. …We may have to start… well, almost start over again, convincing the new senior management team that this is the right thing to do."
English Local Authority 4	Economic - costs of system installation and management;	Economic (local growth and job creation) and Environmental (CO$_2$).	Commercial	Knowledge and experience
	"It will be purely economic. There's no two ways about it. The environmental side, the carbon reduction side, does come into it. But that's extra."	"It's economically focused. Creating more development, you know, building more homes creating more jobs.	"I would like to hope that we could be fully owned by ourselves, but that inevitably won't be my decision. You know, we'll see what comes out as the most viable and cost effective solution and what will have the greatest benefit for the residents in the council."	"At the moment we've not got much experience at all in terms of development. So I've got no experience. So we'll be relying on examples of what other councils have done."
	"We needed a way in to ensure that development that did come forward, where it could, could be as sustainable as possible."	Social factors were considered, but not seen as relevant to the case in question:	"If you can say there's a possibility of the Carbon Reduction Commitment you know, to the hospital and the university, and other players, then that is an added extra. But at the end of the day the carbon reduction commitment is an economic tax. So the environmental side comes down quite low in big terms. And it will be looked on purely in economic terms. If it's not going to be financially viable it won't go ahead."	Resource
		"I would like to include domestic properties into schemes but at the end of the day, it's going to make the financial case a lot harder. And to be honest, there are not an awful lot of the areas that could be helped by a retrofitted district heating scheme. The areas around [the development site] are probably a bit more affluent."		"We've got some resource in terms of staff to help develop it to a stage where we can go out to feasibility study and manage the consultancy work to be chosen. […] You know, on that basis, there is some resource in house but obviously not enough to do the feasibility work."
City Region Local Enterprise Partnership (LEP)	Economic growth/Investment opportunities	CO$_2$	Commercial	Resource
	"The whole point of the city region is to stimulate economic growth".	"At the moment the local enterprise partnership has four priorities of which one of them is facilitator for a low carbon economy."	"Commercial investment opportunities that we can either take forward to further feasibility […]. We would identify the opportunity and then we could go out to the market and say "look, we think we've got an opportunity in [X] town centre, for instance. Are you interested in working with us to develop the opportunity? "	"Only one within the 10 in the [local enterprise partnership] that could resource project management [for developing DH]… the rest of them would need some resource, some help, to bring somebody in."
	"We're developing a low carbon investment pipeline. […] [Projects] are low carbon but they contribute to the growth in the economy."			Knowledge/Quality of consultants
				"There are a number out there in the market that will say they can do this work, but I think there is only a handful that can actually do it well."
Housing Association	Tenant wellbeing, fuel poverty (energy costs)	Cost of investment and management	None	Lack of resources
	"Whilst they are probably not seeing a massive reduction in bills, what they have noticed is a much higher comfort level and a willingness to use the system which for us ticks more boxes in terms of health and wellbeing."	"We then look at the business case to see whether it is worth to join in because in terms of the business case we've got on the one hand that the fuel bills of the tenants are hopefully going down and that is something that as an organisation is very important to us. But still the work has got to be paid for and one the one hand you've got capital costs of installing the equipment and then the on-going maintenance of it. Offset against that, you perhaps haven't got the costs of doing annual gas checks and other things that you might have with a traditional gas heating system".	There is no feasible approach open at present, unless the LA takes something forward.	"We've tapped into what's been available at the time… You've got to equally recognise our size, we don't have the resources to go out and chase every junk of money that's floating around."

Table 3 (*continued*)

	"We've kind of moved away from talking about that affordable warmth for a lot of our tenants, to talking more about making their money go as far as it can, almost acknowledging or accepting that our tenants are on such low incomes they are not going to be able to afford in a lot of cases to heat their properties to a comfortable level all the time because the fuel costs are just too high in relation to their income."		*"Because our properties are so dispersed, it is very difficult for us to look at a project. But what we would want to do is work closely in partnership with other organisations."*	Lack of scale *"Say if there was a project that [our local authority] were working on then we would definitely tap into that. And I think I can safely say that our other partners as well, other housing associations would as well. …We would really want to obviously get the best that we could for our tenants from that. So working in partnerships is something we would definitely, definitely be interested in."*
Energy company 1	Energy Company Obligation (ECO) criteria: carbon reduction and fuel cost reductions *"The analysis is primarily on the value of ECO. So it's talked of in the way that we know that it will give back benefits but we have to be able to make it stack up financially through the ECO in order to be able to make it deliver those benefits."*	Fuel poverty *"It's primarily tower blocks that do not have external insulation already and also have electric heating. […] It tends to give the best position from the tenants perspective, in that, they'll be living in, generally, damp, cold tower blocks that are very poorly insulated with electric heating that has poor controllability and very high cost."* *"The amount of carbon we can save and therefore minimising the cost, if anything, to the housing association or ALMO of the project"*	Compliance with regulatory requirements – Energy Company Obligations (ECO) *"But the analysis is primarily on the value of ECO. So, it's talked of in the way that we know that it will give back benefits but we have to be able to make it stack up financially through the ECO in order to be able to make it deliver those benefits."*	Social value of DH can not be realised without subsidy/incentives *"It is actually hard to see how you could fund these without something like ECO or CESP"*
Energy company 2	Financial *"We understand the technical potential for district heating and providing and improving things like waste to energy district heating. We can see the technical case, but the commercial case really does require big deal collaboration between group authorities to really up the ante with regards to district heating in the UK."*	Future-proofing the company: *"My role is very much the looking ahead at the sort of emerging opportunities that are being driven by legislation, regulation or emerging technologies, and investing in or partnering with companies who may be able to future-proof SSE's business… that would be consistent with looking at district heating as a growing opportunity being driven by the afore-mentioned regulations and obligations, and at looking at our own in-house capabilities, we have expertise and the ability to do it."*	Commercial – but reliant on local authorities in the UK We see it very much as policy-dependent. You do need a great deal of collaboration and support from the local government or whatever to really make it happen. Because, given the recession with regards to new-build particularly in domestic housing; that is where supplying district heating opportunities traditionally come, but in the UK compared to maybe other parts of the world we've been dependent upon local government initiatives to drive forward the opportunities.	Reservations about longer term viability of district heating *"There could be a point where every commercial and domestic building in the future is built for zero carbon and the amount of primary heat you have to put into the building doesn't stack up with regard to the infrastructure you have to put into the ground to service that low heat demand."*
Network operator	Considering a strategic move into district heating provision to compensate for reduced use of the gas network *"We have an overlap into things such as district heating in as much as it's an area that we've looking at in some details over the last 3 or 4 years, prompted largely by the government's 2050 commitments on low carbon. And if you have a look at most of the government or the DECC 2050 pathways there ain't much gas in there".* *"District heating has got a potential role to play within that because actually we're going to need a wider portfolio of energy within the national and the local mix that we do at present. And, there is a role for district heating as one of the planks of that."*	Fuel poverty *"We have a fuel poor agenda which is linked to our regulatory framework. We have specific outputs that we have to deliver around wider social obligations, one of which is fuel poverty."*	Not currently able to operate a network but where their potential interest lies is in commercial models with low risk financial return *"Our license is very limited in terms of what we can actually involve ourselves in financially. We're pretty much limited as a network to actually just transporting gas. We can't get involved in buying or selling gas, or the use of gas. So we play more of a sort of facilitator role in terms of what aspects need unpicking in terms of the legal and regulatory framework, the operating framework that might need to be addressed in facilitating the development of those types of things."* *"Networks, when you start looking at them, are very different in terms of the way they have to do things in much more stable and lower risk. But when they are in that environment they have to be willing to take a longer-term view. Which is why you get very*	Concerned at the level of potential financial risk *"What the danger at the moment is how you would actually fund, how you would actually make a return and who the customer would be in this area is completely unknown."*

Table 4

Thematic analysis of stated motivations and decision criteria transcribed from the interviews conducted. Rankings given in the table indicate the relative number of times motivations were stated by local governments' planning district heating schemes vs. the number of times different decision criteria were mentioned for use within planning to construct a business case for a scheme.

Ranking	Visions and perceived values	Ranking	Decision criteria for taking action
1	**Social**	1	**Economic**
			Where are the opportunities to offer lower-risk, financial returns to:
	• Regeneration of housing stock		• Potential investors?
	• Fuel poverty reduction		• The local government?
2	**Environmental**	2	**Social**
	• Carbon reduction		• Where are opportunities to use ECO funding for a residential DH scheme?
			• Are there opportunities to add on households to a planned commercially competitive scheme?
3	**Economic**	3	**Environmental**
	• Regional competitiveness e.g. attracting industries wanting low-carbon heat and electricity		• Will the carbon savings offered by a scheme reduce costs on the CRC?
	• Local economic growth		

fuel poverty and was also backed by political drivers stated in a number of recent press releases. For example, the Scottish Government (CHPA, 2014) announced the development of DH networks explicitly to support fuel poverty reduction whilst this work was being undertaken.

In contrast, economic motivations were more prominent for some actors. Local governments focused on increasing the competitiveness of their local region, using district heating to attract industrial activity to the area and thus creating more local jobs.

"It's economically focused. Creating more development, you know, building more homes creating more jobs." [LA4]
"The environmental side, the carbon reduction side, does come into it. But that's extra." [LA4]

Motivations were often adapted to the specific political priorities of their own government area.

"We are going to establish ourselves as an energy city and to achieve our carbon reduction targets we are going to do this through our district heating network." [LA1]

Carbon reduction was often mentioned as an important driver. There was also a financial consideration for carbon reduction, as public sector organisations not covered by the EU emissions trading scheme are required to buy allowances for the tonnes of carbon they emit under the Carbon Reduction Commitment (CRC)[2] energy efficiency scheme. Therefore, the ability to deliver carbon savings through the use of district heating can offer financial savings to public bodies.

"I think carbon would come as an underpinning to all of it." [LA2]

An interesting result is that social and environmental drivers were at least as prominent as economic motivations for local governments. What becomes clear is that local governments are aiming to develop DH networks as a means of delivering complex value to their city; they are aiming for multiple benefits across social, environmental and economic areas. It therefore follows that there is no one criterion that can be optimised in planning a scheme, which raises issues for understanding the prioritisation and development of schemes, as we discuss in the next section.

These motivations and drivers form a snapshot in the longer process of developing a shared vision for DH among local actors. It is significant for learning countries that these may be more

complex than national policy currently reflects.

4.2. Decision criteria and related development approaches used by local governments to achieve vision for DH

In the second research question we used the empirical work to examine how local visions are being implemented, by analysing the decision criteria that are used by different actors to assess the viability of schemes.

Despite the variety of DH visions identified by local governments, there were only a limited number of approaches available for them to consider with regard to delivering a scheme. This is probably a result of these niche activities operating within a resistant regime, and the actors having limited resources and powers to drive action. From our analysis we were able to compare stated motivations against criteria used to decide on a delivery approach for DH projects. Noting the mentions of motivations and decision criteria, several broad areas and rankings of importance were revealed and are presented in Table 4.

Whilst the rankings in Table 4 are obviously subject to interpretation in our coding and, given the small sample, are not necessarily statistically significant, the mismatch between motivations and decision criteria is striking, and clearly supported by the recorded narrative.

In addition to this result, three distinct development approaches emerged from the analysis of the decision criteria used to prioritise activities on DH: the funding-driven, commercial, and mixed (strategic) approaches. We consider these each in turn to explore some of the reasons why there is a mismatch between actors' long-term visions and the decision criteria they use to decide on actions.

4.2.1. The public funding-driven approach

Under this approach, local governments focused on accessing sources of public funding to cover all or part of the capital costs of a project and make financial returns more viable. This reduced the amount of risk that had to be taken on by scheme developers and offered the potential to keep consumer prices low by removing the need for recouping capital investments with heat sales. Funding came, or was being sought, from European sources (e.g. the European Regional Development Fund (ERDF)) or the Energy Company Obligation (ECO).

Often the criteria of these funding schemes align with the objectives of local governments, particularly those that are aimed at improving housing standards and reducing fuel poverty. For example, we observed leverage of funding sources to help local governments and housing associations to meet their direct

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[2] The carbon reduction commitment applied to organisations that have a half-hourly metered electricity consumption greater than 6000 MWh per year, and therefore includes local authorities who incur additional costs for electricity use.

responsibilities in terms of social housing quality standards. DH schemes, installed alongside other energy efficiency measures, offered an opportunity to supplement existing budgets to achieve a higher standard of housing for social housing residents, and have the potential to interconnect into larger DH schemes at a later date.

However, the funding-driven approach posed challenges for realising broader long-term visions for DH. Problems of resource, a lack of local government willingness to take on financial risk, and a lack of interested private investors led to a feeling of reliance on funding to enable any action. One interviewee stated:

"There is no way we could deliver this without ECO funding." [LA1]

The need for external funding in this development approach means that planned projects remain at the mercy of political changes in policy. For example, during the 12-month span of these interviews, there was a significant reduction in the scale of ECO funding (Ofgem, 2014).

In addition, projects must also conform to the criteria of the funding available at the time. Project viability is, therefore, ultimately determined by the funding criteria rather than by the strategic objectives of a city or region-wide energy plan.

"I think the projects have probably just evolved as and when funding has become available." [SLA]

There was evidence of social housing managers and energy companies working together to develop schemes, enabling them to meet their respective responsibilities in terms of housing quality standards and the obligations under ECO. However, these actions were not linked to long-term visions for DH and instead led to stand-alone, small-scale projects. This approach has proved useful for getting small stand-alone projects off the ground, and offered an opportunity to support many of the social visions held by local actors in the short-term. However, its vulnerability to changes in funding and lack of action for enabling broader long-term developments, means that this approach is limited in the contribution it can make to long-term transition management to a DH regime.

4.2.2. Commercial approach

Another approach that local governments were using to facilitate development of district heating was to develop and share detailed information about sites that offer a commercially viable business case, in order to attract an investor. Business cases were constructed on the basis of creating a minimum financial profit for the investor (most likely private investors, but potentially the local government) by undertaking energy master-planning to identify the opportunities in a city.

The local governments interviewed in this work who adopted this development approach saw district heating schemes as an opportunity to support economic growth. Often they were targeting HNDU funding to complete city-level mapping and energy master-planning in order to attract private investment in the area. In particular, this could be achieved by attracting industrial or commercial organisations that were looking for a source of low-carbon heat and electricity to reduce their costs under the Carbon Reduction Commitment (CRC) or EU emissions-trading scheme. For example, the interviewee from the local enterprise partnership identified stimulating low-carbon economic growth as a key motivation for undertaking heat demand mapping and district heating feasibility studies:

"At the moment the local enterprise partnership has four priorities of which one of them is facilitator for a low carbon economy. It's one of its key priorities to deliver, so as part of that we're

developing a low carbon investment pipeline. [...] [The projects] are low carbon but they contribute to the growth in the economy." [LEP]

Without additional forms of support, the Heat Network Delivery Unit (HNDU) primarily supports this commercial development approach. Over £9 million of funding has been awarded to 90 local governments across England and Wales since January 2014 to enable them to conduct feasibility studies and develop business plans "which can be used to attract commercial investment" for district heating projects (Government Digital Service, 2014). This model is seen as an alternative method for stimulating activity on district heating for local governments without relying solely on external funding or the council's own finances. As a result, there has been an increase in the commissioning of consultants to carry out heat-demand mapping studies to identify the most commercially viable sites. These maps focus predominantly on techno-economic criteria because their aim is to attract private financial investment, and there is therefore little prioritisation of social visions within these studies. This is clearly at odds with many of the local governments' articulated visions for DH.

The commercial viability of a scheme is likely to be based on estimated heat demand. There are, however, two issues arising from using this as the main criterion for assessing feasible DH sites.

First, and most significant in light of the main benefits sought by local actors identified in this work, it is particularly difficult to assess heat demand for households in fuel poverty, as they, by definition, are suppressing their energy use due to financial constraints. Fuel-poor households, particularly those with low incomes, have lower heat demand per m^2 floor space than non-fuel poor households (Druckman and Jackson, 2009; Hirsh et al., 2011; Preston et al., 2013). This, therefore, makes them a less attractive area for profit-driven providers to invest in DH. However, if affordable warmth was provided via DH then the actual heat demand may be higher.

Second, heat demand does not give an indication of the energy efficiency of a building. It may be that insulating the fabric of the property is a more beneficial route to reduced energy consumption than provision of district heating.

The way that funding is allocated and tools are used to identify areas of high heat demand does not align with the vision that local government are setting out in relation to fuel poverty.

4.2.3. Strategic approach

Larger DH schemes that expand across a town or city are likely to bring greater economic and environmental benefits (Woods et al., 2005). Therefore, for the strategic development of district heating, a city must have a plan for wider expansion and interconnection of smaller schemes. This approach requires a strategic energy plan for the city in terms of a phased roll-out of district heating. Schemes linking dense housing, commercial sites such as shopping and leisure centres and potential heat sources from industrial and waste heat sources are needed. This may require a form of 'cross-subsidy' between the most commercially viable sites with high heat-demand densities (e.g. commercial development) and other sites (e.g. domestic housing) that offer wider social and environmental benefits.

"The council is currently very keen to invest in something like this to obviously generate revenue so we can maintain our level of governance around how it is developed in the future. We don't want to just give it away to a developer who just wants to cherry-pick." [LA3]

This type of development could be facilitated by recycling the profits from commercial schemes into those that require more

underwriting for investment, or by the use of larger heat loads to act as anchor loads for wider expansion of the network in the future (e.g. public-sector buildings like hospitals or universities).

This strategic mixed approach was clearly an ambition for some of the city-based local governments in the study, who were aiming to allow future strategic expansion of initial schemes, to keep heat pricing affordable for residents and to retain profits where possible within the government.

However, within our analysis there was no evidence that this strategic approach had progressed from ambition through to delivery.

> "We have certain key areas in [the city] that we want to look at for putting a district heating network across [the city], you know, almost like a web approach with the areas that we look to target, but we're really only at a discussion stage." [LA3]

The strategic approach brings additional challenges, including that of developing schemes with multiple partners and/or heat demand users.

> "So I suppose we are in two minds about that because on the one hand it is very tempting to get someone to come in and just make the investment and own and operate and we will just take the energy, presumably at reduced costs for the agreed time. But we can access finance much cheaper than a lot of other companies who would probably want to buy into it in another way. So it's likely to be a partnership instead of someone just coming in to invest and say yes, that's how we sell energy. But yes, there are lots of different ways of doing it and we haven't got a preferred one at the moment." [LA2]

There are significant benefits for local government in that they can take ownership of schemes and lead the direction to meet their priorities.

> "[We are] very keen to have a stake in whatever we build so we're looking to invest in it" [LA2]

4.3. Role of other actors in supporting local-government led visions for DH development

Discussion so far has focused on the role of local government in leading the shared vision for DH, but other local and national stakeholders need to buy into these visions for successful schemes to be delivered. In the development of district heating there are necessarily roles for actors other than those in local government. In our interviews we gathered perspectives from a housing association, a gas network operator and two large energy companies. In terms of specific projects related to district heating, none of these actors are investing or taking specific strategic action. They are aware that change in heating supply systems is likely over the coming years and are exploring their options. The business risk is much higher for the network operator, although any significant uptake of district heating would impact on energy companies as well. All the companies interviewed see a strategic move into district heating as necessary to compensate for reduced use of the gas network.

> "District heating has got a potential role to play within that because actually we're going to need a wider portfolio of energy within the national and the local mix than we do at present. And, there is a role for district heating as one of the planks of that." [NO]

While this actor was supportive in theory, there was no evidence for action on their part.

> "We understand the technical potential for district heating and

providing and improving things like waste to energy district heating. We can see the technical case, but the commercial case really does require big deal collaboration between local governments to really up the ante with regards to district heating in the UK." [EC2]

The energy companies appear to be waiting for public-sector actors to lead development, de-risking their involvement later. In addition, the energy company's interest in DH was primarily about meeting regulatory requirements for fuel poverty reduction by identifying the best social housing schemes in which to install DH.

The housing association that was interviewed was very interested in DH in support of providing affordable warmth for its residents, but because its housing stock is geographically disparate, it is unable to take the lead on a scheme and is looking to the local government for coordination of area-based schemes.

The prevalence of the funding-driven and commercial approaches shows that local governments are struggling to go beyond 'stand-alone' projects. The strategic mixed approach features mainly as an ambition for most local governments at this stage.

4.4. The role of national policy in enabling local governments

The interviewees consistently highlighted barriers that were preventing the adoption of the more strategic mixed development approach that many of them desired. Table 3 details each of the actors' comments on the restrictions of the type of development approach they had adopted. For local governments, two key barriers came out throughout the interviews.

First was a lack of staff resource: budget cuts (which are currently significant as a result of the government's austerity measures) and regular restructuring meant that there was no internal capacity to invest in crucial activities such as stakeholder engagement to gain buy-in for potential projects or to build the necessary institutional infrastructure to support project development. Knowledge and experience of DH development is rare in the UK, particularly within local governments, but also amongst energy system actors more generally. This means that external expertise must be bought in to take projects forward and, as a result, greater time and resource is required to gain wider stakeholder buy-in.

> "The city council is undergoing major changes in terms of budget cuts and senior management. They're restructuring. …We may have to start… well, almost start over again, convincing the new senior management team that this is the right thing to do." [LA3]

Second, non-local government actors highlighted the challenges of uncertainty and high risk surrounding the long-term future of DH in the UK. At present projects must compete economically with the existing infrastructure of the gas network and individual building-level boilers. There is also no clear vision of where the future energy system is going to go in terms of the energy efficiency levels of buildings and the implications of this for the long-term heat demands upon which DH business cases rest. Uncertainty and risk was felt to be too high to make financial investments at present (BRE et al., 2013).

In this context, the challenging new role that local governments are taking on in coordinating development of DH has been recognised at the national policy level through the establishment of the Heat Network Delivery Unit (HNDU) within the UK Government's Department for Energy and Climate Change. The support and funding offered by this unit has undoubtedly stimulated increased interest in the potential of DH from local governments. All of the local governments interviewed were new to the process of DH development and clearly valued the support and guidance available from HNDU. It also offered them connections to other local governments facing similar challenges around DH

development, allowing peer-learning relationships to be built for sharing experiences on key issues such as financing of schemes, business models and governance.

However, despite the local governments' desire to take on a strategic approach, the support from HNDU did not enable them to move closer to achieving this. Potential social benefits are not recognised explicitly in the funding application process, with the commercial profitability of schemes being emphasised in the criteria for viability. This was reflected in the experiences of the local governments interviewed in this study, with one local government explicitly including DH within their fuel poverty action plan, but omitting it as a factor for consideration in their energy master-planning specification to consultants. This mis-alignment of local actors' motivations and national policy may hinder mixed-use strategic approaches, where many local governments do not have the capacity, resource or agency to stray from the nationally encouraged delivery approaches.

The issue of lack of internal staff resource is also not addressed by the HNDU support offered. Local coordination and facilitation are important for developing an understanding and appreciation of the potential of DH amongst local stakeholders. HNDU's policy of encouraging widespread commissioning of reports from consultants is succeeding in bringing in expertise on DH, but is not building the capacities within the governments for long-term activities.[3]

> "I do understand for the really early stages and the very specific bits of work that you want to work with consultants who know how heat networks operate but we just want to use our project management team to project manage this so that we've got the project management expertise from [LA2] and the understanding of where our procurement rules are but also to build that expertise that would then allow us to do more in the future." [LA2]

Given the seeming importance of key 'champions' for driving forward scheme developments (Hawkey et al., 2013), it is possible that, without addressing the problem of staff resource alongside enabling access to consultants and expertise, the extensive heat mapping and feasibility studies will not lead to project delivery, let alone longer-term strategic planning of DH systems.

In addition, there seemed to be an indication that there were not enough experienced technical consultants available for all the feasibility work, suggesting that there may be a skills gap in this area.

5. Discussion

The interviews reveal that local governments are clear about their visions for DH, and are aiming to engage in schemes that can deliver multiple forms of value across a range of economic, social and environmental objectives. Their broader appreciation and articulation of the value of DH as an energy infrastructure offers an opportunity to establish alternative business models which could unlock increased levels of deployment. The unique nature of local governments, situated within the public sector with an ability to link multiple forms of value, puts them in a position to bring about a greater variety of schemes beyond just the most commercially viable, delivering benefits for national targets around growth and carbon reduction.

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[3] In contrast to HNDU's approach in England and Wales to focus on local level consultant reports, the Scottish Government has developed a heat-planning map for the whole of Scotland. Local authorities in Scotland can therefore access the heat mapping information without needing to commission a consultant's study. However, similar to England and Wales, the capacities and resources available to local authorities are still constrained for using this information to deliver new schemes.

The ambitions and aspirations of local governments to move beyond an opportunistic approach towards a locally-led, strategic approach that delivers multiple objectives were clear. Other local actors were also looking to local governments to offer the leadership to enable projects to be taken forward (e.g. housing association and energy companies). This goal is supported by lessons from Denmark which highlight the benefits of a local strategic, planned approach for opening up a broader range of opportunities, such as the use of DH for thermal storage or balancing intermittent renewables (Chittum and Østergaard, 2014). Current UK policy advocates the development of heat maps and energy master-plans, which could potentially set the foundations for a strategic approach to DH development. However, this needs to be fully integrated into local planning policy and development plans, and delivered by an empowered local government with the local political agency and trust to enable cooperation across the required local stakeholders and consumers. In addition, master-planning should incorporate social and environmental criteria in order to reflect the importance of these aspects in local government visions. An area of further research would be how local strategic energy plans for low-carbon heating might improve the rate and scale of new DH deployment in a learning country context.

This work has highlighted that, in practice, the challenges of limited staff and financial resources within local governments often restrict the realisation of their full ambitions. Local governments are reliant on support mechanisms from national government to build up their capacities and skills, as well as to unlock some of the institutional barriers and obligations preventing delivery of schemes. Current national government policy has begun to tackle these challenges, but with limited success so far.

The focus by HNDU on the use of consultants is preventing the development of expertise or capacity within organisations. The capacity of local government in terms of staff resource, knowledge and experience is crucial to them taking on a strategic coordination role, and in some cases a delivery role.

Peer networks to enable sharing between local areas could be beneficial in this respect, for example through the Core Cities network (Core Cities, 2013). In recent years, frequent changes of funding schemes and incentives for DH have undermined the development of schemes seeking to tackle fuel poverty and disincentivised long-term planning. Many local governments felt reliant on these funding schemes for enabling investment in their fuel-poverty driven projects where commercial returns were not expected. Given the complexity and long lead-in times of these projects, the changes in support meant that schemes could be undermined after significant amounts of work had already taken place. Long-term policy is needed to reduce investor uncertainty.

National government policy currently focuses primarily on encouraging leverage of private financial investment in schemes by demonstrating potential for a commercial return. However, this focused approach, without consideration of the longer-term outlook for the city or scale of the project, could lock out future opportunities for expansion. A focus on the development of local heat strategies, such as that taken by the Scottish Government (Heat Network Partnership for Scotland, 2015), could be one way to give long-term signals for investors about potential beyond the most commercially obvious sites, although these must have accompanying powers to enable the enforcement and delivery of strategic projects.

In considering how DH may transition from a niche to the mainstream in learning countries, we note that there is a clear disconnect between long-term local government visions and the decision criteria and development approaches that they take in the short-term. The strategic (mixed) development approach is most likely to deliver the values inherent in local stakeholder visions, but, as we discuss, there are a number of barriers and this approach does not align with the vision of other actors that are

needed in moving forward. Moving beyond the current opportunistic approach to development would require challenging traditional financial investment logics and empowering local governments and other public-sector organisations to stretch their processes for demonstrating value for money. One option might be to adopt socio-economic cost benefit analysis (Chittum and Østergaard, 2014). Another possible option could be the use of social accounting methods to provide an evidence base from one project for input to future projects, an area which deserves further exploration. Exploring and formalising these types of approach in the UK context could enable more projects to be deemed viable and pave the way for greater links between energy and fuel poverty policies. While these options would probably take a while to embed in institutions, quicker wins could be achieved by including more nuanced criteria in funding for DH feasibility, offering procurement advice, and supporting shared learning among local actors to increase their capacity to deliver DH projects.

6. Conclusions and policy implications

In this work we have provided analysis of and insight into the UK's experience in supporting the development of district heating. We have investigated aspects of this over a period of fast change for key local and national actors involved in driving uptake of DH in a 'learning country' in order to draw out policy recommendations for other learning countries in Europe.

We have assessed the political and practical drivers affecting DH development at both the national and the local levels and highlighted the importance of recognising that local actors are often seeking multiple types of value. Enabling long-term strategic planning to develop energy infrastructure of this kind must allow the realisation of local visions, which often include more nuanced objectives than those that are solely economic.

If district heating is to deliver the significant carbon reductions for the heating sector that are necessary to meet climate targets then learning countries must adopt policy measures that encourage local actors to develop strategic city-wide heat networks. National policy measures to support innovations in DH 'learning countries' need to support the visions of local actors that are taking on new roles in the energy system. They should take into account social and environmental criteria, and recognise the need for local resourcing and powers to enable strategic development and expansion of schemes.

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