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The role of actor-networks in the early stage mobilisation of low carbon heat networks ☆

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HIGHLIGHTS

- Low carbon heat networks (LCHNs) reduce carbon emissions from heat production and reduce costs.
- Yet market issues and local government cut backs undermine successful delivery of LCHNs.
- Local authorites are charged by government with deploying LCHNS but are not well placed to do so.
- Policy makers need to 'prepare the ground' for LCHN deployment through policy and incentives.

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ABSTRACT

Low carbon heat networks (LCHNs) offer great potential for carbon and heating cost reduction. Despite these benefits, LCHNs provide for just two per cent of heat demand in the UK, when estimates suggest they have the potential to provide for around 43 per cent. These low levels of LCHN provision are in stark contrast to the Nordic nations which exemplify some of the highest quality and most extensive heat networks in the world. It is within this context that the Pioneer Cities project (the project) was launched by the UK government to help local authorities overcome barriers to the deployment of LCHNs. This paper reports the findings of an evaluation of this project, drawing on 86 interviews across five local authorities, analysed using elements of Actor Network Theory (ANT). The evaluation found that the project's success has been limited. Participating local authorities have encountered challenges regarding marketisation, public sector retrenchment and inexperience in mobilising LCHNs. These factors militate against the formation of the robust actor-networks required to deploy LCHNs. Analysis using ANT reveals insights into why LCHNs remain elusive in the UK and suggests that policy makers need to strengthen local authorities' ability to lead and deliver complex infrastructure projects.

1. Introduction

Heat networks (HNs) - systems for distributing heat generated in a centralised location for residential and commercial heating requirements- are an important part of low carbon transition plans across Europe, especially in countries pursuing nuclear phase-out policies (World Energy Council, 2012). They have also been identified by the UK government as an important part of the UK's future low carbon energy supply (DECC, 2012c).

Governmental commitment to HNs in the UK and elsewhere stems from a recognition of their potential benefits. They are well suited to densely populated areas and can reduce carbon emissions when deployed in these environments (DUKES, 2012). A further benefit is that they can be powered using a variety of fuels, including lower carbon sources such as biomass and energy from waste. HNs are also cost-effective compared to individual renewable technologies and have the potential to reduce energy costs for consumers (DECC, 2012a, 2012b, Poyry, 2009; Lund et al., 2010). Indeed, the UK Committee on Climate Change (UK CCC; 2010) stated that where HNs utilise low carbon fuel, they represent one of the most cost-effective carbon abatement measures available.

The promotion of urban HNs, especially low carbon networks, is a priority of the European Commission and of many European countries, yet the proportion of total heat demand served by heat networks varies between European countries, with a higher

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proportion in eastern and northern Europe than the west and south (Goodchild, 2015). The Nordic countries in particular possess some of the highest quality, most extensive heating networks in the world, with the potential for exporting technology and consultancy elsewhere.

Contrary to the Nordic experience, HNs of any significance are comparatively rare within the UK, providing for just two per cent of heat demand (DECC, 2012c), when recent estimates suggest that they have the *'technical potential to supply up to 43 per cent of heat demand…by 2050'* (DECC, 2015a).

There are various historical, technical, financial and organisational reasons for this low provision and it is within this context that the Pioneer Cities project (the project) was launched by the UK government in 2013, with the aim of helping to address key barriers that local authorities (LAs) encounter during the early stages of HN development and that often prevent deployment. This is not to suggest that the UK is the only country to experience challenges in the implementation of HNs. Indeed, even in the Nordic countries which exhibit the best quality networks, the drive for greater efficiency, consumer accountability and for carbon emission reduction still continue (Goodchild, 2015). However, the focus of this paper is on the UK experience as an example of a country that faces multiple barriers in mobilising heat networks and as such, can generate lessons for other countries with little history of HN deployment but that are considering utilising them to help decarbonise the heat supply. The learning to emerge from the UK example may also be of interest to countries considering expanding or renewing existing HNs, including, for example, Eastern European states seeking to modernise or replace existing HNs put in place during the Soviet era.

To help galvanise HN development in some of England's major cities and generate exemplar schemes, the project involved the allocation of grant funding (of between £200,000 and £300,000 per city) to five English cities to support the early stage planning and development of HNs powered by low carbon fuel sources (LCHNs). The funding could be used flexibly by the cities but was generally used to hire consultants to produce feasibility studies for new or extended HNs.

The project was developed in recognition of the range of systemic and practical challenges faced by LAs in developing LCHNs in the UK, as documented by Ambrose (2013); UK CCC (2010); DECC (2013); Heat and the City (2011) and Kelly et al., 2010, amongst others. These sources identify four core challenges:

1. Substantial project development costs (in addition to capital costs) including: feasibility studies, attracting finance, master planning and legal advice.
2. Lack of necessary skills and expertise within LAs to deliver such projects, especially in the absence of established procedures.
3. Obtaining funding to cover capital costs for the implementation of HNs, particularly in the context of reduced LA budgets since 2010.
4. Little direct ownership over existing energy infrastructure. In some cases, the ownership and on-going responsibility for existing HNs has been transferred from LAs to private sector bodies.

Each of the five participating cities was at different stages in the development of plans for LCHNs and had varying levels of relevant experience. For example, two of the cities had existing HNs that they wished to expand and de-carbonise, whereas others had no history of implementing and operating them at all. The precise nature of the barriers faced therefore varied between cities and contexts.

The original research objective was to develop an understanding of the extent to which the project helped the cities to overcome both the general and the context specific barriers they faced in developing LCHNs. A secondary focus was to better understand the processes that LAs worked through in pursuit of LCHNs.

Key to the mobilisation of infrastructure projects, such as LCHNs, is the ability of the lead organisation to forge and sustain effective networks that bring together all the actors necessary to enable development or to at least establish its feasibility (Bulkeley et al., 2006). Identifying the actors required is a challenge in itself, and there is no established model for HN development, especially in the UK where there has been and continues to be experimentation with different organisational forms (Heat and the City, 2011). Once a configuration has been agreed upon, the resultant actor-network must find a way to work within and around the various contextual constraints it faces in achieving its goals (King et al., 2011).

While previous research into the mobilisation of HNs has explored the processes involved, focussing heavily on the economic challenges (Hawkey et al., 2013), there has been little consideration of the *'work done'* within those processes to enrol key actors and draw them into a stable configuration or actor-network capable of delivering LCHNs. This paper draws on data that provides insights into the attempts of LAs to enrol key actors into such a network and the relationship between this and their effectiveness in mobilising HNs. The paper therefore contributes towards addressing a gap in our current understanding of the factors that can inhibit HN development.

This paper also recognises that LCHNs represent a'double challenge' in the sense that HNs are challenging enough to mobilise but those that utilise low carbon sources are more complex still (DECC, 2013; King et al., 2011). The specific challenges involved in mobilising LCHNs, as socio-technological innovations, have received little attention in the existing literature, which predominantly considers the development of fossil fuel powered networks (see Hawkey et al., 2013; Williams, 2010).

The innovatory aspects of LCHNs in turn suggest the use of appropriate socio-technical theoretical frameworks to contextualise the processes involved in their development. In this paper Actor Network Theory is applied as a framework through which to understand the work done in the formation of the actor-networks necessary to mobilise LCHNs and if appropriate, where they are falling down in pursuit of this goal.

This paper comprises of six sections, including this one. The following section outlines the analytical framework underpinning this paper. There then follows a brief explanation of the methodology employed before the main findings are set out in the fourth section. Section five provides a discussion of the results in the context of the analytical framework and the paper ends with key conclusions and policy implications.

2. Analytical framework

HNs are the outcome of the construction and stabilisation of a broad collection of human (social) and non-human (technical) elements. As such, a key question for those seeking to understand how new HNs are brought about relates to the processes by which these different elements are drawn together to create a new entity in the shape of the HN or, in this case, the LCHN. In this vein, Hawkey et al., 2013 conceptualise HNs through allusion to actor-network theory (ANT), with particular reference to the need to consider *"the work done to configure the heterogeneous components of the system with the aim of establishing a stable foundation for urban heat and cooling networks"* (pp.23).

ANT is highly relevant to HN development, being mostly concerned with understanding how scientists and technical experts