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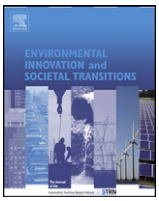

District heating in the UK: A Technological Innovation Systems analysis

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ABSTRACT

District heating infrastructure could contribute to the UK's energy policy goals of decarbonisation, renewable energy deployment, tackling fuel poverty and ensuring energy security. However, while a number of schemes have been developed over the last decade, deployment of the technology remains limited. This paper adopts a Technological Innovation Systems framework to ask what the principal challenges are to significantly scaling up the deployment of DH in the UK. While district heating networks are inherently local infrastructures, they are positioned in regulatory and market contexts organised at larger spatial scales, making geography an important factor and coordination across spatial scales an important policy area for accelerated deployment.

1. Introduction

The UK has a long and chequered history of attempts to develop district heating (DH) systems – networks of insulated pipes which deliver heat via steam or hot water to serve the space and water heating demands of multiple buildings (Russell, 1993). UK Government and Devolved Administrations (particularly in Scotland) state that accelerated roll out of the technology would contribute to achieving national energy policy goals (Department of Energy and Climate Change (DECC), 2012; Scottish

Abbreviations: CHP, combined heat and power; CHPA, Combined Heat and Power Association; DECC, Department of Energy and Climate Change; DH, district heating; ESCo, Energy Services Company; GLA, Greater London Authority; HCA, Homes and Communities Agency; IEA, International Energy Agency; LA, local authority; LEP, London Energy Partnership; RDA, Regional Development Agency; SDC, Sustainable Development Commission; TIS, Technological Innovation System; UK, United Kingdom.

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Government, 2011). However, given a history of failed attempts to establish far-reaching DH programmes in the past, and the small share of DH in the space and water heating market (around 2% in comparison with Denmark's 47% and Sweden's 55%, Euroheat & Power, 2011), the extent to which DH will be deployed, particularly on the timescales established by 2020 carbon and renewable energy targets, is highly uncertain. This paper's central question, therefore is: "what are the principal challenges to significantly scaling up the deployment of DH in the UK?"

While the technical components of DH are relatively mature, having been developed over forty years of widespread use in Scandinavia (Dyrelund and Steffensen, 2004; Ericson, 2009; Rutherford, 2008; Werner, 2010), their deployment in the distinct physical, social and institutional contexts of the UK presents new challenges requiring innovative organisational, contractual and commercial solutions. Two features of the UK context are important here. First, while DH is an inherently local infrastructure (limited to high density areas by financial, rather than physical, constraints, Roberts, 2008), it is nonetheless situated in systems of regulation and government, resource flows and markets which operate at local, regional, national and international scales. Liberalisation and privatisation of the UK energy market have altered the scope for public authorities to direct development of energy systems towards social and environmental goals, and have consolidated existing assets under the control of a small number of companies whose international scope challenges development of locally-specific systems (cf. Rutherford, 2008). Secondly, shifts in the role of local government, from service provision to enabling others to provide services (Bulkeley and Kern, 2006), accompanied by a proliferation of public and private service providers (Cook, 2009; Leach and Percy-Smith, 2001) has reduced the in-house capacities of local authorities to plan, design and/or operate technically and financially viable schemes. Both features contrast with the municipal energy companies which developed DH in Sweden and Denmark in the twentieth century (Dyrelund and Steffensen, 2004; Summerton, 1992; Werner, 2010). While the UK is arguably at an extreme end of these spectrums, given its early energy market liberalisation and history of centralised control over local authorities (Wilson and Game, 2002), these broad issues reflect the direction of travel in other European countries (Ericson, 2009; Monstadt, 2007; Rutherford, 2008). Addressing DH in the UK can therefore shed light on the processes by which contemporary municipal actors can orchestrate or influence local responses to sustainability challenges, and thereby contributes empirical material to a growing literature on the roles of geography in innovation processes (Geels, 2011; Hodson and Marvin, 2010; Truffer and Coenen, 2012).

The paper is organised as follows. Section 2 introduces the Technological Innovation Systems (TIS) analytical framework and source material used. The following three sections apply the analytical framework, Section 3 describing the structure of the TIS, Section 4 detailing the TIS's functional pattern and Section 5 discussing inducement and blocking mechanisms, and key policy issues. Section 6 discusses implications of the analysis for DH in the UK, and draws conclusions.

2. Research approach

2.1. Theoretical framework

Carlsson and Stankiewicz (1991, p.111) define a Technological System as "a network of agents interacting in a specific economic/industrial area under a particular institutional infrastructure or set of infrastructures and involved in the generation, diffusion and utilisation of technology." Markard and Truffer (2008) unpack this definition into a *production* system which slowly evolves, accumulating incremental innovations, and a Technological Innovation System (TIS) which brings about radical innovation (which may include the establishment of entirely new production systems). TIS provides a suitable framework for addressing the central question of this paper, for while DH is a well established technology in other countries, new commercial and organisational forms for the development and operation of heat networks are central to the prospects for greater deployment of the technology, which represents a radical break with incumbent heat (gas distribution networks) and power (centralised electricity systems) technologies, in the UK.

The emphasis on the *systemic* nature of a TIS highlights the roles of multiple actors and the networks through which they interact, in mutual learning and knowledge creation which underpins technological change, in contrast with a simplified "point source" view of innovation (Coenen and Díaz López,