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Energy supply and urban planning projects: Analysing tensions around district heating provision in a French eco-district

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HIGHLIGHTS

- Analyses of tensions in the choice of energy supplies for eco-districts.
- District heating networks can be vehicles of renewable energy.
- District heating networks are threatened by drops in energy consumption.
- Energy supply issues oppose urban planning and energy policy in municipal departments.
- Technical and financial adjustments can be made by the municipality to justify its energy choices.

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ABSTRACT

Through the analysis of energy supply choices, this article explores the way in which energy priorities and their climate-related features are incorporated into urban public policy. These choices must take account of different factors, as is the case with district heating, which is justified as a vehicle of renewable energy while subject to pressure in eco-districts because its techno-economic balances are destabilised by falls in demand. Our study focuses particularly on the city of Metz (France), which has chosen district heating as the primary source for provision for the municipal area and for its first eco-district. We analyse the tensions within these choices, with particular attention to the way in which they are negotiated inside municipal departments and with the local energy operator. This enables us to explore the tensions in defining the scale that governs decisions and the linkages between energy-related and urban priorities.

1. Introduction

The development and modernisation of district heating and cooling networks in cities have been prioritised by the European Commission within the framework of a masterplan for a European energy network (European Commission, 2010). The International Energy Agency also stresses the importance of decarbonising these networks (International Energy Agency, 2012). District heating networks are indeed a major instrument of renewable energy policy in urban areas, because they offer the possibility of incorporating alternative energy into their fossil energy mix (Holmgren, 2006; Kelly and Pollitt, 2010; Hawkey et al., 2013; Rocher, 2013). At the same time, their characteristics of Large Technical Systems imply very large infrastructure costs and a need of high energy consumption to in order to pay their way (Hughes, 1983; Summerton, 1992). As a result, there are two sets of contradictions inherent in the policy-making process: firstly between the advantages of district heating in terms of the use of renewables and the desirability of networks with very high infrastructure costs (Rocher, 2013); and secondly between the need for a certain level of guaranteed consumption to ensure economies of scale and the technical functioning and policy push for reduces consumption.

In order to understand the way in which local authorities handle these contradictions in their urban energy choices, this article analyses the case of the city of Metz (France), which has much long-standing experience in the field of heating networks. Metz has been developing a district heating network for many years through a local operator owned by the municipality – a rare situation in France – and is now extending it to its first eco-district. Here, we propose to retrace the ambivalences and tensions in this energy supply choice related to new municipal climate change and urban planning objectives. This led us to focus more particularly

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on interactions within the Municipality, and between the Municipality and its local energy operator, with the objective of understanding how the inherited district heating infrastructure impacts the energy supply choices in an evolving urban context.

This article is divided into four further sections. In Section 2, we look at existing studies to understand the connection between the development of low-energy buildings and district heating systems. In Section 3, we describe the particular situation of the city of Metz and the importance of its local energy operator. This enables us, in Section 4, to analyse the decision to connect Metz's first eco-district to the district heating system. The latter is a source of tensions regarding the urban dimension of the energy system, and requires major adaptations, both technical and economic. In Section 5, we conclude with a summary of our arguments and put forward proposals relating to this connection between urban planning and energy.

2. District heating networks: controversial tools for reducing greenhouse gas emissions?

2.1. Large technical systems whose organisation is determined by the scale of their infrastructure costs

District heating networks are built specifically to distribute heat produced by one or more central energy sources for the domestic heating and hot water of multiple users. The heat is distributed – in the form of steam or hot water – by primary networks, underground pipes running below the streets, to a substation located at the foot of each connected building. Once the heat has reached these substations, a return circuit carries the heat-bearing fluid back to the production plant to be reheated. Secondary networks in the buildings distribute the heat to the end users. These systems are expensive. The cost of laying one metre of network has been estimated in France at between 1000 and 2000 euros, depending on a number of local factors (CETE de l'Ouest, 2011). District heating networks are so-called Large Technical Systems, i.e. sociotechnical systems that need to spread out to become more efficient, to offset the high fixed costs and to optimise supply and demand by increasing their diversity (Hughes, 1983). As Summerton noticed, district heating is specific because it operates like island systems, without long-distance interconnections (Summerton, 1992).[1] It differs from gas and electricity networks in that it is usually not concerned with continuous growth in scale, because it has no interconnections beyond the local scale, due to its high infrastructure cost. It does possess, however, all the characteristics of a large scale technical system, except for size (Offner, 1999), and can thus be described as a "local-scale Large Technical System".

These features of district heating imply strong links with urban planning. Indeed, urban layout often determines the extent to which buildings can be connected to the district heating system. To be technically and economically viable, these systems necessitate a high energy density, maximising consumption per metre of network. District heating operators therefore usually target dense areas, where energy demand is high (Kelly and Pollitt, 2010; Hawkey et al., 2013) and have historically been associated in France with large housing estates built in the 1960s (Rocher, 2013).

In addition to this need for energy density, there is also the necessity of balancing supply and demand as far as possible within a small area. Because of this, it is important to have a mix of uses in connected buildings. The energy demand from connected users should balance out both over the day and over the seasons (Hawkey et al., 2013). This means, for example, a combination of customers who consume primarily during the day – e.g. business premises – and others in the evenings and at weekends – such as domestic premises (CETE de l'Ouest, 2012). Writing more specifically about district heating from cogeneration, Kelly and Pollitt describe these systems as "bespoke technology". Running them requires ways of handling fluctuations in demand, for example by storage or alternative uses of surplus heat (Kelly and Pollitt, 2010). Because of their specificities, district heating systems thus depend greatly on the organisation of the districts they serve, in particular with regard to density and a mixture of user types.

2.2. Tool for decarbonising urban energy consumption

District heating networks are being adapted to changes in local authority attitudes to energy and to the development of climate policies. The forces at work in this adaptation of district heating infrastructures to respond to these policies provide a way to understand the connection between Large Technical Systems and energy and climate issues (Rocher, 2013) in the continuation of the debate on adaptation of Large Technical Systems in a changing context (Summerton, 1994; Coutard, 1999). Initially liberalisation (*Ibid.*; Graham and Marvin, 2001) and currently increasing political interest in the environment (Coutard, 2010; Coutard and Rutherford, 2013) are the main issues that impact Large Technical Systems. They destabilise the balance between supply and demand and the infrastructural fixed cost offset, requiring the Large Technical Systems, and here the district heating, to adapt.

Indeed, district heating networks are not central to the European Union's scenarios for achieving the 3×20 targets[2] and the 80% reduction in greenhouse gas emissions by 2050 (Connolly et al., 2014), but they are considered as a major tool to improve energy efficiency mainly by using high-efficiency cogeneration or installing heat pumps on the network (Lund et al., 2010). The Energy Efficiency Directive adopted in 2012 promotes efficiency in heating and cooling district networks and Member States shall take adequate measures for such infrastructure to be developed. District heating networks, particularly those driven by cogeneration plants, are thus seen as major ways for local authorities to intervene in the energy sphere (Rocher, 2013). They appear as fast and collective ways to achieve a significant level of renewables in the city consumption, by converting the energy mix in a heat production plant fuelled by coal and gas to biomass or residual energy from waste incineration, thus reducing dependence on a single energy source (Holmgren, 2006; Grohnheit and Gram Mortensen, 2003; Kelly and Pollitt, 2010). Indeed, compared to policy oriented through individuals to increase the renewable share of energy mix, negotiations are here centralised between the Municipality and the operator. Decarbonising the energy mix in district heating networks by this means is often the main way to increase the proportion of renewable energy in urban energy consumption. These new objectives can be considered as opportunities for district heating systems.

2.3. Rising difficulties associated with the pursuit of lower energy consumption

Apart from their renewable energy aspect, the 3×20 targets are about reducing energy consumption, in particular through energy efficiency. The pursuit of greater energy efficiency in

[1] However, production plants that use cogeneration are connected to the power grid.

[2] Voted through in 2008, the Climate and Energy Package requires European member states to set a target for 2020 of reducing both greenhouse gas emissions and energy consumption by 20%, and to produce 20% more energy from renewable sources.