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How Danish communal heat planning empowers municipalities and benefits individual consumers

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HIGHLIGHTS

- Danish district heating has cost-effectively reduced the country's emissions.
- Danish heat planning has been critical to the district heating sector's success.
- Danish heat planning confers substantial power to municipalities.
- Empowering cities offers significant benefits to cities and consumers.
- Danish planning practices can be implemented today in the U.S. and other locations.

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ABSTRACT

Danish municipal heat planning empowers municipalities to implement locally appropriate energy solutions that are the best fit for the locality as a whole and the individual consumers served. Supportive policies and actions at the national and local levels have encouraged heat planning that confers significant autonomy to local governments. By examining how power is distributed and shared by different levels of governments in the planning process, this paper investigates how comprehensive energy planning in Denmark has supported the development of highly cost-effective district heating systems. Lessons from the Danish approach to heat planning are considered for their relevance to the United States, where significant technical district heating potential exists, yet remains well outside the typical energy policy discussions. While the specific Danish political context may not be transferable to other locations, the practical aspects of power sharing, socio-economic cost–benefit analyses, and communal decision-making may inform approaches to local heat planning around the world.

1. Introduction

In the past two decades, cities and nations around the world have established aggressive new goals for reducing harmful greenhouse gas (GHG) emissions. Increased deployment of renewable energy generation is necessary to meet these goals, but such resources are not always cost-effective when compared to other alternative dirtier energy resources, especially at the individual-building scale (Chow, 2009; Dyrelund and Overbye, 2013).

Many energy system analysts identify district heating (DH) networks as a critical prerequisite to cost-effectively integrating the zero- and low-emissions energy technologies necessary to meet GHG reduction goals (Baber and Damecour, 2008; Chow, 2009; Dyrelund and Overbye, 2013; Lund et al., 2010; Østergaard et al., 2010; Østergaard and Lund, 2011; Voss and Thorsen, 2012). DH networks aggregate loads and provide economies of scale for a wide variety of heating and cooling supply streams, as well as provide balancing capabilities for the electric system when integrated with technologies such as combined heat and power (CHP) (Lund and Østergaard, 2000).

The aggregating capabilities of DH systems reduce per-customer costs and make certain resources economical that would be uneconomical on an individual customer scale. Costs of new heat resources, such as drilling a geothermal well, are the same whether the resource serves one house or many, and DH helps spread those costs amongst a larger group of customers.

Denmark has done more than most countries to maximize the benefits of DH, which provides heat to about 60% of Danish households. DH has been critical to the decoupling its energy

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use from economic growth better than almost any other country in the world (Energistyrelsen, 2009; Lund et al., 2010; EIA, 2014). One analysis found that the increased use of CHP and DH in Denmark reduced CO_2 emissions in the heating sector by 60%, from 25 kg/m^2 of heated floor space in 1980 to 10 kg/m^2 in 2010, while another found that DH has reduced the overall nationwide emissions by 20% since 1990 (Christensen, 2009; Dyrelund et al., 2010).

Despite the many benefits of DH, few countries leverage its benefits extensively. Where excess heat from power generation and industrial processes is largely wasted in countries like the U.S. – where the average electric generation efficiency is 32% (Laitner, 2013) – heat plays an important role in Danish energy planning. Indeed, the Danish energy success story is largely one of heat: planning for it, distributing it, maximizing the efficiency of its production, and identifying it as a resource in situations where other countries view it as a useless or even environmentally harmful by-product. In particular, municipal heat plans and planning, which were first required by national law in 1979, have long been credited with providing the policy and regulatory framework that has underpinned the sustained growth of Danish DH (DEA, 2010; Kerr, 2009; Parajuli, 2012).

Heat plans are locally developed plans that identify the existing and future heat demand of buildings in a given area as well as current and potential heat resources. The planning process includes an assessment of which heat supply options are most cost-effective and appropriate to an area (DEA, 1998). The plans inform decisions about land use, DH infrastructure, and other relevant aspects of comprehensive planning (King, 2012; Larsen, 2013; Rand, 2009). In Denmark, it appears the presence of a stable heat plan helps foster long-term confidence in DH systems by reducing real and perceived risks to customers, heat suppliers, the municipality, and DH system owners. Denmark's 400 DH companies enjoy an average connection rate of 82%, which compares very favorably to that of other countries with high penetrations of DH (IEA, 2012). Many Danish municipal DH systems are currently expanding, reflecting an attractive investment environment and steady consumer demand supported by local heat planning actions (Dyrelund and Overbye, 2013; IEA, 2012; Larsen, 2013).

1.1. The national role in local energy planning

It has been widely noted that while early international efforts to address climate change focused primarily on the roles of nation-states, cities have recently adopted their own aggressive environmental goals, often absent corresponding action at the national level (Bulkeley, 2010; Rosenzweig et al., 2010). Additionally, the NGO community has increasingly focused efforts on local actors and their ability to make large strides toward environmental goals. Organizations such as the Rockefeller Foundation, the C40 Cities Climate Leadership Group, and the United Nations have identified cities as critical players in the race to reduce GHGs. However, it is also widely noted that cities' abilities to fully address climate change challenges and opportunities are frequently hampered by the structure of extant national policies (Bulkeley, 2010; Sperling et al., 2011).

In contrast, Danish energy policy tends to confer a high level of autonomy and flexibility to local energy actors to reduce GHGs and respond to climate change-related challenges. This is especially true in the development and planning of DH systems, where local decision-makers are clearly delineated as the chief arbiters of system design. However, this local power relies on a centralized policy and technical framework maintained at the national level. This framework includes policies such as national building codes and the nationwide transmission system maintained by Energinet.dk (Sperling et al., 2011).

Though the Danish energy story has long captivated academics and policymakers (Garforth International, 2009; Kerr, 2009; Sovacool, 2013), little academic attention has been paid to two significant aspects of Danish energy policy: the specific tools and powers granted by the national government to Danish municipalities that have resulted in the expansion and continued investment in cost-effective DH systems, and the unique autonomy of cities to make their own long-term decisions about their energy future as it relates to heat. Several published energy planning guides offer important suggestions for project development and local planning, but lack discussions of the best practices in long-term heat planning and local empowerment (Garforth International, 2009; King, 2012; DOE, 2009). Rising interest in DH around the world and a growing recognition that locally developed DH systems are critical to climate change mitigation efforts suggest that a detailed analysis of the Danish approach to heat planning would be a useful addition to the academic literature.

1.2. Scope of this paper

This paper's focus is how powers and responsibilities are bestowed to and used by local actors in Danish heat planning, and how those actors reflect and represent local priorities to best enable locally appropriate and cost-effective DH networks. It is argued that the flexibility granted to local actors helps to provide communities with the most cost-effective heating solutions available for *that specific community.*

The overall objective of exploring the Danish approach to such planning is to identify and better understand which characteristics are relevant and perhaps applicable to local, regional, and national policymakers in countries beyond Denmark. The target country for this particular paper is the U.S., but findings also apply to many other countries. This paper emphasizes the practical aspects of Danish heat planning that could ostensibly transcend specifically Danish constructs. For instance, the substantial taxes levied on energy products are not a focus of this paper, as Danes are generally more supportive of higher tax rates and a generous redistributive welfare state than citizens of other countries (Bay et al., 2013; Copenhagen Post, 2013; Diamond and Lodge, 2013).

The first half of this article examines the policies and practices that form the foundation of Danish heat planning. Section 2 summarizes the methods used to assess these policies and practices and presents the relevant historical and current policy context. Section 3 identifies the results of the investigation into these policies, including the current planning framework, and the powers, responsibility, and tools held by the main actors involved in Danish heat planning.

The second half of this article then examines the 'effects' of these policies and practices. Section 4 discusses and analyzes how the costs, benefits, risks, and rewards of heat systems are shared among actors. Section 5 explores how aspects of Danish heat planning might be useful to policymakers in the U.S. and other countries, and suggests some areas of further analysis.

2. Methods: Examining the Danish policy framework

Denmark's extensive DH sector is no accident, but was instead very intentionally pursued after the oil shocks of the 1970s, which especially affected households that relied solely on oil for heat (DEA, 2012). Prior to these policies, over 90% of the country's entire energy supply was based on imported oil (DEA, 2010). Afterwards, Denmark began a concentrated effort to increase reliance on domestic fuel resources and improve overall energy efficiency. While an alternative scenario heavily reliant on new