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Actors, networks, and translation hubs: Gas central heating as a rapid socio-technical transition in the United Kingdom

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ABSTRACT

To achieve UK government targets to reduce carbon emissions by 80% on 1990 levels by 2050 will require a radical shift in domestic heating practices, which are currently dominated by gas central heating,[1] installed in 82% of UK homes (Palmer and Cooper, 2014).

Using a socio-technical systems analysis, based on Actor Network Theory, this paper examines what can be learned from previous transitions in heating, in particular the series of changes which led from the majority of UK homes being heated by open coal fires in the middle of the twentieth century, to a very high proportion of gas central heating by the end of the century. Two stages of transition are investigated: the expansion of central heating use in the 1950s and early 1960s, initiated by new technology development by the coal industry, followed by the dramatic increase in the use of gas for home heating as the supply was converted to North Sea gas in the late 1960s through to the 1970s. How did a new technology (small bore central heating systems) spread rapidly and effectively, and how was a fundamental change to a natural gas fuel infrastructure achieved? What does this tell us about the establish of strong and stable heating networks, and what are the lessons for future transitions to low carbon heating systems?

1. Introduction

In the UK, a commitment to reduce greenhouse gas emissions by 80% from 1990 levels by 2050 [1] has intensified the focus on the main uses of fossil fuels in the country. Domestic space heating fuelled by natural gas is responsible for 11% of the UK's CO_2 emissions [2]. Britain's low-quality housing stock and reliance on natural gas are a clear focus for efforts to reduce emissions, with increasing pressure to achieve a "transition" to new forms of domestic heating that are less reliant on fossil fuels. Even though social historians of energy have been at the forefront of recasting our understanding of human energy use as socio-technical systems (e.g. [3–5]) analysis of previous experiences of domestic heating transitions in the UK remain limited. Historical analysis can provide insight "by identifying often-overlooked considerations among practitioners who propose and implement energy policies" ([6]: 106) even if, as Hirsh and Jones make clear, history does not "offer powers of prediction". With this in mind, we argue it is pertinent to consider the remarkably rapid and far-reaching introduction of gas central heating to UK households in the 1960s and 70s as a particular instance of rapid transition.

According to Sovacool, mainstream views of energy transitions imagine them, as "long, protracted affairs" such as the "switch from wood to coal or coal to oil" (2016: 202), yet few, if any of these transitions could be seen as either definitive, complete or temporally finite. Araújo [7] has elaborated on the lack of coherence in discussions of energy transitions, and the many competing trends and approaches to defining and understanding what a transition is. Sovacool [8] points out the importance of defining the scope and starting points of transitions and acknowledges that what may appear retrospectively to be radical transitions may be the culmination of a cohort of smaller changes. Understanding such transformations requires both the over-arching view of the sweep of history but also the detailed analysis of particular changes, the circumstances under which they occurred, their vulnerabilities and critical factors. Hence Mitchell's [9] Carbon Democracy gives us a broad picture of global energy geopolitics, while Lorkowski's fascinating account of the 20th century Berlin rental business for storage water heaters [10] shows us how socially-embedded technologies brought about widespread changes in domestic practice through planned as well as unexpected alignments between technological development, economic interests, domestic practices and political governance.

Given the now general consensus that energy systems, or elements

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[1] Throughout this paper, the term "central heating" refers to individual home heating systems which heat the whole dwelling.

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of an energy system, cannot be properly understood through a focus on technology or society alone, in this article we take a socio-technical approach to the dramatic transition in domestic heating seen in Britain[2] in the second part of the twentieth century.[3] This involved both a change from single room heating to central heating of the whole house and from coal to gas as the predominant heating fuel ([11]: 88).

To analyse this transition, we use socio-technical methods that fall under the general banner of Actor Network Theory (ANT) and associated approaches. In a communication in this journal Wong [12]: 106 advocates ANT as "a frame and mode of thinking about inter-disciplinary energy research". ANT is a loose grouping of analytical and methodological approaches that has developed since the 1980s [13] whose over-riding central concern is with how people, non-humans and materials interact to do things in the world. It aims to go beyond institutional or social analysis, laying aside the primacy of either technological, material or social relations and give them equal significance in our explanations of the world. It is one of few methodologies that allow us to conceptualise, describe and understand a whole system, or rather to understand a system holistically. In highlighting the interactions and links between diverse entities, it enables us to demonstrate how apparently stable systems come about, how they are maintained and how they might become unstable; in other words, to understand what a transition might be and how it might come about.

ANT is neither a restricted methodology, nor the only possible approach to understanding socio-technical change and stability (see [14,15]), but as a particular interpretation within Science and Technology Studies, it offers a useful approach for conducting historiographic research in this area. In this article, we consider an often overlooked moment in the history of British domestic heating when a large scale technological and social change was enacted. This work is complementary to Arapostathis et al.'s [16] analysis of historical transitions in the UK gas industry, which takes a multi-level perspective (MLP) on transition pathways and focuses on governance and institutions. It expands on the mention of the new markets offered by central heating in Turnheim and Geels' [17] discussion of the destabilisation of the British coal industry in the period to 1967.

Section 2 explains how we apply actor network concepts to the case of home heating in the UK. Section 3 outlines the methods used and introduces the primary sources which underpin the historical account of the transition from single room heating to central heating (in Section 4), and the move from a mix of heating fuels to a predominance of natural gas (in Section 5). Section 6 draws out lessons for future heating transitions and Section 7 reflects on the benefits of applying ANT. The conclusions are outlined in Section 8.

2. Understanding heating systems using ANT

In order to understand the transition in systems, we trace the relations between the diverse actors, including human and non-human actors (sometimes referred to as 'actants') using an approach inspired by Actor Network Theory (ANT). Our approach to heating systems starts with the identification of key actors, both human and technical, and of the links between them. Heating systems are complex networks including material objects, persons, institutions and organisations. They contain all the material connections between fuel source and heat delivery in the home, from power stations and gas drilling rigs, gas mains and electricity cables, through to heating pipework in buildings. The infrastructure linking fuel supply to heating equipment in the home is owned and managed by energy companies. Human actors associated with heating equipment thus include installers, manufacturers, designers, retailers, builders' merchants, regulators, etc. These people are linked together by professional networks and relationships of trust between buyers and suppliers, as well as by further technological infrastructures (transport, communication, regulation, etc.).

A heating system does not spontaneously develop and find itself in a house. A long chain of events and relationships have to be enacted for a heating system to emerge. In this article, we are concerned to understand the emergence of gas central heating as the dominant form of domestic heating in the UK in the 1960s and 70s. Which were the elements that enabled this transition from coal-fires to gas central heating with small diameter water pipework, how was the transition facilitated, and what are the insights that might be relevant for future transitions away from fossil-fuelled domestic heating?

The concepts of *translation* and *alignment*, as they are used in ANT, are important for this investigation. Callon [18] describes the process of translation taking part between the actors in a network. This involves one actor translating a network element for another actor in terms that are meaningful to the second actor (an example in the heating field might be a 1960s advertisement for central heating seeking to persuade householders that it is both desirable and affordable for their homes). The process of translation involves aligning the interests of a variety of actors, enrolling and mobilising allies so that they work together, strengthening the network [19].

An important influence on our analysis is the concept of the *heterogeneous engineer*, who "seek[s] to associate entities that range from people, through skills, to artefacts and natural phenomena" ([20]: 129), a figure that stands for the operation of translating between different elements of a multi-dimensional network. Because the notion of the heterogeneous engineer tends to conjure up an individual person, in our analysis, we coin the notion of a *translation hub*, to characterise a concentration of translation activities in one organisation which aligns the interests of a constellation of actors and creates stability in the network, in a similar way to the activities of an individual heterogeneous engineer.

Callon describes how *intermediaries* circulate between actors in a network and provide the means by which "actors define one another in interaction" ([18]: 135). Fuel supplies and information in the form of texts (e.g. instruction manuals, energy bills) are examples of significant intermediaries in heating networks, as are payments for equipment and fuel. Similarly, infrastructure and equipment afford specific practices and relations. Such objects materialise the relations between elements that can pre-empt the potential for future uses, as particular pieces of equipment or relations between consumers and providers afford restricted options for change. We should be alert to the relations that are fixed through the particularities of a heating system in different contexts, and the forms of path-dependency implicated in the system [21]. Such materials help to stabilise the network, whose practices and procedures can be described and imagined as a stable state.

ANT examines why some networks are more stable than others by examining the alignments between actors and sees stability as based on a process of *enrolment* into the network rather than coming from the state, markets or social institutions ([12]: 107). We use ANT methods to describe the relatively stable states for domestic heating before and after the transition to gas-fuelled central heating, and the transition from one to another, asking: how have stable networks been achieved in the historical transition? What were the differences between the stable configurations actually achieved and other options that were available but did not become widely established? How were the interests of different actors aligned, and are there actors playing the role of "heterogeneous engineer" to achieve this? Can we see a collection of such "engineers" working together as a kind of "translation hub"?

3. Methods

The heterogeneous networks associated with home heating are reflected in the varied evidence we use to trace them. The focus of the

[2] The focus is on Britain rather than the whole of the UK since the situation in Northern Ireland, where natural gas was only introduced in 1996, is rather different.

[3] Fouquet [11]: 433 shows an increase in effective domestic heating in the UK from 17.3Mtoe in 1950 to 47.9Mtoe in 2000.