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UK natural gas system integration in the making, 1960–2010: Complexity, transitional uncertainties and uncertain transitions

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ABSTRACT

The article focuses on the development of the natural gas system in the UK from its establishment to the present day, as an analogue for the challenges of integrating large, infrastructural technical systems for a sustainability transition. It is inscribed within the multilevel perspective approach yet concentrates on 'system integration' as a complex and uncertain socio-technical process. The case study focuses on two interrelated transitions in order to provide a co-evolutionary and comprehensive understanding of the uncertainties in system development and integration faced by the UK natural gas industry. Through thick historical analysis of the gas grid transition we provide insights into the sustainability of similar network technology transitions. At the same time we contribute to complex systems modelling approaches (broadly defined to include quantitative and qualitative modelling) by unravelling the roles and agencies of actors, institutions and technologies in the modelling and making of sustainability transitions.

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1. Introduction

This article addresses transitions of the UK natural gas network between the late 1950s and 2010. We focus on the system integration of natural gas, in order to analyse the complexities and uncertainties as they appeared to contemporary practitioners (mostly engineers, policy makers and politicians) during the periods of transition and to draw out implications for complex systems modelling. We have identified two main periods of historical importance in the development and integration of the network: the first from the late 1950s to the mid-1980s and the second from the mid-1980s to the present. The introduction of natural gas in the British context was preceded by radical changes in the gas industry that resulted in the nationalisation of the industry in 1948 and changes in the technologies of production of manufactured gas (the so-called 'town gas') (Arapostathis et al., 2013). This provided the context for the first transition that we analyse, in which the state-owned gas industry reorganised itself to make a transition from dependence on a manufacturing process with a single feedstock, coal, to a highly networked industry now based on natural gas. There was then a further transition, beginning in 1987 when the industry was privatised and re-regulated and became more international. In these two periods, we show how the physical infrastructure was co-constructed and co-evolved with changes to the system's political and social components. We suggest that focusing on a biographical analysis of the network yields valuable insights into both the dynamics of these developments and into how social and political changes shaped the network's technical characteristics (see Section 2).

The article has the following structure: Section 2 describes the analytical approach; Section 3 reconstructs the changes in governance patterns that led first to nationalisation and then triggered and directed the transition from manufactured town gas to natural gas in the first period of the study; Section 4 explores the conversion to natural gas as a complex, purposeful transition in the face of uncertainties associated with increased complexity; Section 5 examines the second transition, involving regime change and network developments from the mid-1980s to 2010; and Section 6 concludes.

2. The analytical approach

The analysis starts from the premise that this system integration was a continuous process; thus by adopting a transitional perspective we can understand it better through studying the structural changes and historical contingencies experienced. In this context, the system integration is viewed partly through the lenses of the 'multi-level perspective' (MLP) of socio-technical transitions (Geels, 2002, 2005, 2004; Geels and Schot, 2007) that stresses the co-evolution and co-constructive character of network technologies with changes in the political, policy and regulatory regimes. The MLP approach focuses, mainly but not exclusively, on past socio-technical transitions of infrastructure networks like energy, water, transport or sewage. MLP scholars stress that transitions occur in technological systems that comprise 'a cluster of elements, including technology, regulations, user practices and markets, cultural meanings, infrastructure, maintenance networks and supply networks' (Geels, 2004; Lawhon and Murphy, 2012). While the MLP approach draws elements from the technological systems approach as developed mainly by Thomas Hughes, it has not emphasised the 'system integration' dimension of regime construction. This is something that our work adds to the MLP literature, providing both empirical material and theoretical insights. The 'system integration' approach followed in the article gives equal analytical weight to the material and social elements of the system. In this respect the distinction between the physical infrastructures and the system's social components becomes fuzzy, as there are continuous, changing interactions. This provides a symmetrical and more complete understanding of regime construction.

Furthermore, it is fruitful to apply the MLP's multi layered conception of the socio-technical transition, which unfolds and is structured through interactions between landscape and regime and/or between niche level innovations and the regime. The layered analysis functions heuristically and clarifies the analysis of 'system integration' as a dynamic process shaped through such continuous interactions (Meadows, 2008). Pressures from the landscape or the niche level or due to inherent regime tensions and problems can form the conditions for the co-evolution of technologies,