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Remaking the UK's energy technology innovation system: From the margins to the mainstream



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HIGHLIGHTS

- Analyses the dramatic recent remaking of the UK energy technology innovation system.
- Identifies three distinct phases of innovation dynamics and governance since 2000.
- The private sector has played a leading role in UKs innovation system rebuilding.
- There has been a broad shift from niche to mainstream, continuity-based innovation.
- The UK system suffers from unstable funding, fragmentation and low transparency.

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ABSTRACT

The UK energy technology innovation system (ETIS) has undergone wholesale remaking in recent years, in terms of its aims, funding and organisation. We analyse this process and distinguish between three phases since 2000: *new beginnings*, *momentum building* and *urgency and review*. Within an international trend to ETIS rebuilding, UK experience has been distinctive: from a low starting base in the early-2000s, to system remaking under a strong decarbonisation policy imperative in the late-2000s, to multiple and contested drivers in the early-2010s. Public funding levels have been erratic, with a rapid increase and a more recent decline. The private business sector has played a leading role in this remaking, and as this influence has grown, the role and style of energy innovation has shifted from long term niches to the shorter term mainstream. The UK ETIS suffers from persistent problems: fragmentation, low transparency and weak links to the research evidence base.

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1. Introduction

One prominent feature of contemporary energy policy and research is an emphasis on accelerated technological change for more affordable energy system transition pathways (e.g. Henderson and Newell, 2011; HMG, 2011; IEA, 2012a). The International Energy Agency (IEA) has declared that 'a national strategy ... to accelerate the development and adoption of low carbon technologies is the single most important step to address the energy innovation challenge' (IEA, 2012a, p. 117). A number of scenario studies have suggested that meeting ambitious energy and climate change policies

can be most affordably realised with significantly higher levels of spending on energy innovation (CCC, 2010a; IEA (International Energy Agency), 2010a). The UK Energy Research Centre suggested that a 'step-change increase' in UK public spending on energy supply technology RD&D (Research, Development and Demonstration) was economically justified (Winskel et al., 2011, p. 215).

Unsurprisingly then, policymakers in the UK and elsewhere have recently sought to remake energy technology innovation systems—systems that were greatly run-down over preceding decades. The UK's recent efforts at remaking its energy technology innovation system (ETIS)—in terms of the main the actors, networks and institutions involved (Carlsson and Stankiewicz, 1991)—are the focus for this paper.

There is a large recent body of conceptual and empirical research on energy technology innovation (e.g. Chiavari and Tam, 2011;

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Wüstenhagen and Wuebker, 2011; Grubler et al., 2012). Many studies have examined the appropriate mix of support policies (e.g. Fri, 2003; Stern, 2007; IEA, 2011a, 2011b). Among more formal innovation systems approaches, framings vary – focussing on, variously, national, regional or technological scales. Foxon and Pearson (2008) suggested that innovation systems studies can be collectively characterised by their systemic, dynamic and non-linear perspective. Technology-focussed innovation systems analysis has been a very active area of research over the past decade, with more recent work tending to adopt an explicitly functionalist analysis of system performance (e.g. Jacobsson and Bergek, 2011; Suurs and Hekkert, 2012). Within this, there have been relatively few studies of the UK ETIS (e.g. Gross, 2004; Foxon and Pearson, 2008; Watson, 2008; IEA 2012b).

A number of authors have derived ‘best practice’ guidelines for energy innovation policy from the research literature. Among the high-level messages here, Chiavari and Tam (2011) and Grubler et al. (2012) noted the need to position and align innovation policy within overall energy policy objectives; Grubler et al. also called for a systematic approach spanning demand-side technologies as well as supply, and also, sustained support over time rather than ‘stop-start’ efforts. Winskel et al. (2006) and Foxon and Pearson (2008) highlighted the need for distinctive policies at different innovation stages, with design variety support in early-stage innovation and market creation and domestic industry support in later-stages. Foxon and Pearson (2008) also noted the need to avoid short-term, inflexible and ‘incumbent-oriented’ policies. Watson (2008) identified a need for ‘radical system innovations and not just incremental ones’, and he noted that incumbent companies may not be best placed to implement radical innovations.

Watson (2008) also considered UK ETIS developments in the context of Rothwell’s typology of organisational modes of innovation: from the highly linear technology-push mode in the 1950s to the networked model in the 1990s (Rothwell, 1994). As Winskel et al. (2006) noted, the networked model of innovation—with its emphasis on distributed agency and learning, and inter-organisational networks and feedbacks—has underpinned much innovation systems research over the past two decades. In UK ETIS case analysed below, by contrast, more directed, linear and incumbent-oriented organisational modes of innovation re-emerged in the late-2000s, reflecting urgent pressures for wider energy system change. The challenge that this (re)linearisation presents to the networked model still prevalent in much wider innovation studies is an interesting issue for further research.

At the end of the paper (in Section 6) we reflect on the UK experience of ETIS system remaking in the light of these high-level best-practice guidelines. However, our main analytical concerns here are descriptive and interpretive, rather than functionalist or prescriptive. While we discuss some implications for policy and research, we do not attempt to benchmark UK developments against an ideal system or optimal set of specific policies. Like Grubler et al. (2012), we see much of the value of an ETIS perspective as identifying patterns and guidelines across different technologies and contexts, rather than more specific prescriptions or hypotheses, and we have avoided a formal, functional analysis. Following Sagar and Holdren (2002, p. 468), our concern is with ‘a mapping of the relevant institutions, their energy innovation activities, and the relationships between them’. However, we also interpret these changes by reference to the innovation studies literature, in terms of shifting styles of innovation dynamics and governance.

Innovation systems research spans a broad spectrum of interwoven socio-technical practices. While acknowledging this breadth, our unit of analysis here is the Energy Technology Innovation System (ETIS), reflecting our analytical focus on technological innovation rather than more ‘purely’ regulatory or organisational innovation. We conceive of the ETIS as the set of

main actors/organisations, inter-organisational networks and institutions (including market, regulatory and planning rules, and also less formal norms and values) concerned with energy technology innovation. We see the ETIS as being partly-coupled and partly-aligned with the wider energy system, and while our focus is on technology innovation, we also discuss the changing wider energy system and how changing wider system drivers and responses reshaped the role and make-up of the UK ETIS. The wider energy system is seen as an important source of pressures and imperatives on innovation dynamics and governance

Innovation systems are social constructs that reflect particular material, institutional and cultural settings (Hughes, 1983; Anadón, 2012). The rationale and composition of such systems—their aims and expectations within wider socio-technical change, as well as the actors, networks and institutions involved—are themselves fluid and contested. As we discuss in Sections 5 and 6, the remaking of the UK ETIS over the past decade has involved shifting and contested notions of the role of technological innovation in wider energy system change. While the UK is our main focus—reflecting our primary expertise and interests—we also briefly consider wider international patterns of energy technology innovation, common international challenges and UK performance in international context.

UK experience of energy innovation system rebuilding has been a distinctive one, in terms of the very low starting point in the early-2000s, the rapid pace of change from the mid-2000s, and the erratic pattern of public spending. For much of the period covered here, a strong decarbonisation imperative played-out over a highly liberalised and fragmented institutional context. Over the course of its remaking, there was a shift from niche to mainstream and continuity-based innovation, with a leading role for the business sector and public-private partnerships. However, while it reflects a particular mix of international drivers and local context, the UK’s experience also exemplifies international concerns to reconcile different energy policy drivers—decarbonisation, affordability, security and business development—and common challenges, such as creating co-ordinated, ‘mission-oriented’ innovation systems in privatised industry sectors and liberal economies.

The case study presented here is based on quantitative analysis of spending patterns, qualitative analysis of policy and strategy documents, and our own knowledge and experience of working inside the UK’s public ETIS over the past 15 years. Our analysis is also informed by recent research on energy innovation governance. In the next Section we trace the changing composition of the UK ETIS since 2000, in terms of its resourcing, strategic objectives and organisational make-up (Section 2); we then consider UK developments in their wider international context (Section 3) and research debates on energy innovation governance (Section 4). Section 5 brings these different elements together to develop a number of discussion points and lines for further research; Section 6 concludes.

2. Remaking the UK energy technology innovation system

2.1. New Beginnings (2000–2004)

Technological innovation was a marginal pursuit in the UK energy system of the early-2000s. From the mid-1980s onwards, market liberalisation and industry privatisation led to a collapse in RD&D efforts; whilst these forces were felt globally, they were experienced particularly strongly in the UK (Helm, 2003). The UK’s privatised energy companies had little strategic interest in technological innovation and there was very little public or private investment in energy innovation in the 1990s (Fig. 1; BIS (Department of Business, Innovation and Skills), 2009). One material aspect of this was the closure of much of the UK’s public

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