Mobilising Energy Demands, Enacting Supply: The Paradox of Renewable Fuels in UK Transport Policy

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Abstract

In this paper, we contribute to discussions of the work that imagined futures do for policy, focusing on how future projections of renewable fuel supply have enabled the mobilisation and enactment of energy demand in UK transport policy over the past 15 years. Transport policy was traditionally built on a predict-and-provide model where expectations of (inevitably rising) demand helped make the case for provision to fulfil these demands (e.g., by road-building). Departing significantly from this approach (Goodwin 1999), the UK government's ambitious New Deal for Transport (DETR 1998) invoked a future in which people routinely undertake fewer car journeys and where public transport is safer and more accessible. Reducing CO2 emissions was part of this vision, but in conjunction with projections of reduced demand from infrastructural changes. Throughout the 2000s national transport policy became more firmly rooted in the language of climate change, but with little by way of travel reduction strategies (Marsden and Rye 2010). We examine the paradoxical role of renewable fuel mandates in this transformation, focusing specifically on technical models of (future) energy demand and bioenergy (supply) potential, and government foresight documents from this period up to the more recent 2012 Bioenergy Strategy. Three turns are discernible. First, epistemic claims for future energy demands have reinforced political authority for biofuel supply policies, resulting in interventions to support the development of a biofuel production and research infrastructure. Second, these emerging infrastructures have in turn changed the baseline context for conceptualising future demand and how demand will be met. In the process, what counts as a viable transport infrastructure has been reimagined, remobilised and reconfigured, which we illustrate with the example of the interweaving of biofuel and (bio)hydrogen futures. As such, we show how notions of 'demand' and 'supply' form a powerful interface as part of past and on-going future-oriented world-making.

1 Introduction

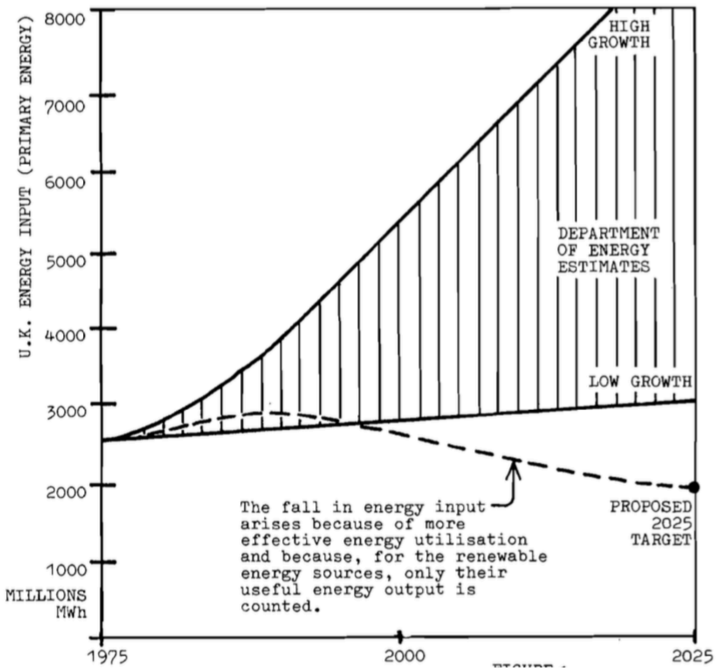

Figure 1: UK Government energy demand projections, and alternative scenarios (the proposed target) taken from the 1977 '*Alternative Strategy for the United Kingdom*' (Todd et al. 1977 2).

Looking into the future is an established practice in the development of both technology and policy (Georghiou et al. 2008). Neither the UK and energy production are strangers to this practice. In the 1970s, the UK Government's energy projections methodology became cemented in quarterly reports (Wigley & Vernon 1983), a practice that has continued to this day (DECC 2016). Of course, making future projections is not simply a case of imagining a future that is but a fancier version of the present, replete with symbols of progress, papering over an unchanged status quo (Marvin, 1990). Models of the future also allow the projection of alternative options. The Centre of Alternative Technology, even in these formative early stages, was invested in the process of proposing alternative futures (see figure 1), proposing and affecting change to steer futures in new directions through socio-technical change (Todd et al. 1977). It is clear then, that such projections – and models more generically – embed particular value judgements and can be used to spur more fundamental socio-technical change; As Mackenzie (2006) wryly notes, models are 'engines, not cameras', both creating and folding into the invisible infrastructures that are created (Star 1999). Within the transport sector, perhaps the most infamous form of future-gazing is embodied in the notion of 'predict-and-provide'. This model of policy planning has been thoroughly critiqued (Adams, 1981;

Owens, 1995) but continues to influence expectations (Goulden, et al., 2014), directly informing decisions about the constitution of transport infrastructure, its ongoing extensions, expansions and evolutions. What is less commonly explored within this sector is the way in which such 'futuring' is shaped and interfaces with existing infrastructural inertias, an interface recognised as increasingly important elsewhere (Selin & Sadowski 2015).

Our analysis centres on understanding the role of future projections in the pivot towards biofuels, understood as liquid fuels derived directly from biological materials, that occurred in British renewable transport policy at the turn of the century. Biofuels have had a mottled history of development and deployment and have occupied many geographical and socio-technical niches (Kovarik 1998). They have, however, been most visible as alternatives for petrochemicals, often coming to prominence in times of supply crisis or as means to support agricultural sectors. Most recently, Government policies have positioned biofuels as a solution to reducing carbon dioxide emissions from the transport sector (e.g. DECC et al. 2012). In focusing specifically on the work that demand projections do in creating energy futures, we are not suggesting that such activities are of special significance over other features. Recent biofuel developments are perhaps best viewed as resulting from intricate interactions of ideas, discursive demarcations and political interests which are constructed and interpreted within particular institutional contexts (Palmer 2010). Rather, focusing in allows us to begin to see the detail and connections of one important dimension of these intricate webs, making visible the kinds of negotiations, assessments and concerns that were being made and which serve to frame the present sedimented narratives.

2 Looking beyond future demands

Using the narrowly-bounded, future orientated modelling exercises embodied within traditional energy forecasting to outline potential demand has been critiqued by a range of scholars. Work by scholars such as Elizabeth Shove, Gordon Walker and Matt Watson has highlighted the localised nuances and complexities that influence changing patterns of energy demand and need for a range of energy intensive technologies.

However, emerging STS scholarship has shifted empirical scrutiny from looking *into* the future to looking *at* the future. Future-orientated imagination takes on new qualities when certain types of imagination are distinguished from fantasy and illusion and recognised as having performative power, projecting expectations and mobilising efforts to respond to them (van Lente, 2012). Future-gazing can therefore provide visions of the positive futures attached to the adoption of certain technologies, warn of the risks of failing to pursue certain future trajectories, as well as anticipate the risks of things going awry if innovation is not managed appropriately (Jasanoff & Kim, 2009; Jasanoff, 2015). No longer perceived as a 'neutral temporal space' (Brown & Michael, 2003), the future is an important resource forming a crucial part in social and political life (Jasanoff & Kim, 2009), contested as an object of social and material action (Brown, et al., 2000). Thus, if demand projections are presented as established methods for looking into the future, then they are also a legitimate object of study in their own right.

The future is often mobilised to legitimate and justify decisions with regards to supporting certain techno-scientific projects, e.g. biofuels. Most relevant here are the ways in which expectations of changing future demands create space for new supply technologies to be framed as meeting this demand, allowing the marshalling of resources, coordination of innovation and development activities and management of uncertainty (Brown & Michael, 2003). Future visions are not intended to remain as rhetorical devices. Materialising the future through producing concrete artefacts whether they are large, nuclear power plants (Jasanoff & Kim, 2009) and mines (Storey, 2015), or minuscule, genetically modified organisms (Smith, 2015) and nanotechnologies (Burri, 2015), is central to the role played by imaginaries. And through this process emerging technologies – artefacts and infrastructures – can intervene in the present, subsequently shaping future realities (Selin, 2008). Therefore, crucial to meeting demand now and in the future is a range of different physical infrastructures that extract, process and market/supply energy to consumers. These infrastructures are not static, evolving in response to regulatory changes, shifts in planning, and demands for energy and its form.

Demand-focused scholars have been conscious of the importance of evolving physical infrastructures in two respects. Firstly, by positioning physical artefacts and infrastructures as woven into the bundles and complexities of social practice that realise energy supply and demand (Shove & Walker, 2014). Technologies for cooling the internal spaces of homes and places of work have been a topic of particular interest. Walker et al. (Walker, Shove, & Brown, 2014) examines the ways in which the need for mechanical cooling materialises through encounters between changing physical infrastructures, technology, humans and practices that configure to produce need for mechanical cooling systems. Further to this, the expansion and reproduction of air conditioning as a part of building infrastructure has produced the conditions within which "many objects are now designed to perform best at around 22°C." (Shove, et al., 2014), including the people inhabiting these spaces (Shove, 2003). In these ways infrastructures shape and are shaped by social norms and practices of normality and comfort that has implications for energy demand and supply.

Secondly, the obdurate nature of physical infrastructures, whether due to their massive scale and composition from durable materials, or the major investment and sunk costs they signify, is recognised as prefiguring change in these infrastructures and in turn the development of new ones (Schatzki, 2011; Shove, et al., 2015). Equally, these characteristics of scale and cost, as well as the purpose of infrastructure position them as collective undertakings often realised through deliberate planning and intervention by local and national governments (Shove, et al., 2015). This conception of infrastructure as evolving, collectively planned, and shaping future forms of infrastructural change is an important area of cross over for this work.

Drawing these two literatures together, the purpose of this paper is to examine why at significant forks in the road, certain choices are made and changes pursued over others. Using the case of liquid biofuels, we interrogate the role of demand modelling, and the influence of physical infrastructures in shaping important technological choices regarding liquid fuel supply around the turn of the century.

3 Building and mobilising biofuel supply

In a number of other situations, most notably in Brazil since the 1970s, biofuels have seen significant use, but in the UK the first significant production and consumption of biofuels since the 1940s occurred in 2002 (Bomb et al. 2007). Up until this point, biofuels had been held in a position of 'relative obscurity' as a suite of largely marginal and niche technologies (Boucher 2010). Nevertheless, there were a number of developments – necessarily partially explored herein – that would eventually facilitate their rise up the policy agenda.

To examine the interfaces between demand, supplicant infrastructures and futures in the making, we focus on three key turns within UK public policy. In the first period, up to approximately 2002, we explore the shifts in renewable energy and transport policy doctrine that positioned future demand as a prescient concern. In the second turn, we show how these projections of demand were mobilised and coupled with assessments of (lack of) policy efficacy to begin to imagine and mobilise biofuel supply infrastructures. Finally, we show how the resulting established and increasingly obdurate supply infrastructure is being reimagined to contribute to new projections of future demands using long-voiced technological imaginaries.

3.1 Performative projections

The Labour Government's white paper, *A New Deal for Transport* (DETR 1998) is commonly taken as a rhetorical turning point in transport policy (Goulden et al. 2014). Prior to the white paper, standard transport planning practice involved producing forecasts of private mobility demand and then building roads to meet those forecasts – colloquially known as 'predict and provide' (Goodwin 1999). The white paper contained a rhetorical realignment: Instead of increasing capacity to meet projected demand, the Labour Government would develop schemes to manage, maintain and make more efficient use of existing road infrastructure, thus decoupling economic growth from road traffic. Here, it is significant in several other ways.

Climate change gained increasing prominence within policy agendas, culminating with the European Union's 1997 adoption of the Kyoto Protocol. Here, and within subsequent policy discourse, climate change and energy converged (Lovell et al. 2009). Although earlier policy actors had emphasised the contribution of transport to environmental degradation (e.g. National Audit Office 1994; RCEP 1994), the reform of energy production and consumption across a range of sectors, including transport, were now specifically framed as central to any attempt to address climate change.

And whilst seeking to embody a new policy paradigm, the rhetorical realignment remained grounded in two future projections. The first, derived from an earlier report from the the Royal Commission on Environmental Pollution (RCEP 1997), took past traffic growth and projected it in an essentially linear way out to 2021 with the central forecast predicting a roughly 40% increase in demand for private mobility. The second projected emissions from road transport to rise from roughly 35 million tonnes of carbon per year to 50 million tonnes in 2021 (DETR 1998). These projections, when coupled to the increasing need to reduce greenhouse gas emissions from the transport sector, acted as powerful justificatory symbols for the enclosed policy prescriptions.

It is worth emphasising that biofuels were to play no role within this vision, something that would continue beyond the turn of the century in the *Climate Change Programme* (DETR 2000a) and *Transport Ten Year Plan* (DETR 2000b). Overall emissions reductions were intended to be achieved through a combination of reducing tailpipe sulphur emissions, implementing European-mandated efficiency savings and increasing fuel duty to discourage driving and stimulate the use of public transport, thus reducing demand for personal motorised mobility. What the white paper did do was to connect demand for private mobility to a growing climate change agenda, and employ projections of the future as key ways to demonstrate the need for action.

3.2 Stimulating supply chains

Throughout the 2000s national transport policy became more firmly rooted in the language of climate change, but with little by way of travel reduction strategies (Marsden & Rye 2010). Indeed, the ability of measures highlighted in the *A New Deal for Transport* (DETR 1998) to deal with projected increases in mobility demand whilst delivering predicted carbon reductions were soon questioned. The RCEP report *Energy - The Changing Climate* (RCEP 2000) reviewed past policy attempts to alter both mobility trends and transport's carbon intensity, noting that there were "no signs of large change in previous trends that had been pointing towards [...] rapidly rising road traffic levels" (RCEP 2000, p.113). Given the rapid growth in the transport sector's energy consumption, the committee argued that even if successful, efficiency savings and demand management would not significantly impact on what would still be an extremely large demand for a "readily portable energy source with a high energy density and power density suitable for propelling personal vehicles" (ibid p.157).

With demand expected to continue its upwards climb, and efficiency measures only managing to keep carbon emissions from car transport flat (DTI 2003), if carbon reductions were to be achieved policy would have to address the carbon intensity of fuels. Although hydrogen, and to a lesser extent electric, was envisioned as the long term dream ticket, the need to meet short term targets laid down in the Kyoto Protocol, and EU pressure created space for biofuels to be reconsidered. This reassessment is visible, for example, in the November 2002 pre-budget report, which referred to various assessments of the greenhouse gas, energy balances and emissions performance of biofuels (Armstrong et al. 2002; L-B-Systemtechnik GmbH 2002; Reading et al. 2002). In particular, one DfT-commissioned Life Cycle Analysis (LCA) positioned biofuels as a favourable intermediate option (Eyre et al. 2002).

Despite the heterogeneous and sometimes conflicting results that the abundance of assessments produced, biofuels rapidly became positioned as *the* short term option. A partial recognition of infrastructural inertia was crucial to producing this narrative. On the one hand, petroleum-dominated rolling stock and fuel delivery were widely acknowledged. Crude oil derived fuels supply around 97% of the energy used in transport (DECC, 2011). In the short and medium term biofuels were posited as a low carbon substitute fuel (EC, 2000; DTI, 2003) capable of interfacing relatively easily with existing infrastructure and rolling stock when blended at low levels (Foresight Vehicle, 2004; DEFRA, et al., 2007). When deployed in this capacity, biofuels require no change to consumer behaviour. In contrast, electric vehicles were and are continually deemed to face technological, range, infrastructure and behaviour barriers limiting their rapid expansion (Garling & Thøgersen, 2001).

On the other hand, claims that positioned biofuels as an easy intermediate option, capable of appropriating existing petroleum infrastructures on the transition to a hydrogen or electricity based transport system (e.g. IEA 2004), often neglected the necessarily wide range of biomass production infrastructures required to fulfil even relatively modest blending targets of 5.75% by 2010 (Thornley & Cooper 2008; Adams et al. 2011), adopted in European (EU 2003) and national renewable transport policies (HM Government 2007). Plantations, harvesting and logistical capacity, storage and processing facilities have all required construction, whether from scratch, in the case of the majority of the UK biofuel production infrastructure, or through expanding and diversifying existing agri-processing facilities. By 2013 10 biofuel production facilities had been commissioned in the UK, with a combined capacity to produce 1,495 million litres of fuel and representing in excess of £1b in investment (ECOFYS, 2013, p. 2). These plants consumed 787,000 tonnes of UK grown crops in 2013/14 (DEFRA & Government Statistical Service, 2014)

3.3 Infrastructural inertia and established imaginaries

Despite the 2007-2008 global financial crisis, projections of future transport demand remained relatively buoyant. The Committee on Climate Change (CCC, 2008) projected a continued — albeit slightly reduced *vis-a-vis* 1990s estimates — growth of 1% per annum in passenger cars. In 2010 with the recession beginning to bite, the *Fourth Carbon Budget* (CCC, 2010) optimistically expected the short term decline caused by the financial crisis to remain no more than a blip. Although it provides no concrete figure, demand for transport is expected to continue on its upward trend. By 2015, the publication of the *Fifth Carbon Budget* (CCC, 2015) signals a shift in expectations. The ride to endless growth is replaced with predictions of modest decline. Recession and slow economic recovery have achieved what the *Transport Ten Year Plan* did not, putting a break on transport growth. In a landscape of growth, efficiency measures only flattened emissions, but in decline they offer carbon savings.

Given that projections in increased transport growth were central to justifying biofuel deployment in the UK, how is their role being imagined in light of now-falling projections? Whilst technological change should not be thought of in mono-rationalistic terms, there are legitimate reasons to hypothesise a waning niche for bio-based liquid transport fuels. Despite almost ten years of ramp-up, analyses have tended to view the UK government's biomass support policies as flawed (e.g. Thornley & Cooper 2008). Prominent stakeholders have claimed lack of investor confidence and regulatory uncertainty as the first- and seventh-most significant risks facing future biofuel deployment (Adams et al. 2011; Hammond et al. 2012). Leading up to the *UK Bioenergy Strategy* (DECC et al. 2012), one key assessment projected significant uncertainty in biomass supply potential, highlighting potential constraints from the large capital investment, increased international competition for biomass, and challenges of ensuring sustainable biofuel feedstock supply chains (AEA Technology 2011). These uncertainties, coupled with the technical challenges have meant that commercially-viable 'advanced' biofuels (derived from feedstocks such as wood and algae) have remained largely a pipe-dream; of the aforementioned ten production plants in the UK, all rely on long-established 'first generation' production pathways.

Perhaps the most compelling reason for reconsidering biofuels' prospects in light of recent mobility projections that biofuel itself has always been framed as a time-limited fuel option (c.f. Foresight Vehicle, 2004; DTI, 2003; DTI, 2007; DEFRA, et al, 2007): Hydrogen and the hydrogen fuel cell has remained the long term vision for transport fuel and drive train technology. However, as the previous section emphasised, blending biofuels into existing infrastructure requires the materialisation of a whole new set of production infrastructures. This now-present infrastructure represents sunken investments, enduring physical artefacts, tacit knowledge of its operation and construction, and vested interests (c.f. Adams et al. 2011). Not only do infrastructures prefigure the change that can be practically achieved (Schatzki, 2011; Shove, et al., 2015), but they also shape what is imagined as attainable. This is observable with the re-articulation of hydrogen-based drive chains, as in the CCC's *Fifth Carbon Budget* (CCC, 2015).

In 2003 the DTI white paper *Our energy future - creating a low carbon economy* situated hydrogen and liquid biofuels as different technologies (DTI 2003: p. 69). Hydrogen was to be primarily produced through non-carbon electricity (*ibid*: p. 19), not the processes and technologies that produce bioethanol and biodiesel. This is unsurprising; the production process for bioethanol and biodiesel are very different, and represent a potentially similarly different socio-technical regime of transport fuel and mobility. Biomass' sole presence was in the form of speculative and tentative policy visions such as using cyanobacteria exposed to sunlight to produce hydrogen (DfT, 2002). Contrast this earlier incarnation of hydrogen expectations with the aforementioned *UK Bioenergy Strategy* (DECC et al. 2012). Here, hydrogen is folded into broader bioenergy and biofuel options, with 'gasification' the key bridging technology. Under this pathway, a synthesis gas is conceived as a base substance from which to produce one of many possible outputs:

heat, electricity, gaseous or liquid biodiesel fuels (via the Fischer-Tropsch process), and pure hydrogen (*ibid*: p. 80). Other bio-based visions of hydrogen production, such as hydrocarbon reforming, are beginning to gain traction (UK H2 Mobility, 2013). Whilst currently involving fossil fuels, hydrocarbon reforming can be completed using sugars and alcohols as base materials (Cortright, et al., 2002). Thus, as previously outlined, infrastructural inertia was witnessed as part of early justifications for biofuels. A similar process is now emerging with regards to the re-articulation of hydrogen production in UK policy: Ten years later, juvenile biofuel supply infrastructure is now a resource to be reimagined, helping not only to make a hydrogen future 'plausible' (Selin & Guimaraes Pereira 2013), but also to re-mobilise existing first-generation and prospective 'advanced' biofuel production infrastructures as internal combustion engine drive-chains are 'discontinued' (Visser 2012).

4 Conclusions

We started out by posing the question, why at significant forks in the road are certain choices and changes made over others, and what is the role of demand projections and physical infrastructures in shaping this future change. Our analysis points to three important turns in UK transport and energy policy.

In the 1990's demand for personal motorised mobility was projected to continue its rapid upwards climb. The Labour Government's *'New deal for transport'* responded by signalling a rhetorical shift away from predict-and-provide. This first turn, situated in the context of meeting climate change policy targets, aimed to reduce carbon emissions through demand management and behaviour change initiatives which would shift mobility away from the personal car, and efficiency measures.

By the turn of the millennium this newly minted strategy was already being questioned. Its prescriptions were expected to fail at reducing carbon emissions or stalling growth. With transport demand still projected to rise and efficiency measures keeping emissions flat, a choice needed to be made: Either find a way to make the original policy prescriptions work, or deploy a short to medium term alternative transport fuel to reduce the carbon intensity of transport. This second turn saw support coalesce around liquid biofuels as a means of continuing a trajectory of transport growth but while reducing carbon emissions. However, demand projections were not alone in creating a space to deploy biofuels. The recognised inertia of petroleum infrastructure meant that short term success was posited on integrating new technologies into a context restricted by the dominant fuel delivery and rolling stock infrastructure. Biofuels filled this gap, positioned as readily available to be blended with petroleum fuels, compatible with modern engines in low quantities and requiring no changes to consumer behaviour. Despite such an optimistic assessment, this focus on petroleum infrastructure ignores the significant production and processing capacity that needs to be built to turn biofuels into a working reality, infrastructure that once constructed gains inertia of its own.

Recent projections, such as those of the CCC, have re-articulated a vision of falling transport demand. In the face of this vision, juvenile biofuel infrastructures that have been supported are being reimagined to support longstanding, and historically speculative, visions of a hydrogen drivetrain future. This, we suggest, represents not just an example of path-dependence, but one under-explored example of the ways in which technologies may emerge, be maintained and be discontinued as sites of coalescence between infrastructure, the future and social change.

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