Transition pathways to a low carbon economy: Linking governance patterns and assessment methodologies

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Abstract

This paper describes work being undertaken as part of an interdisciplinary project on transition pathways to a low carbon economy, bringing together insights from engineers, social scientists and policy analysts. The project is examining the plausibility of different transition pathways for a low carbon energy system in the UK, under different governance patterns, in relation to both centralised and decentralised systems for meeting energy service demands. It uses a conceptual and analytical framework combining the multi-level transitions perspective of landscape, regime and niche levels, with more detailed analysis of the technological feasibility and social acceptability of the pathways. The research uses an interpretative frame based on an 'action space' of governance patterns relating to the mix and balance of actions led by three sets of actors in central government, in liberalized markets and in civil society. In order to evaluate these pathways, the project team is employing a 'toolkit' of techniques to explore and evaluate specific implications of the selected transition pathways to a highly electric, low carbon economy. These aim: to provide a transparent sustainability appraisal framework (economic, social, environmental and technical benefits) for the transition pathways; to explore and evaluate the 'whole system' implications of the selected transition pathways. This paper highlights how these assessment tools will be used to explore the implications of different governance patterns in relation to the transition pathways.

1. Introduction

An essential part of transitioning global societies to a 'green' economy is to achieve a transition to low-carbon energy systems, in order to address the challenges of climate change and energy security. Despite the lack of detailed agreement at the Copenhagen Climate Conference in December 2009, many countries have already made commitments to reducing their greenhouse gas (GHG) emissions, with a focus on decarbonising their energy systems. For instance, the UK has put in place a legally-binding target of an 80% reduction in its GHG emissions by 2050, with an intermediate target of a 34% reduction in its GHG emissions by 2020 relative to 1990 levels, as part of the EU target of a 20% reduction in GHG emissions by 2020. To meet these targets, the official UK advisory Committee on Climate Change has recommended almost full decarbonisation of UK electricity supply by 2030, so that its carbon (CO_2) intensity is reduced from 550 gCO_2/kWh in 2006 to below 100 gCO_2/kWh in 2030

(Committee on Climate Change, 2008). To facilitate meeting these targets, the UK Government published a Low Carbon Transition Plan in July 2009, which aims to obtain 40% of UK's electricity from low-carbon sources by 2020. The route to this target includes 30% renewable generation, up to four demonstrations of capturing and storing carbon emissions from coal power stations, and facilitating the building of new nuclear power stations (HM Government, 2009).

This paper describes work undertaken as part of an interdisciplinary project on transition pathways to a low carbon economy, bringing together insights from engineers, social scientists and policy analysts. The project examines the plausibility of different transition pathways for a low carbon electricity-based energy system in the UK by 2050, under different governance patterns, in relation to both centralised and decentralised systems for meeting energy service demands. In order to assess the plausibility of these pathways, the project aims to relate analysis of the roles of three different sets of actors, in government, the market and civil society, in the governance of the pathways, to a 'whole systems' assessment of the sustainability impacts of the different pathways. The paper describes the approaches being taken for the analysis of governance patterns and the whole systems assessment, and the initial work in applying them to outline transition pathways.

2. Outline of 'Transition Pathways' project

The 'Transition pathways to a low carbon economy' project is a collaborative research project, involving leading UK engineers, social scientists and policy analysts, supported by the UK EPSRC and the energy company E.ON UK. The project aims to (a) to learn from past transitions to help explore future transitions and what might enable or avoid them; (b) to design and evaluate transition pathways towards alternative socio-technical (or socio-ecological) energy systems for a low carbon future; and (c) to understand and where appropriate model the changing roles, influences and opportunities of actors in the dynamics of transitions. The conceptual and analytical approach for the project has been described in detail elsewhere (Foxon et al., 2008a,b, 2009), and so will only be outlined here. The approach applies the multi-level perspective for analysing socio-technical transitions, based on interactions between three levels: *niches, socio-technical regimes,* and *landscapes* (Rip and Kemp, 1998; Geels, 2002). The transition pathways are a form of *socio-technical scenarios*, which explore the potential future development of socio-technical systems through interactions between ongoing processes at the three levels (Elzen et al., 2002; Hofman et al., 2004; Elzen and Hofman, 2007; Meeuwsen, 2007). They also draw on a wider review and analysis of lessons from UK and international low carbon energy scenarios, undertaken as part of the project (Hughes, 2009a,b; Hughes et al., 2009). This analysis has shown that scenarios could play a significant role in helping to build consensus between different actors for a shared vision and complementary actions needed to bring about a low-carbon transition.

An initial set of outline transition pathways for a UK low carbon energy system have been developed, which are described below. These are being investigated and compared using a range of modelling and assessment tools and criteria, both to assess their plausibility and to identify areas where more detailed specification is needed. This includes identification of endogenous decisions that are amenable to influence by UK actors, and of potential tipping points and exogenous 'shocks' to the system. The initial outline transition pathways have been identified using an approach applying three main steps (Foxon et al., 2009):

(1) *Characterise the existing energy regime, its internal tensions and landscape pressures on it*;

(2) *Identify dynamic processes at the niche level*; and

(3) *Specify interactions giving rise to or strongly influencing transition pathways*.

3. Exploring transition pathways with different governance patterns

The initial outline transition pathways focus on alternative plausible governance patterns for UK energy systems and how they could affect technological, institutional and social changes in these systems. The governance patterns relate to the mix and balance of actions led by central government, actors in liberalized markets and civil society actors. We have designed an interpretive frame to assist in this analysis of these different governance patterns, as shown in Figure 1.

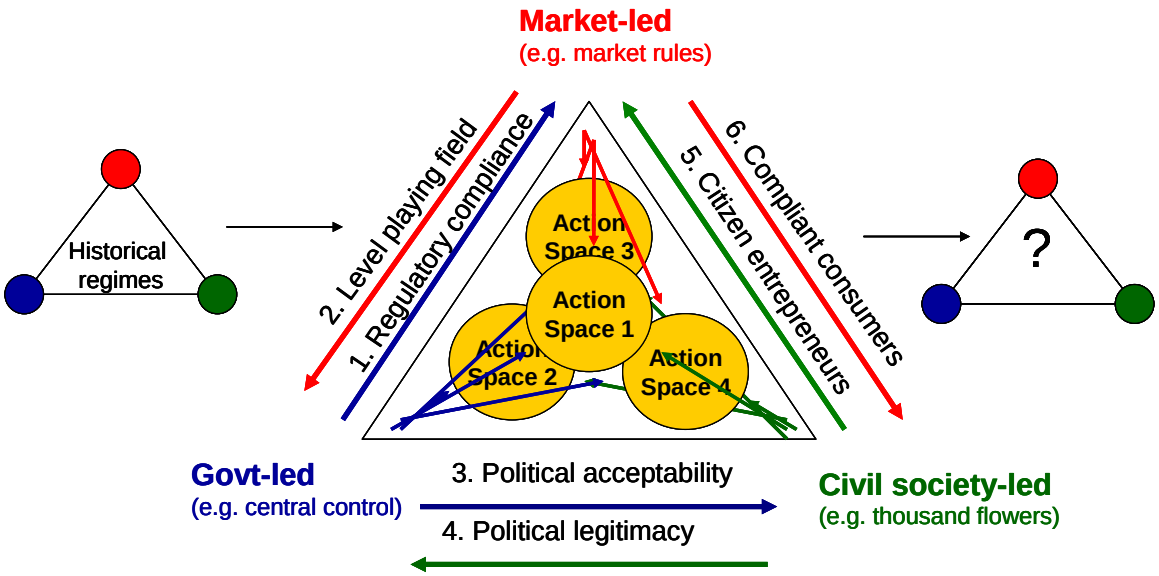

Figure 1. Action space for transition pathways (Source: Authors)

In this frame, the main actors are very broadly categorised into three different types:

1. Government-led – this covers government departments, advisory and regulatory bodies, and the legislation they create.
2. Market-led – this covers the major vertically integrated supply companies, but also smaller market based actors e.g. emerging energy service companies (ESCOs).
3. Civil Society-led – this includes not only 'end-users', but also other civil society actors such as trade unions, the media, and organised environmental protest movements.

These three different kinds of actors create a broadly defined 'action space' in which the current energy regime sits. Different kinds of relationships between actors exist and different forms of transition may develop, depending on the evolving balances of 'power' between these actors. Viewing these relationships and the interplay between them through this interpretive lens should provide insights into how the initial phases of transition pathways might play out within the current energy regime, and how different actors might be likely to react to transition processes. This will then inform the further development of the pathways.

Using this framework, we are developing and exploring a set of low carbon UK energy system transition pathways. These pathways explore different governance patterns, depending on the relative power and influence of the different categories of actors, and the mix and balance of centralized and decentralized decision-making within energy systems. The specification of these pathways draws on the multi-faceted experience of the project

team, the insights provided by stakeholders at workshops and through 'gatekeeper' interviews, and insights from other modelling and foresight exercises. Our three initial outline pathways are:

- *Market Rules*: this envisions the broad continuation of the current market-led governance pattern, in which the government specifies the high level goals of the system and sets up the broad institutional structures, in an approach based on minimal possible interference in market arrangements.
- *Central Co-ordination*: this envisions greater direct governmental involvement in the governance of energy systems, applying some of the principles of transition management.
- *Thousand Flowers*: this envisions a sharper focus on more local, bottom-up diverse solutions ('let a thousand flowers bloom'), driven by innovative local authorities and citizens groups, such as the Transition Towns movement (Hopkins, 2008), to develop local micro-grids and energy service companies.

Initial analysis of the 'gatekeeper interviews' with 32 stakeholders covering the range of energy actors has identified how different representations of UK 'public' and 'government' by different types of actors could influence which pathway will emerge. Thus, for instance, market actors tend to view the public as more or less rational consumers, sometimes in need of education to help them make more rational energy management decisions. Government actors, however, see the public as both consumers and citizens, concerned with the price of energy services as well as local community/ environment, but facing real limits to their power to influence change purely as consumers. Civil society actors see the public as a complex and varied group, with multiple roles and identities, but as being marginalised in wider debates about energy futures.

Market actors tend to see government as best placed to set policy, but as suffering from incompetence, and so call for government to set a strong policy framework and then to disappear to let the market deliver. Civil society actors tend to see government as suffering from bias and lack of transparency rather than incompetent, and so they call for strong government and leadership rather than "dancing to the tune of industry". The self-representations of government actors changed over the period of the interviews from September 2007 to October 2009. In the early interviews, the emphasis was on the government withdrawing and handing over decision-making to expert bodies, such as the Committee on Climate Change, and to the market. In later interviews, the emphasis had changed to a view that markets alone are unlikely to deliver the radical changes needed to meet the targets and that stronger government action was beginning to be put in place, stimulated by the strengthening climate science and the economic analysis of the Stern Review. Which of these representations of 'public' and 'government' gains wider credence could strongly influence which pathway is followed.

4. 'Whole systems' assessment of sustainability impacts

In order to evaluate these pathways, the project team is using a 'toolkit' of techniques to undertake a 'whole systems' appraisal of the selected transition pathways to a highly electric, low carbon economy. The notion of whole systems analysis and thinking is open to a variety of interpretations. Here it is viewed as providing a transparent sustainability appraisal framework (of economic, social, environmental and technical benefits) for the transition pathways that are being explored. Several economic, social and environmental appraisal techniques will be employed on a life-cycle, 'whole systems', or 'full fuel cycle', basis (Hammond and Winnett, 2006). These linked methods will provide a 'toolkit' for interdisciplinary sustainability appraisal (Gibson *et al.*, 2005). It will also constitute a

mechanism for illustrating the interconnections within the energy (principally electricity) system, and for identifying significant constraints associated with the adoption of the selected routes to a highly electric, low carbon economy. Electricity is a high-grade energy carrier in the sense that it can be used to provide either power or heat. There is an increasing end-use demand for high grade, clean (at the point of use), convenient, and controllable carriers. The sustainability attributes of interest in connection with power networks therefore suggest the elements of the co-produced 'toolbox' needed to evaluate specific requirements of transitions to more highly electric futures. Those tools includes: thermodynamic analysis (Hammond and Stapleton, 2001; Hammond, 2004; Hammond and Winnett, 2006 and 2009); environmental life-cycle assessment and cost/benefit analysis (Allen *et al.*, 2008; Hammond and Winnett, 2006); financial and economic analysis of generation and network technologies (El-Fadel *et al.*, 2010); infrastructure assessment and planning; risk assessment (Hammond and Waldron, 2008); and stakeholder mapping and engagement. The framework will also examine the (embodied and process) energy and carbon implications of the pathways (Hammond and Jones, 2008a,b); and provide an indicative assessment of their environmental impacts using carbon and environmental footprint analysis. Preliminary analysis of the carbon intensity of electricity grid supply has highlighted the dramatic carbon (GHG) intensity reductions from around 530 gCO_2e/kWh in 2020 to around 160 gCO_2e/kWh in 2035 that would be needed under the 'Market Rules' pathway to be on track to reach the UK government's legally-binding target of an 80% reduction in its GHG emissions by 2050. In turn, this will require concerted action by a range of actors in the decade leading up to 2020 in order that the investments and infrastructure improvements to achieve these reductions can be put in place.

5. Conclusions

This paper has outlined our approach to exploring and analysing transition pathways for a low carbon electricity-based energy system in the UK by 2050. It has argued that transition pathways can be used to explore alternative plausible governance and socio-technical patterns for UK energy system futures, that different actors within these systems have different representations of the role of 'public' and 'government' in relation to these governance patterns, and that which of these representations gains wider credence could strongly influence which pathway is followed. It has examined the toolkit of techniques being used to explore and evaluate the 'whole system' implications and sustainability impacts of the selected transition pathways.

We argue that our approach highlights the importance of research that not only addresses alternative technical energy system configurations but also explores the future governance of energy systems, as any form of low-carbon transition will involve interactions between government, market actors and civil society actors, playing different but complementary roles. For example, moving to a highly electric energy system will require new regulatory and/or financial incentives for upgrade to 'smart grids' that enable intelligent management of two-way power flows, new business strategies, such as moving to an energy service company model, and more active engagement of users involving changes to everyday habits or practices of energy use (Nye et al., 2010). We hope that the specification and analysis of transition pathways could play a useful role in helping actors to engage in open discussion about the governance and evaluation of moves towards low carbon energy systems – and perhaps also to build consensus amongst the different actors for the actions needed to bring about a successful low-carbon transition.

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