Part 3: Innovations for Low Carbon Mobility

11 The Constrained Governance of Socio-technical Transitions: Evidence from electric mobility in Scotland

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Introduction

The everyday use of cars to service the mobility requirements of citizens in most economically developed nations represents a firmly embedded social phenomenon. In 2013, 83.2% of all passenger kilometres were conducted in cars in the European Union, with little variation away from this statistic across the different member states (Eurostat, 2015). Whilst strategies to encourage multimodal behaviour by promoting the wider utilisation of public and active transport may assist in rebalancing the provision of transport (Graham-Rowe *et al.*, 2011; Santos *et al.*, 2010), the car is likely to remain the dominant form of mobility for the foreseeable future. Consequently, developing strategies through which to shift car based mobility onto a sustainable trajectory represents a prominent transport policy issue.

In an effort to address the considerable environmental externalities associated with the current mobility system, including the emission of greenhouse gases and local pollutants, focus has been on the development and deployment of technical innovations which may offer partial solutions to these problems (King, 2007, 2008; Schwanen *et al.*, 2011; The Committee on Climate Change, 2015). Most apparent in the technical innovations put forward involve alternative vehicle propulsion systems. Electric vehicles (EVs) are considered to be the most realistic alternative propulsion system and are currently entering the mainstream automotive market (Offer *et al.*, 2010). EVs have zero tailpipe emissions, allowing them to respond to the growing concerns around air quality, and they have the potential to offer low carbon mobility as a growing proportion of renewable energy generation comes online. With these benefits in mind, fostering an electric mobility (e-mobility) socio-technical transition has established itself as the primarily mechanism through which a sustainable future for the transport system in most economically developed nations will be achieved (Dijk *et al.*, 2013).

Due to the highly competitive nature of the mainstream automotive market combined with the current deficiencies of EVs regarding a number of key vehicle performance attributes (such as vehicle range and cost premiums), a natural introduction of EVs into the market will likely be ineffective (Steinhilber *et al.*, 2013). The continuity of the status quo in the automotive market is further supported by the high level of resilience displayed by the existing internal combustion engine regime (Wells & Nieuwenhuis, 2012). Governments are becoming increasingly aware of the need to assist and steer the purposive transition towards e-mobility. With this in mind, the government of Scotland has established a transition strategy aimed at promoting the adoption of EVs (Transport Scotland, 2013).

The specific circumstance of the Scottish Government, which represents a devolved administration of the United Kingdom (UK) with restricted authority, offers an interesting case through which to consider the governance of the e-mobility transition. It is the purpose of this chapter to consider this governance strategy by charting its development, implementation and evaluation. To assist in structuring the analysis, Loorbach's (2010) governance framework is employed which categorises aspects of transition policy into four different types of governance activity. Specific attention is paid in the analysis to ways in which governance activity is constrained as a result of the particular circumstances of the Scottish Government. These constraints cover issues related to restrictions in the Scottish Government's agency in certain areas due to powers reserved by the UK Government, the transference of regulatory authorities to the European Commission and the local conditions which exist within Scotland.

This chapter proceeds with an overview of socio-technical transition theory and the literature which discusses the governance of transition before outlining the strategy developed and so far implemented by the Scottish Government in an effort to support the transition to e-mobility.

The governance of socio-technical transition

The field of socio-technical transitions examines the processes of long-term structural change which involve transformations in technologies and shifts in the configurations of social activities within and between major sectors such as energy generation (Foxon *et al.*, 2010) and transportation (Cohen, 2012). Transition research pays specific attention to how these shifts and transformations lead to technological innovations progressing from niche applications to attaining a mainstream presence in the established socio-technical regime. These processes are often illustrated through the Multi-Level Perspective (MLP: Geels, 2002, 2005) which is displayed in Figure 11.1 and utilises three analytical levels to chart system evolution. These analytical levels cover technological niches, which encompass laboratories of variation and innovation, socio-technical regimes, which represent semi-coherent and established systems, and the socio-technical landscape, which represents deep structures that govern system operation.

Increasing structuration
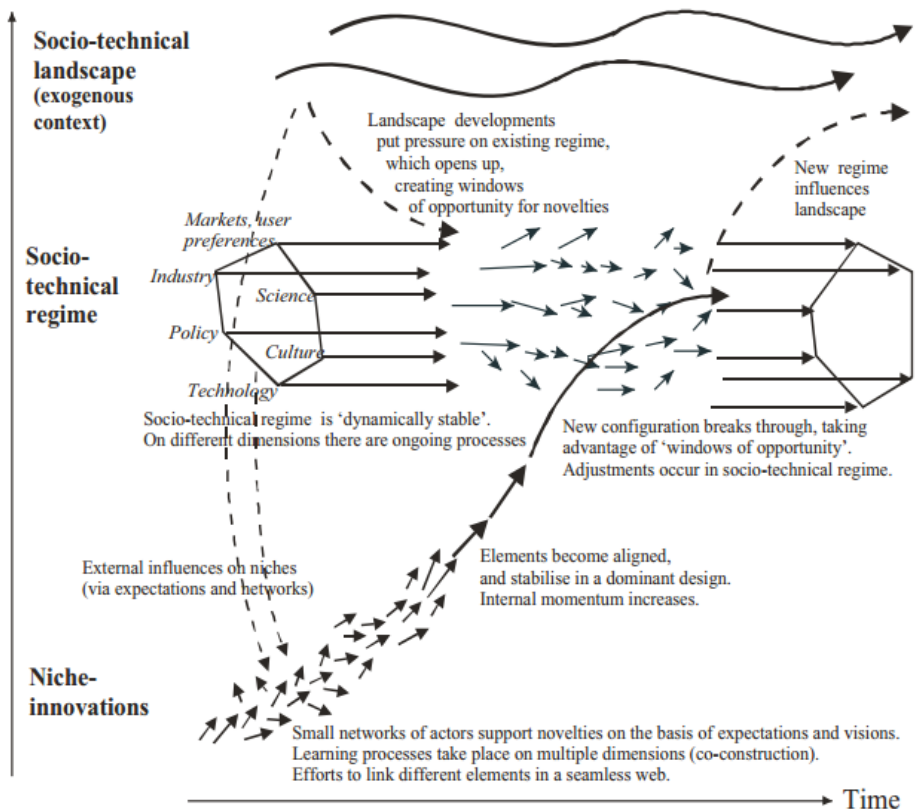of activities in local practices

Figure 11.1: Multi-Level Perspective of the process of socio-technical transition. Source: Geels (2002).

Transitions can be generated by a mixture of emerging conditions and issues which produce selection pressures on the incumbent regime that induce change. Smith *et al*. (2005) suggest that the context which defines the nature of a transition can be mapped by considering the juncture of two dimensions. The first of these dimensions relates to the *level of coordination* displayed by regime actors and transition managers in their response to the changing selection pressures. The second dimension concerns the *locus of resources* required to respond to the changing selection pressures and whether these resources are internal to the regime or exist externally. Geels and Schot (2007) propose an alternative classification of transitions which makes use of the MLP to format a series of transition pathways which socio-technical transitions may follow. Their classification first acknowledges that selection pressures are highly varied, generating diverse responses from the regime actors and niche innovators. Moreover, both the *timing of the interactions* which occur in socio-technical transitions and the *nature of these interactions* will likely foster different types of transition.

Whilst the transition classification systems proposed by both Smith *et al*. (2005) and Geels and Schot (2007) use different approaches, they both recognise the role of *agency* in transition. Smith *et al*. (2005) argues that the ability of agency to make an appreciable difference in the transition process necessitates the exercise of political, economic and institutional power. The political expression of agency in the transition process is often referred to as transition management (Meadowcroft, 2009), which involves active governance that aims to guide transitions along desirable pathways. with increasing attention being paid to the facilitation of transitions towards sustainability (Markland, 2012).

The application of governance to facilitate desirable socio-technical transitions represents an intricate web of expressed visions, policy frameworks and intervening actions. In an effort to bound transition management into a series of issues, Loorbach (2010) put forward a governance framework which outlines the cycle which transition management tends to follow and classifies transition management into four types of activity. Frantzeskaki *et al*. (2012: 26) describe these categories as:

1　*Strategic*: activities at the level of a societal system that take into account a long time horizon, relate to structuring a complex societal problem and creating alternative futures often through opinion making, visioning and politics.

2　*Tactical:* activities at the level of sub-systems that relate to build-up and break-down of system structures (institutions, regulation, physical infrastructures, financial infrastructures and so on), often through negotiation, collaboration and lobbying.

3　*Operational:* activities that relate to short-term and everyday decisions and action. At this level actors either recreate or change system structures.

4　*Reflexive:* activities that relate to the evaluation of the existing situation at various levels and their interrelation or misfit. Through debate, structured evaluation, assessment and research, societal issues are continuously structured, reframed and dealt with.

E-mobility transition management

Understanding the structure and dynamic nature of governance in the transport system is a topical area of study, likely motivated by strategic importance of this sector. Considering the operation of governance to pursue the sustainability agenda in transport, Marsden and Rye (2010) note that the complex arrangement of formal governance institutions in the UK, which exist across different spatial jurisdictions, generates confusion regarding institution responsibility and leads to a lack of commitment to the management of transport demand. Schwanen *et al.* (2011) offer additional insight on this issue and suggest that the *governmentality* approach of UK transport policy, which is based on the principles of ecological modernism where the goals of economic growth and environmental sustainability coalesce in a green economy, contextualises the current orientation towards the application of technical innovations and economic instruments in the transport sector. This perspective is attuned to the focus on promoting a transition to e-mobility, primarily serviced through the provision of EVs, which allows the system of automobility to be retained and for green growth to be promoted through the manufacture of low carbon high-value technologies.

Of particular relevance to the focus of this chapter, the ways in which the governance system can take an active role in fostering a transition towards e-mobility has also received focused attention (Nilson *et al.*, 2012). Using the automobility system as a case study, Schot *et al.* (1994) discuss three principal strategies which could be useful in stimulating socio-technical transitions. These strategies involve the modification of the selection environment, such as through implementing new regulations or altering taxation policy, the creation of a technological nexus, where new agent networks are established, and the development of alternative variations through technical innovations. This final strategy is often referred to as Strategic Niche Management (Kemp *et al.*, 1998), which aims to improve the under-utilisation of technologies by the establishment of protected spaces in which niche innovations can be experimented with and further developed in order to address prominent transition barriers.

Considering the barriers which are restricting an e-mobility transition, Steinhilber *et al.* (2013) conducted an in-depth assessment of the testimonies offered by key stakeholders in the EV sector, with their analysis suggesting that two issues related to e-mobility governance require focused attention. First, governance has the opportunity to steer developments in vehicle technologies, ancillary systems (such as energy and information communication technology) and vehicle production processes to enhance the technical utility of EVs. Second, governance can foster the introduction of novel business models to improve the attractiveness of EVs to private citizens and corporate fleets. Most recently, Mazur *et al.* (2015) assessed the policies employed by the UK Government in order to promote a transition to EVs. Their evaluation was based on the transition pathways of the MLP outlined by Geels and Schot (2007) and involved an analysis of the existing mix of policies which are aimed at supporting the EV transition and the expressed future vision for

vehicle transport. They argue that the UK's transition policy for EVs holds parallels with the reconfiguration pathway, which spans significant alterations in the socio-technical regime's architecture and can lead to incumbent regime actors (such as mainstream automotive manufacturers) being displaced by emerging niche agents (such as e-mobility start-ups).

The Scottish context

The distinctive nature of Scotland's transport policy since devolution has already attracted academic attention, with Shaw *et al*. (2009) noting that whilst high level strategic transport objectives across the devolved administrations of the UK (partially illustrated in the left image of Figure 11.2) are relatively synchronised, the implementation of specific policies to pursue these objectives have somewhat diverged. This policy divergence is likely motivated by the unique properties of Scotland's transport system (partially illustrated in the right image of Figure 11.2), which is required to respond to varied demands ranging from those of highly congested urban centres (located in Scotland's central belt) to those of isolated rural communities such as the highlands and islands (located towards the north and west of Scotland). Indeed, it is the unique characteristics of Scotland's transport system and the constrained level of authority held by the Scottish Government in its management of the system which offers an interesting case study for the e-mobility transition.
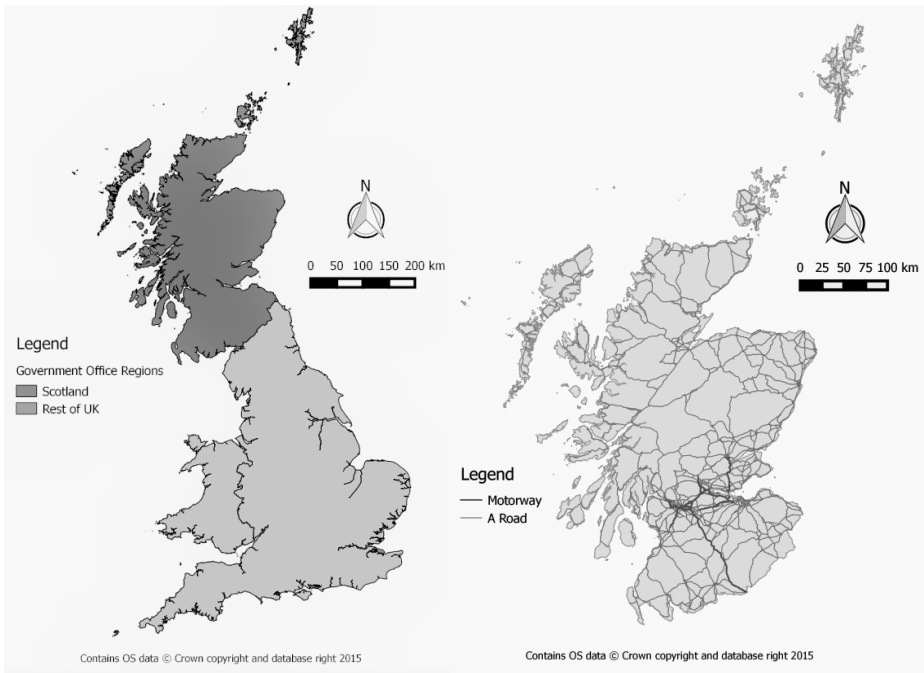

Figure 11.2: [left] Map of Scotland in situ with the rest of the United Kingdom. [right] Internal map of Scotland depicting road configuration.

As previously noted by Smith *et al*. (2005), the application of governance to manage transitions often faces constraints concerning the activities which can be pursued. With this in mind, acknowledging the presence of such constraints and understanding the limitations they impose will likely represent an important step in the development of a successful transition management framework. A number of the constraints faced by the Scottish Government concerning the e-mobility transition stem from the specific conditions surrounding the authority granted to it in terms of transport policy since devolution. As concisely outlined by Butcher (2015), certain powers have been transferred to the Scottish Government (such as the management of the strategic road network), whilst others have been reserved by the UK Parliament (such as the taxation of vehicles and fuels). The reservation of some powers is justified by the argument that a certain degree of harmony is required between the transport systems in Scotland and the rest of the UK. This implies that, for certain aspects of transport policy, the Scottish Government has to comply with the legislation enacted by the UK Parliament. A similar situation is present concerning the regulation of car technical attributes, with the European Commission setting the legislation which certifies if a particular vehicle model meets the required standards to be sold within the EU through the European Community Whole Vehicle Type Approval process (European Commission, 2007).
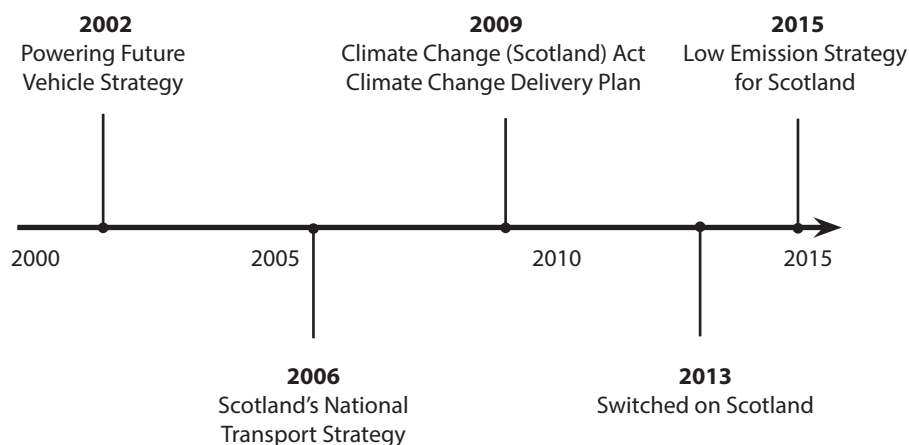

Figure 11.3: Timeline detailing the main policy documents concerning Electric Vehicle policy in Scotland.

Whilst the Scottish Government's power to govern the transition towards e-mobility is constrained in particular areas, enough agency exists for a unique e-mobility policy to be developed. Figure 11.3 details some of the key policy documents which have discussed EVs, commencing with the UK Government's Powering Future Vehicle Strategy (Department for Transport, 2002) which represents the first articulation of a desire to support alternatively fuelled vehicles, through to the Scottish Government's most recent consultation relating to how e-mobility coalesces with Scotland's low emission strategy (Scottish Government,

2015). Of particular importance is the document *Switched on Scotland* (Transport Scotland, 2013), which acts as an integrated transition strategy aimed at achieving the widespread electrification of road transport.
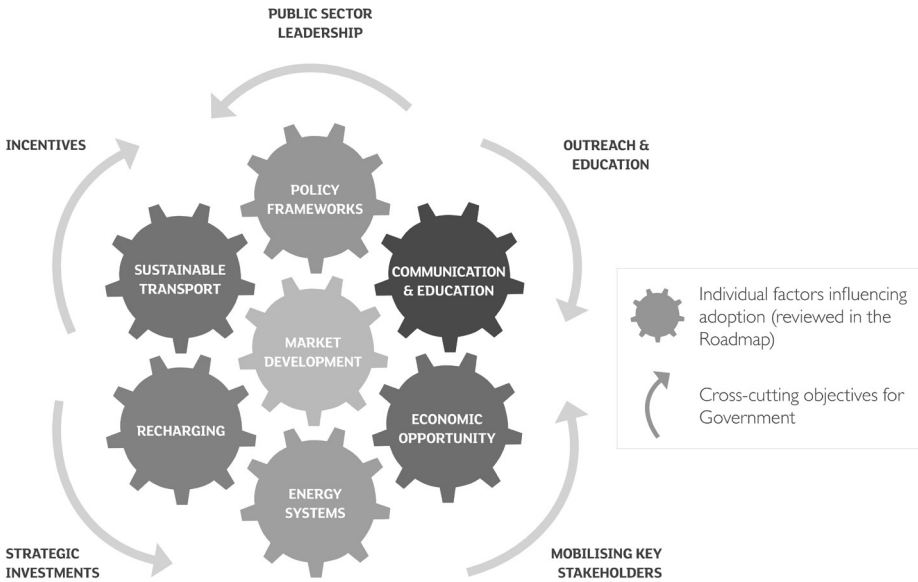

Figure 11.4: The Transition Framework for promoting electric mobility in Scotland with seven key policy areas. Source: Transport Scotland (2013).

The development of this transition strategy was the product of a series of collaborative workshops which engaged with stakeholders from a wide range of backgrounds in order to generate a comprehensive inventory of opinion concerning e-mobility. The assessment of this inventory followed an exploratory road-mapping approach (Beeton *et al.*, 2008) which led to the establishment of a Transition Framework that details a group of interlinked components displayed in Figure 11.4. The framework components are represented as cogs in order to illustrate how progress in the transition towards e-mobility will require synchronised activity, with the framework only rotating as quickly as the slowest cog. Around the circumference of the framework are a series of cross cutting objectives that cover areas which the Scottish Government has the ability to influence and assist in guiding governance activity.

The remainder of this chapter focuses on this Transition Framework and makes use of the governance framework developed by Loorbach (2010) in order to analyse how the Scottish Government has established its governance approach to fostering a transition towards e-mobility, the key elements which this approach contains and some of the constraints the application of governance faces.

Strategic transition activities

The development of the e-mobility transition strategy was motivated by the requirement for the transport sector to contribute towards Scotland's strategic objective of a greener society (Scottish Government, 2011) and Scotland's ambition to achieve substantial reductions in its greenhouse gas emissions inventory (Climate Change (Scotland) Act, 2009). This alignment between the transition strategy and high-level policy objectives provides credibility to the strategy but necessitates that its outcomes are assessed though their ability to deliver tangible benefits to these objectives. With the e-mobility transition likely to require significant levels of investment in the short-term and with sales of EVs expected to remain niche until the medium-term, this can create a certain degree of tension between the transition strategy and the strategic objectives. Thus, establishing a widely accepted long-term *Strategic Vision* for the e-mobility transition, which clearly articulates the desired pathway and sets out a series of logical steps to achieving this pathway, may alleviate some tension.

Early in the development process, a strategic board was convened to assist in guiding the production of the Strategic Vision for e-mobility in Scotland. This strategic board was comprised of a varied set of representatives, covering individuals working in local government, private sector energy companies, charities, automotive manufacturers and e-mobility supply chain companies. This mix of participants helped to unlock diverse perspectives on the topics to be considered and for the Strategic Vision to be formed out of a participatory policy process. However, this diversity also introduces challenges for policy formation, as managing the perspectives and expectations of different actors who are engaged with the e-mobility transition can prove difficult when views are divergent. Disparities concerning what should and should not be included and the priorities assigned to different issues require sensitive navigation. Thus, the creation of a Strategic Vision for the transition can prove to be a contentious issue, requiring negotiation between the government agencies managing the transition and the associated actor network.

In an effort to visualise the transformational changes which will take place in Scotland's car fleet resulting from the e-mobility transition, a *Market Outlook* was estimated as part of the strategic visioning. This Outlook is displayed in Figure 11.5 and illustrates the anticipated rate at which EV propulsion systems may diffusion into the mainstream car market and provides a quantitative basis through which to consider the Strategic Vision of the transition strategy. The outputs of technological horizon scanning methods, from which the Outlook was developed, generally become vaguer as you move further into the future, which leads to increasing levels of uncertainty surrounding market structures in the medium to long-term. Consequently, transition governance can face constraints which stem from the inherent uncertainties surroundingmedium and long term system developments (Morton *et al.*, 2014). Whilst the establishment of strategic visions can be useful in illustrating the desired development of a particular transition, these visions require embedded flexibility to allow them to adapt to emerging developments. To this end, the Market

Outlook attempts to strike a balance between providing some clarity concerning the potential shape of the e-mobility transition in terms of objective figures whilst understanding that a spectrum of futures for e-mobility are possible.
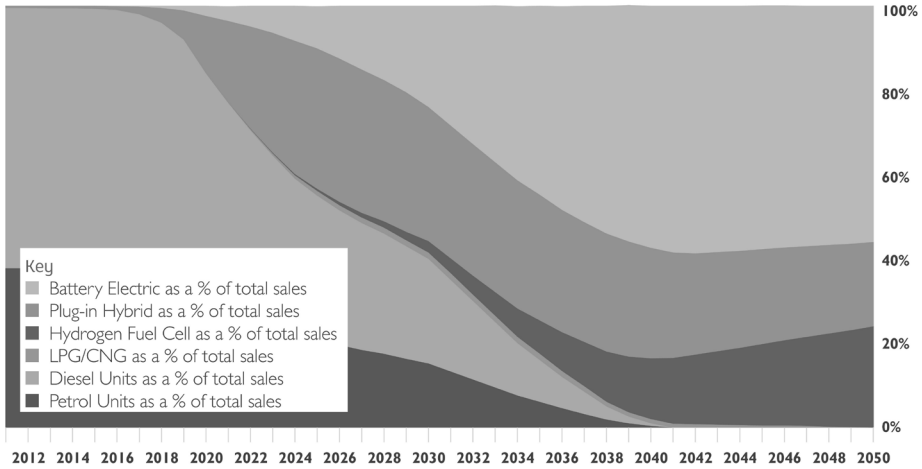

Figure 11.5: Market Outlook for the potential diffusion of Electric Vehicle propulsion systems throughout Scotland's car fleet. Source: Transport Scotland (2013).

Tactical transition activities

The Strategic Vision for the e-mobility transition set out in Switched on Scotland represents an aspiration which will require transformational changes in car fleet composition and the structure of ancillary systems. To bridge the gap between ambition and realism, the transition strategy sets a series of *Enabling Measures* which are associated with the different components of the Transition Framework (Figure 11.4). These measures concentrate on the issues for which the Scottish Government has the means to act, to allow effort to be focused on delivering achievable outcomes, and are temporally synced to the Market Outlook.

With the Scottish Government representing one of the largest car fleet operators in the country, one of the Enabling Measures is assigned to utilising public procurement policies to promote the deployment of EVs in the early stages of the market. Regulations aimed at increasing the visibility of the benefits stemming from the purchase of an EV and to guide procurement decisions have been produced (Transport Scotland, 2014). The installation of such regulations displays public sector leadership in the shift towards e-mobility, assists in demonstrating the functionality of EVs to the general populace and provides confidence to private sector firms to invest in the market.

Whilst the Scottish Government has the ability to regulate purchasing behaviour within its own fleet, its legislative authority concerning the management of the entire car fleet in Scotland is constrained in two areas which may limit its ability to stimulate the early market for EVs. First, the UK Government has reserved the

power to set fiscal policy concerning transport fuel duty and vehicle registration and circulation tax rates (Butcher, 2015). This restricts the Scottish Government's ability to stimulate EV adoption through alterations to the taxation policy surrounding the vehicle market. An example of such an alteration is Green Fiscal Reform (Ekins *et al*., 2009), whereby tax rates on environmentally damaging activities (such as the purchase and operation of vehicles with high emissions levels) are increased whilst tax rates on activities viewed as public goods (such as employment) are reduced to produce a revenue neutral outcome. The second constraint is associated with the powers reserved by the European Union to set vehicle fuel efficiency and emissions regulations, with one of the current targets stipulating a requirement for automotive manufacturers to have an average emissions factor for the cars they sell within the union to be no greater than 95 grams of carbon dioxide per kilometre by 2021 (European Commission, 2014). The ability of the Scottish Government to put in place more stringent targets or to alter the approach to setting targets in this area is thus restricted to its ability to influence the legislation set concerning this issue at the European level.

Operational transition activities

The Enabling Measures of the transition strategy detailed in Switched on Scotland tend to cover intermediate objectives which are aimed at realising the Strategic Vision for an e-mobility transition. To generate a link between the Enabling Measures which are required to promote EV adoption and the immediate activities of governance, a set of *Actions* have been developed. These Actions cover more tangible activities with clearly defined outcomes intended to direct day-to-day operations. A number of these Actions involve identifying niche markets for EVs to deploy in, which provides an opportunity for EV performance to be evaluated and acts as a platform for EVs to enter the mainstream market. With the car market expected to see the proliferation of innovative business models over the next decade, the potential to connect the diffusion of EVs with the promotion of alternative vehicle access solutions represents a clear opportunity for niche market deployment (Shaheen & Chan, 2015). Linking the e-mobility transition strategy to policies aimed at developed car club operations in Scotland offers dual benefits in promoting sustainable mobility by reducing the need to own private vehicles and encouraging the use of EVs. A wider interpretation of this is that understanding how the Actions associated with a specific transition strategy can feed into and receive input from tangential government operations may assist in identifying prospects for joint initiatives.

Associated with the procurement regulations aimed at promoting EV uptake amongst public sector fleets, a £3.6 million fund has been made available to Scotland's local authorities which aims to bridge the purchase price differential between an EV and a conventionally fuelled vehicle (Transport Scotland, 2010). Adoption of EVs amongst local authority fleets provides both a niche market for EV deployment and allows for this technology to be evaluated across a range of different conditions and circumstances. This example illustrates the cooperation which is

often necessary between national government, that has the capacities necessary to develop transition strategies, and local government, which has control over much of the transport systems throughout Scotland's settlements. This control covers a number of areas which could be of use in promoting EV diffusion such as parking regulations, the installation of EV charging infrastructures alongside the potential to introduce low emission zones. Thus, with a transition strategy being set at the national level but the ability to perform actions to promote EV adoption being held in part by local authorities, there is the potential for a disconnection to emerge between national strategy and local activity if coordination in transition activities is not pursued.

Reflexive transition activities

The topic of e-mobility transitions alongside the market potential of EVs has seen significant levels of attention over the past decade leading to rapid developments in the understanding of sector conditions. This pace of change leads to a situation where any established transition strategy will quickly become outdated if it is not reviewed and amended to account for new developments. To ensure that Switched on Scotland benefits from emerging insights, two mechanisms have been installed into the transition strategy to allow for reflection and adaptation.

The first mechanism involves arranging regular events with stakeholders in order to provide forums for the discussion of recent developments and gather opinions on points of interest. In order to link the events to the existing structure of the transition strategy, each of the forums is connected to one of the components of the Transition Framework (Figure 11.4) which acts as a focus point for the forum's discussion. These forums follow a regular format, whereby external speakers who are engaged with the e-mobility transition are invited to share their insights followed by open discussions surrounding the particular topic of focus. Through these discussions, emerging issues are identified and the potential consequences for the transition strategy are considered. The second of these mechanisms relates to scheduled appraisals of the transition strategy, which formally review the progress made to date and considers if amendments to the structure of the strategy are required to either account for changes in sector conditions or to improve the strategy's effectiveness.

Conclusions

The use of governance to steer socio-technical transitions in key systems onto sustainable trajectories through the development and deployment of transition strategies is becoming an important means through which to generate desirable futures which are harmonious to societal objectives. Using the transition towards e-mobility as a case study, this chapter investigates the activities of governance in Scotland in an effort to demonstrate how transition management operates across different timeframes which range from long-term strategic visioning to short-term actions. Through the evaluation of the transition strategy developed by the Scottish

Government, it is apparent that not all options are on the table, with the activities of governance being constrained by a mixture of different issues. A number of these constraints have been described in this chapter and reflect the restricted authority of the Scottish Government to manage the transport system alongside the situational context of Scotland as a nation. However, governance constraints can also extend beyond these issues to incorporate considerations such as the political acceptability of transition activities, the allocation of resources to support transition activities and the experience levels of managers assigned to develop and deploy transition strategies.

Understanding the constraints which governance faces will likely represent an important step in producing an effective transition strategy for two principal reasons. First, charting the presence and extent of the constraints which restrict transition management activities will be of benefit in the short-term by allowing effort to be directed at issues over which governance has an adequate degree of control. The issues which can be affected by governance represent areas where governance agency should be directed so that resources are allocated efficiently. Additionally, charting the governance constraints which are present can assist in understanding when the authority to affect a specific issue is held at either a different level of governance or with a different transition actor. An appreciation of how governance authority can be spread across a range of different actors, institutions and levels of governance can prove useful in perceiving where the establishment of strategic partnerships could allow for the agency of a transition strategy to be extended.

Second, with socio-technical transitions generally occurring over an extended period of time, the identification of constraints which are restricting governance at the start of the transition process does not necessarily mean that these constraints are fixed for the duration of the transition process. Constraints may become flexible in the medium to long-term due to emerging conditions which either affect the particular issue being constrained or the ability of governance to exert influence over the particular issue. An example of such a situation might be the further devolution of taxation authority to Scotland from the UK parliament, granting the Scottish Government the ability to set different rates for vehicle registration and circulation taxes in order to encourage the adoption of EVs. With this in mind, governance should not consider constrained issues as representing closed books in transition management, but rather take the opportunity to evaluate what may alleviate the restrictions imposed by these constraints and formulate potential strategies to deploy if alleviation occurs.

Acknowledgements

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