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Paper for *Transport Geography*

Path dependence and technological expectations in transport policy: the case of Finland and the UK

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Research highlights

- Evidence of policy path dependencies and path creation in future visions of transport and transport innovation policy are compared for Finland and the UK
- While the observed emphasis on technological substitution is out of step with climate urgency, policy for demand reduction is nonetheless evident
- We regard this as evidence of emergent, societal innovation and more research is warranted on the processes by which this is entering the policy space

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Abstract

This paper investigates path dependence and path creation in transport policy and related innovation policy in the case of Finland and the UK. The paper uses document content analysis and elite interviews, drawing on literatures on the relationship of institutional and policy path dependency to technological expectations and images of the policy problem. We find that although policy expectations and visions of transport system innovation are still very much focused on motor vehicle technology change in both countries, particularly technological substitution, there are nonetheless indications of acceptance of transport demand reduction policies, which in turn may be regarded as a form of social innovation. Given the importance of transport demand reduction as part of GHG emissions and congestion reduction strategies, there is a need to better understand how policy for social innovation is entering the sphere of transport and related innovation policy and how these processes might be supported.

Keywords

Transport, technological substitution, innovation, expectations, policy path dependency social innovation

1. Introduction

When it comes to transport, the transition to a low carbon economy cannot be achieved by relying on technology alone. While technological options in transport are not yet ready in forms that are publicly acceptable in terms of cost and function (Hoen et al, 2009), limiting global warming to less than +2°C requires sustained and substantial emissions reduction during the period 2010-2020, not later (McKinsey and Co, 2009). This strong temporal dimension to climate policy underpins the focus here on institutional path dependence for private motorised transport. As McKinsey and Co (2009) observe: “If the world wants to set itself on an emissions pathway with a high probability of containing global warming below 2 degrees Celsius, taking action is urgent. The window for an effective response to climate change is relatively narrow – explicitly, the next five to ten years”. In the transport sector, it is increasingly implausible that the necessary technological options could be deployed in time at sufficient scale – it is only when combinations of low-carbon energy carriers and advanced vehicle technology become available at a large scale that 65-95% CO_2 reduction targets can be met by the sector (Hoen et al, 2009).

This temporal constraint is the main reason why demand reduction in mobility is not only important but crucial (Hoen et al, 2009). It is why the scope of the innovations conceived of as relevant to transport policy needs to be broadened to include measures that assist in demand reduction, including forms of social innovation. Importantly, the field of relevance extends beyond transport technology and into alternative modes of land use planning and practices (particularly cycling and walking) that involve both marketable and non-marketable forms of innovation. Some newer policies for transport demand reduction might also be treated as a form of social innovation, which Howaldt and Schwarz (2010, p.21) more specifically define as "new combination and/or new configuration of social practices in certain areas of action or social contexts prompted by certain actors or constellations of actors". While the vehicle technology focus of transport-related innovation is understandable, it does nonetheless reflect particular ideologies of action, notably ecological modernisation and a liberal market ethos (Schwanen et al, 2011).

Currently the rate of global decarbonisation is so slow that even doubling this rate keeps the world on an emissions trajectory consistent with 6 degrees of warming by the end of the century (PWC, 2012). To address this problem, we need a broader interpretation of innovation in all sectors, at least akin to the definition of Meuss and Faber (2012, p.68-69): "Innovation means the development and implementation of new ideas and knowledge into a socially and economically successful product, process or service innovation" - to which we can clearly add 'environmentally successful'. Conceptually, social innovation contributes to the wider approach of system innovation advocated as a means of disrupting environmentally damaging production and consumption structures (e.g. Weber and Hemmelskamp, 2005) and facilitating their transition to more sustainable directions (e.g. Kemp et al. 2012). In the case of transport, this implies a need to prioritise architectural innovation - defined as linking existing technologies in new ways (Meeus and Edquist, 2006) and as involving processes crossing sectoral boundaries and benefiting from social innovation – over modular innovation, defined as changes in the core concepts of technologies but maintaining existing linkages (Henderson and Clark, 2004), such as in the case of electric vehicles, biofuels and other technological options that maintain rather than disrupt mobility patterns. Practical challenges to achieve this in transport policy include uncoordinated or even incoherent policies between and within local-regional and national governance levels (e.g. in Finland: NAoF, 2011).

A further reason for not relying solely on technology in transport carbon emissions abatement relates to the issue of the scale of resources required to maintain mobility patterns and their replication globally: such is the energy density of fossil fuels relative to lower carbon alternatives (e.g. Giampietro and Mayumi, 2009; MacKay, 2009) that demand reduction for mobility is necessary if needs currently met through mobility are to be met in future, assuming on-going economic development globally. Given this, and reiterating that technological substitutes and efficiency improvements are unlikely to be in place on the necessary timescale, one might look for, if not expect: (a) a shift in transport policy towards representations and assumptions of transport futures in which demand for mobility reduces; and (b) representations of transport in innovation policy in which technological change is accompanied by behavioural and other measures that support demand reduction. As Bannister (2008) identifies, technological innovation is but one of several options available in the sustainable mobility paradigm, the others being: (i) reducing the need to travel through substitutional methods such as use of telecommunications; (ii) modal shift, to transportation modes that reduce use of the private car; and (iii) land use policy measures that reduce the distance that people need to travel to meet their needs.

Accordingly, our purpose here is to provide an assessment of the relative balance of policy for societal and technological innovation in the key transport policy and innovation policy documents of the UK and Finland, two developed countries with contrasting scales of car economy but similar levels of car usage. That we find a mixed picture, with transport policy visions that include climate mitigation goals being met primarily through technological innovation, but also with some reference to measures intended to reduce demand for private motor vehicle transport, may come as little surprise, but nonetheless raises a number of questions. In addition to documenting the status quo in terms of the relative balance of technological and non-technological expectations in transport and transport innovation policy, the questions that we focus on here are: why technological options continue to dominate and what processes may be involved in eroding this dominance. Regarding the first, we characterise the observed emphasis on technology innovation in transport policy as a form of institutional path dependence arising from a range of prior commitments, reinforced by economic objectives and dynamics and supported by scientific and technological partnerships across governmental, academic and commercial sectors. Regarding the second issue of change processes, we draw on the literature of policy change as punctuated equilibrium (originally Baumgartner and Jones, 1993) and, while finding the situation nuanced in terms of the balance of technology and non-technology references, ask how variety in policy responses might be encouraged.

Others have also observed that the specific policy directions shaped and followed by transport policy institutions may be path dependent, with governance systems that are resistant to change (e.g. Mees, 2000; Geels et al. 2011). Yet despite a large and multi-disciplinary literature on low carbon transport, there is little work on the representation of transport-related innovation in policy or in relation to path dependence and path creation in socio-technical systems. For the reasons given above in terms of the need to reduce private motorised mobility (i.e. a mismatch of the time scale of required emissions reductions and the deployment of low carbon, private motorised transport technologies), here we particularly focus on the persistence of the specific vision of *continuing levels of private motorised mobility* in key transport policy and innovation policy documents of the UK and Finland.

In terms of the structure of the paper, we first introduce the policy path dependence, path creation and policy change literatures as a theoretical framing, followed by an overview of the themes of the most recent transport policy documents in the UK and Finland, focussing particularly on their explicit reference to innovation. We then also consider the representations of innovation that we find, classifying these in relation to the processes of policy path dependence that theory suggests.

2. Theoretical Context

As described above, we are concerned here with the role of visions and expectations in policy path dependence and policy change, specifically the relative balance of anticipated technological substitution and demand reduction in the transport sphere. There is a developing policy literature on institutional persistence, often described as 'stickiness' and path dependence. Generally attributed originally to North (1990), developed by e.g. David (1994) and Pierson (2000), discussions have focussed on the factors that make path dependence, via positive feedback processes, as much a feature of politics as of economics and technology. As policies and politics are integral parts of socio-technical regimes, they are influenced by increasing returns related to industries and technologies. As Levi (1997) and Pierson (2000) observe, the costs of reversing a policy path may become increasingly high, despite the existence of choice points. David (1994) identifies three main conditions that give rise to path dependence: (i) the role of historical experience in forming mutually consistent expectations that permit coordination of individual agents' behaviours without centralized direction; (ii) the information channels and codes required by multi-person organizations to function; (iii) the interrelatedness of the constituent elements of complex human organizations and the constraints that result from pressures to maintain consistency and compatibility within the larger structure.

Related to the expectations and visions of the first condition above are particular modes of science-policy interaction, the most relevant of which here is the dispositional variant of the advocacy model identified by Hoppe (2005: 211). This views science and technology advisors and policy actors as jointly shaping political discourse around a central story line (Hajer 1995), problem definition (van der Sluys 1997), or rhetorical style (Hood 1998) (Hoppe, 2005). These aspects of discourse connect different epistemic and interest communities and government agencies to form interlocking networks of knowledge and power or discourse coalitions (Wittrock 1991, p. 333). One of the ideas that we consider here is that these features of a combined political and technological discourse are acting to maintain policy path dependence, such that where innovation features in (terrestrial) passenger transport policy, it is primarily technological and relates to variants of existing motorised transport, particularly the private car.

In contrast, the idea of path creation relates to path dependence through deliberate and emerging processes that engage in the creation of alternative expectations and visions to support particular socio-technical or technological paths, often through active agency (e.g. Garud and Karnoe, 2001). It is increasingly argued that we need actors who mindfully deviate from dominant systems, to unlock existing paths (ibid). It should be noted, too, that path creation efforts have historically been tied to ideas about (visions of) particular technological trajectories (such as wind power, studied by Garurd and Karnoe, 2003). Rarely do these visions, particularly at the level of national policy, involve or invoke constraints on consumption envisaged decades ago by ecological theorists of a steady-state economy (e.g. Daly, 1991). Yet the documents examined do also refer to options that amount to reducing demand for private motor vehicle use, alongside the more dominant discourse of technological substitution. Assessing whether this heralds a significant policy change will require a retrospective view from the future. At the present time, we can only observe that there are signs of change and seek to account for these.

In seeking to account for policy change rather than path dependence, we draw on an approach that views policy change as punctuated equilibrium (i.e. longer periods of stasis interrupted by shorter periods of change) arising from a change in the image or idea of a policy problem and hence allowing the involvement of new people and new perspectives (Baumgartner and Jones, 1993, 2002; Princen, 2000; Egmond and Zeiss, 2010). Policy stasis in the sense of the continuation of past policy paths is explained by the dominance of closed groups of policy experts, but with policy equilibrium also subject to competitive processes, both between government departments and in wider society, in which actors seek to achieve policy change that is consistent with their agendas (ibid). A change in understanding of the policy problem in question affords entry to these groups or their ideas. Another way in which change may come about is that policy problems may come under scrutiny for one reason or another, such that the associated pressure raises them beyond the routine continuation of the status quo, making them more liable to be areas of change, where new policy interventions are made (Baumgartner et al, 2006).

As traditional, state-centred governance has tended towards the use of multi-sector partnerships, advisory groups and other soft modes of governance (Borras et al, 2007), so has the mix of politics, norms, science and policy become ever-more layered. At the same time, the production of scientifically and technologically informed and focussed visions of the future has become mainstream in policymaking, with 'foresight' exercises now conducted internationally (Calof and Smith, 2012). This articulation of visions is also a key component of sustainability transition exercises (e.g. Rotmans and Loorbach, 2009). Yet, future visions involving new technology in many respects often remain dependent on past structures and ways of thinking (e.g. Wells et al., 2012).

Generating shared expectations of the future helps to co-ordinate action horizontally and vertically, within and between organisations, acting as a 'constitutive force', particularly in the early stages of the social embedding of an innovation, when different options are competing for investment and attention (Borup et al, 2006). Yet such expectations tend to generate self-fulfilling, corresponding action (i.e. they are 'performative') (Brown et al, 2006), such that they can become both 'promise and requirement' (van Lente and Rip, 1998). This may in turn generate material and social path dependencies (lock-in or irreversibility) that themselves become the basis future envisioning, as Borup et al (2006: 293) express it, 'predisciplining' the imagination. Once a technology system has progressed beyond expectations and becomes real, tangible and pervasive, it can be difficult to imagine living without it, or some version of it (ibid). A variety of reinforcing factors can then develop: sunk policy and/or socio-technical costs; shared expectations and information sources; and organisational interconnections, including collaborations of policy and science and technology actors. Moreover, in a situation of shared expectations, justification and legitimation may not be seen as necessary (ibid).

Policymaking and particularly strategic policy documents, as we examine here, may address several alternative or complementary visions, partly anticipating the future but also reinforcing current structures. Future visions typically represent some sort of consensus among the more powerful political actors, such that while government policy strategies frequently refer to a range of technological alternatives (Nilsson, 2005), some options may be more obviously favoured than others (Kivimaa and Mickwitz, 2011). Particular socio-technical transitions strategies also reveal the assumptions underlying policies and tend to connect a range of issues, technological artefacts and behavioural patterns with policy problems and goals (Scrase and Ockwell, 2010; Kivimaa and Mickwitz, 2011).

In the following sections, for the two countries, we first describe how innovation in terms of behavioural or technological change is represented in transport policy and then how transport is referred to in innovation policy. In this way we aim to capture both sides of the inter-relationship of transport policy and innovation policy. We then introduce the evidence for the existence of the path dependency processes referred to above. In summary, these consist of: (i) sunk policy and/or socio-technical costs; and (ii) a set of interconnected factors, comprising: the history of shared expectations; organisational interconnections; shared information sources; and strong collaborations of policy and science and technology actors. It is notable that all, particularly the processes in set (ii), relate to the existence of robust networks. Throughout, we use as evidence sources publicly available knowledge of the organisations involved, innovation and policy document analysis and a number of supporting interviews.

3. Material and methods

3.1 Country selection

The cases of the UK and Finland are selected so as to offer contrasting scales of 'car economy', with UK auto sector turnover being more than 260 times the size of Finland's (based on ACEA, 2012). While we would not expect a simplistic relationship between the significance of car manufacturing to an economy and the degree of policy path dependence therein, not least because in this case Finland and the UK have similar levels of per capita car ownership (ibid), we would expect to observe at least some policy differences related to differing manufacturing or other contextual differences (such as geography). In Finland the auto sector's turnover was €1.076 billion in 2004, while the UK automotive economy had a core manufacturing, distribution and servicing turnover of €287.16 billion (ibid). In 2006, UK-based manufacturers produced 1.44 million cars, 53% of them carrying Nissan, Honda and Toyota badges. In 2008, by comparison, Finland produced 18,376 motor vehicles of all types. The ACEA also emphasise the deep extent of UK government support for automotive R&D, highlighting the €143.5 million Foresight Vehicle programme of R&D projects involving government-industry-academia collaboration.

3.2 Research design and data sources

The research design is one in which the objective is to explore theory on the basis of a small number of cases, for the purpose of subsequent multi-case exploration. In fact much of the socio-technical transitions literature is built on detailed investigation of single cases (e.g. Geels, 2006). Here we use two cases with a degree of contrast to help reveal differences. The main data source of the study is UK and Finnish transport and innovation policy strategies, complemented by seven corroborating interviews in Finnish and UK government departments and agencies involved in transport and/or innovation (e.g. UK Department for Transport; Tekes, the Finnish Innovation Funding Agency; and the Finnish Transport Agency). In both countries, statements of policy direction and intent are chosen, rather than documents relating to regulation or other specific implementing measures, as these set out the broad, guiding vision for a sector. While documents specifying implementing measures are important, they would not serve the present purpose.

In terms of the research process, we first identified the priorities and themes of the transport strategies in so far as they relate to innovation, together with any transport-related themes in central innovation policy strategies. The focus is specifically on innovation policy for transport, hence in the document analysis we compare, for example, the degree of support for private vehicles with demand side management options on the basis of relative numerical incidence of references, the language used and its meaning (in short, the methods of content analysis) (Budd, 1967; Weber, 1990). We also questioned transport policymakers in the two countries on the degree of integration of transport policy and transport innovation. In terms of scope, the focus is on urban passenger transport. In terms of data source analysis methods, document contents were selectively summarised in MS Excel (Meyer and Avery, 2009), noting source, main vision and references to transport systems, traffic management, vehicle technologies, public transport, walking and cycling. The relative prevalence of references to particular themes was noted in addition to tone of reference, defined as positive, negative or neutral.

3.3 Key organisations and documents

In both countries, national transport policy relating to climate change mitigation takes place in the context of European policy and directives, particularly (but not only) the 'biofuels directive' (2003/30/EC), which required that "biofuels or other renewable fuels" constitute 5.75% of the energy content of petrol and diesel sold for transport in member states by 2010; the 'renewable energy directive' (2009/28/EC), which superseded 2003/30/EC and which requires that the share of energy from renewable sources in the transport sector of each Member State must amount to at least 10 % of final energy consumption in that sector by 2020; and EC Regulation No. 443/2009, which sets binding targets for reducing the g/km CO_2 emissions of new cars to an overall average of 130g/km CO_2 from 2012. Here we focus on the national policies that are in part driven by this European context.

In Finland, policymaking influencing transport falls under several ministries; most importantly ministries covering transport and communications, environment, finance, and employment and economy (in charge of both energy and innovation policies).Transport policy is also being developed and implemented by the agencies that fall under the guidance of the Ministry of Transport and Communications. A rather significant administrative reform took place in 2010 when the previously separated agencies for aviation, rail, road and marine transport were merged to a new transport infrastructure agency called the Finnish Transport Agency. This is responsible for maintaining and developing the standard of service in the transport system, overseen by the government. The other important governmental agency is the Finnish Transport Safety Agency. Finnish transport-related research, both technological and policy-related, involves the R&D funding agencies, the Academy of Finland and Tekes, the Finnish

Funding Agency for Technology and Innovation. A notable transport example is the EVE programme – Electric Vehicle Systems Programme 2011-2015.

The key political strategy for Finnish transport is set out in the *Transport Policy Report of the Government to the Parliament* (Council of State, 2012), a successor to the previous transport policy report from 2008 (Council of State, 2008). The other key strategy is the Climate Policy Programme of the administrative sector of the Ministry of Transport and Communications (MTC, 2009).The government has also published a discussion paper called *Transport Revolution* (MTC, 2011), which was a joint paper of different ministries and governmental agencies[1]. On the innovation policy side, the *Research and Innovation Policy Guidelines for 2011-2015* (RICF, 2011) is relevant for our purposes. *The National Innovation Strategy* (MEE, 2008) and the *Goals of the Innovation Department* (MEE, 2011) do not refer to transport at all and so are excluded from the analysis. These are widely considered to be the main statements of intent as regards transport and innovation policy in Finland.

The key public organisations in UK transport and innovation policy currently include the Department for Environment, Food and Rural Affairs (DEFRA), Department for Transport (DFT), Department for Business, Innovation and Skills (BIS), Carbon Trust, local authorities, LowCVP (Low Carbon Vehicle Partnership) and the Research Councils. The chosen documents for the UK analysis are again significant public statements of policy intent: the 2011 White Paper – *Making Sustainable Local Transport happen* (DfT, 2011), the 2007 UK Department for Transport's discussion document *Towards a Sustainable Transport System – Supporting Economic Growth in a Low Carbon World* (DfT, 2007) and its Progress Report from 2008 *Delivering a Sustainable Transport System: Main report* (DfT, 2008). The main UK innovation document chosen for analysis was the *Innovation and Research Strategy for Growth* (BIS, 2011. The UK has a significant commitment to low carbon vehicle innovation dating back to the early 2000s. In the UK, in July 2002 the Powering Future Vehicles Strategy envisaged the UK leading the transition to a low-carbon transport economy over the following 10 year period, and established a 2012 target of 10% of new car sales in the UK having emissions of 100 gCO_2/km or lower (DfT, 2002). In subsequent years a considerable number of organisations and programmes have been established by Government to help meet this objective.

[1] We do not include this in the country comparison in detail, but do reflect some of its content.

4. Results

4.1 Representations of innovation in transport policy

The existing commitments and goals of transport policy in the two countries are key to considering path dependence processes and we provide an overview of these here, with illustrative supporting quotations provided in Table 1. The main goal of UK transport policy is that transport should support economic growth (DfT, 2007). Finland uses the word "competitiveness" (Council of State, 2012) instead, yet the emphasis is the same: transport is viewed as a vital system for the whole economy and should run smoothly. In both countries, the strategies highlight that this should be done in a manner that supports climate policy. Convenience, security, health and environmental problems are also frequent themes in all the strategy documents. Solving the problem of congestion is more dominant in the UK documents, where it is referred to as a priority (DfT 2007, p.49).

In both countries, at least at the strategy level, there is reference to the objective of synergies or co-benefits (such as health and environment), as well as conflicts between different targets. Environmental goals and CO_2 reductions are understood to entail costs, but the motif is that with intelligent action and good planning, ambitious climate policies may also bring economic benefits. Synergies between policies to reduce air pollution and health goals are affirmed. In both countries, cycling and walking are seen not only as a more sustainable transport mode but as a good way to promote an active and healthy lifestyle.

The term *innovation* per se receives little reference in the transport strategy documents and is usually used in the context of technological innovations in vehicles, smart ticketing systems of the public transport or public transport 'services' in general. In the strategy papers there is no reference to either cycling or walking as in any way innovative. There is some general reference to service innovations in transport management in Finland (Council of State, 2012), but these are not identified as a target of specific innovation policies. Broadly, the references to innovation in the key transport policy documents of both countries fall into two categories: references to (a) collaborative, inter-agency and inter-sectoral practice, (b) improved motorized transport technology (particularly cars) and (c) a combination of the two, sometimes in combination with other references such as to the policy context. Table 1 provides examples of these and Table A1 <appended> summarises the strategic goals of the reference policy documents in relation to technological and non-technological options.

Table 1: Representations of innovation in Finnish and UK transport policy: collaboration for improved motorised transport

Source	Inter-agency and inter-sectoral collaboration	Motorised transport technology	Composite
Transport Policy Paper (Council of State, 2012) - Finland	"Upgraded roles of the agencies open up the opportunity to reform the thinking and practices and to develop a more user-acquisition procedures and know-how, so that the market potential and innovations can be fully utilized." (p.8)	"Technology and innovation trends bring new procedures to our use almost daily, which is why future problems should not be tried to fix with today's tools." (p.17)	"To support the implementation of intelligent transport strategy it is necessary to establish national pilot regions for innovation, research and development of the transport system." (p.42)
Climate policy paper Transport 2009 - Finland		"New technological innovation can help to reduce the energy consumption of railway rolling stock." (p.24)	"In 2008 the European Commission adopted a Communication on energy efficiency, in which the promotion of research and the introduction of new innovations was recommended, so that the energy intensity of the economy could be reduced by adding intelligence to components, equipment and services." (p. 19)
Transport Policy Paper (Council of State, 2008) – Finland	"Projects are designed and implemented as larger entities, in which case there is more potential for efficient use of resources and innovations" (p.43)	"To improve efficiency in logistics, Finland must be able to lower transportation costs... new technology, innovation and R&D activities must be able to take advantage of. (p.7)	Profit from the State-owned companies has been used for many years to the transport infrastructure. When shares in annual sales exceed 400 million, the maximum of 25 percent of this (up to a maximum of EUR 150 million)

			can be used for innovation and economic growth-enhancing investments. (p. 45)
Creating Growth 2011 – UK	"We will work with the rail and bus industry on what can be done to stimulate improvement and innovation in the ticket products available to passengers." (p.57)		"We will continue to assess how we can develop the legislative framework to support integration and innovation, and promote interoperability between schemes (end-to-end journeys)." (p. 58) The Government believes that harnessing the innovation and enthusiasm of civil society is essential to tackle the social and economic challenges faced by the United Kingdom. (p. 80)
Delivering Sustainable Transport 2008 – UK	"Through the Transport Innovation Fund, we are making available up to £200 million a year until 2014 to support investment in such schemes [in the context of congestion charges]" (p.29)	"We are also working with the sector to help them to build on existing capabilities, for example in following up the Supporting Innovation in Services report." (p.36)	Our response needs to be cross-modal and involve not only infrastructure improvements but also innovation and behavioural change. (p. 6)
Towards a Sustainable Transport System 2007 - UK	"We will also continue to facilitate research, development and demonstrator projects, including a new Innovation Platform to fund UK R&D into lower carbon vehicle technologies, and a new £20 million programme to support public procurement of innovative	"Encourage and enable low-carbon technology innovation in the transport sector." (p. 44)	"Stern identified three essential elements of policy for minimising the costs of moving to a low carbon economy and reducing emissions in a way which is achievable, affordable and consistent with high and sustained economic growth. These elements are: establishing a carbon price…; encouraging innovation in low

	low carbon vehicles." (p.32)		carbon technologies; and removing barriers to action." (p.9)

The above notwithstanding, while in both countries there is still a strong focus on motorised road vehicles as the main focus of innovation relating to urban passenger transport, there is also the clear co-existence of different approaches. For example in the UK there is a nationally-funded scheme for the local implementation of non-car-based transport projects, the Local Sustainable Transport Fund, to which local authorities bid (DfT, 2013). At a strategy level, both countries state that mitigating climate change calls for shift in the focus of action at multiple levels. Hence the 2008 UK follow-up report recognises that "*...reliance on technology alone may not be sufficient to deliver those targets...”* (DfT, 2008, p.20). It is also worth noting that in the UK, although the land use and planning system is determined at a national level, it is implemented locally and investment in infrastructure relating to walking and cycling is largely the responsibility of regional and local authorities. Indeed, at the time of writing in the UK, steps are being taken to further devolve decisions on local major transport schemes to “Local Transport Bodies (LTBs), i.e. voluntary partnerships of local transport authorities, local enterprise partnerships (LEPs) and possibly others.” (DfT, 2012, p.6).

Finland's policy report from 2012 also states that in order to achieve the necessary emission reductions, there is a need to reduce passenger kilometres as well as renewing the vehicle fleet and developing low-carbon technologies and sustainable fuel options (Council of State, 2012, p.41). Some reference to a different approach is also present in the Finnish interviews (referred to below) and in the Transport Revolution discussion paper. One of the Finnish interviewees emphasised 'mobility management' as new type of an approach, one that has risen up the policy agenda in Finland. The interviewee stated that the government of Finland has sought more information on this issue and has gradually begun to develop corresponding policies relevant to its own context. Transport policy in Finland has long been based on ‘predict-and-provide’, yet in the 2012 policy report there seems to be a change in the overall thinking, also evident in the reform referred to above, in which the Finnish departments administering transport have been re-organised such that transport modes are no longer dealt with by separate administrative units.

At least given the differing local/national responsibilities in the above, it could be argued that it is to some extent not surprising that there is little emphasis on non-motorised transport in national transport and innovation strategies. Yet we would suggest that the differing level of attention given to social and technological innovation relates more to the sunk investments and economic path dependencies involved. The budgets allocated to local 'soft' schemes and national infrastructure schemes are profoundly different. In the UK, the funding allocated to the Local Sustainable Transport Fund to encourage cycling, walking, public transport, including a variety of 'smart' (e.g. ticketing-related) projects is an average of £150m (176.41m euros) per year for the period 2011-2015, i.e. (this excludes funding to London Transport). In contrast the 2013-14 (one year) budget of the UK Highways Agency, responsible for operating, maintaining and improving England's strategic road network is £2.91bn (3.42bn euros) (Highways Agency, 2012). Similarly the annual spend of Network Rail, the UK agency responsible for operating and maintaining Britain's railways system (not the trains themselves), is budgeted as £7.58bn (8.92bn euros) for 2014-19 (Railnews, 2013). While local cycling, walking and public transport schemes could and (we would suggest) should be expanded with larger budgets, the long-distance, national network systems by their natures demand a substantial fraction of the transport budget. National road and rail systems are necessary to sustain prevailing economic patterns, while at the same time reproducing those patterns; and both rely on motorised transport. With high costs and high economic importance, national, motorised systems take the large share of policy attention; yet the technological options by which their climate impacts can be reduced are being realised too slowly, without a commensurate policy response in terms of mitigating alternatives.

4.2 Representations of transport in innovation policy

Both countries aim for innovation policies that support 'sustainable' growth and employment: innovation policies are conceived of as being about the promotion of "high-quality information and knowledge creation" (RICF, 2011) and the "development of new products, services and processes, which may be based on cutting edge research" (DfT 2011). Beyond this, though, the Finnish Innovation Policy Guidelines are rather general and make little reference to the transport sector. The transport sector is referenced only twice and transport innovations are referred to only in the context of public procurement. Apart from this, the only transport-related subject referenced is biofuels, which have an important role in Finnish transport and energy policy[2]. Interestingly, in the Finnish interviews, while the role of electric vehicles was very prominent, this isn't (yet) strongly reflected in the policy papers. Usually the ministry refers to innovations in rather a general manner and leaves matters of substance to the research organizations, particularly TEKES, the Finnish innovation funding agency.

[2] Finland has a national transport biofuel target of 20% by 2020 (Act 1420/2010), using the accounting rules of the EC Renewable Energy Directive, which give additional weight to particular sources.

The Finnish interviews also emphasized the economic co-benefits of technological innovation in the transport sector. For example:

"Innovation policy objective is generally to promote the development and use of new environmentally friendly solutions, which can also be seen as international business growth opportunities. Biofuels for Finland are useful in many ways – they are a high-value-added eco-friendly product; we can use domestic biomass as raw material, which will improve self-sufficiency and the current balance of payments; there is also a growing demand from international markets."

Even more clearly: *"In the electric vehicle sector, we have also started by taking advantage of strong domestic expertise and by that search for a lucrative, high value-added niche in global networks. As a bonus we could also get rid of fossil fuel sources, which would improve our balance of payments, although current electric vehicle volumes have only marginal effects."*

The UK Innovation policy paper (BIS, 2011) is similar in its economic focus, referring to low carbon vehicle technologies as one of the sectors where UK is already one of the world leaders (DfT 2011). The sector is supported by the Industry-Government Automotive Council as an initiative working to deliver a range of new low carbon technologies and supply chain opportunities in the UK. The UK's innovation strategy also refers to the role of public procurement as a method of promoting innovations. Low carbon vehicles are referenced as one of the three targeted areas in this respect. The role of the cross-Government Low Carbon Innovation Co-ordination Group has become important in setting UK innovation priorities relating to lower carbon emission technology, specifically via its leadership of the UK's Technology Innovation Needs Assessment process, through which technological innovation priorities are determined[3]. Biofuels are subsumed within the Bioenergy TINA, but while a transport TINA has been discussed (DECC interviewee), there is no such exercise at the time of writing.

Two Finnish interviewees took the view that current Finnish innovation funding policy does not actively guide funding projects aimed at creating services innovations, mobility management

[3] For further detail please see: http://www.lowcarboninnovation.co.uk/about_the_lcicg/

innovation or innovation related to transport system as whole. There is some discussion about whether TEKES (the innovation funding agency) should fund the local authorities, which are often responsible for mobility management. Currently there is no funding available for public sector to innovate in terms of new ways of working and proving services. Indeed, some of the Finnish interviewees considered that there is a need for new type of funding for public authorities related to innovations. The situation in the UK is similar, although the UK does have the Innovation Unit, a social enterprise previously part of the Department for Education and which works to advance practice and improve outcomes in public services generally (Innovation Unit, 2013).

4.3 Path dependence and path creation processes

Regarding the first set of path dependence processes, i.e. long-standing commitments and investments, it is clear that there is an historical commitment to motorised transport in both countries, particularly for the private car. While acknowledging that averages obscure the details of dynamics, patterns and differences (e.g. 2009-10, rail passenger kms increased in the UK by 5.7% while private car kms decreased by 2.9%) (OECD, 2012a and 2012b), the mean per capita distance travelled by private car in 2010 in Finland was 12,063km and in GBR 10,657km (based on OECD, 2012), a combined average of 31km per person per day[4]. A comment by a civil servant from the Finnish Ministry of Transport illustrates an awareness of the problematic nature of the old mobility growth paradigm, though it remains to be seen how far new approaches will take Finland from a paradigm of passenger transport based around private cars:

"Some people say that it (the Finnish Transport Agency) is just a road infrastructure automaton. They have forecast that the traffic flows will increase and that to avoid problems new roads (or bigger roads) should be constructed. And then of course the traffic has increased. This is an example of the old transport policy at its worst... For new scenarios we have used also consultants and we have obtained some new ideas, so that it would not be just the old civil servants doing it."

[4] The problematic nature of this from a climate perspective can be seen when placed in the context of a 2050 per capita UK carbon budget of 2.1kgCO_2 for all economic activity (Upham et al, 2009), which with present passenger vehicle technology would be consumed in some 10km of passenger travel (ibid).

We return to the latter issue of the entry of new policy ideas below, but in terms of the second cluster of processes relating to policy path dependence, namely the expectations, knowledge and organisational interconnections that are shared within each country, the policy and strategy documents of both countries continue to assume that low carbon vehicle (particularly private car) technologies will feature highly in future mobility and this expectation is evidently shared across the policy documents examined and by interviewees. For example when a civil servant from the Finnish Transport Safety Agency is asked what innovations they consider interesting, they reply: *"the integration of intelligent services and vehicle technology. I hope Finland could be part of the global movement to create new applications for vehicles."*

In terms of other specific technological visions, biofuels figure more highly in policy documents in Finland than in the UK. This is a turn-around, given that Finland originally opposed the Biofuels Directive, justifying its low national target for 2005 (0.1%) on the grounds of limited national resources (Government Bill 231/2006). The new Finnish policy development can be explained by the relationship of advanced biofuel production to the established and economically significant forest industry (e.g. Kivimaa and Mickwitz, 2011), i.e. the result of organisational interconnections and prior investments.

5. Discussion

Although the innovation and transport policies of both countries make some reference to the desirability and means of reducing the demand for private, motorised transport, activity considered to be innovation is largely technological, and future visions and expectations relating to urban passenger transport remain largely, though not solely, built around variants of the private car. While there is some experimentation with, and funding of, non-motorised vehicle technology options, emissions reduction is expected to primarily come from vehicle technology change rather than behavioural change. In this respect we see path dependence related to (a) acceptance of the growth of car use and (b) provision of the road capacity to accommodate this (cf. Goodwin, 2003). Despite the technological emphasis of future visions in transport policy and of transport in innovation policy, in general, the two spheres are not strongly interconnected in policy terms.

The limited reference to demand reduction options (Bannister, 2006) does nonetheless beg the question of both the provenance of these deviations from the dominant path – the processes through which these policy references is coming about - and their future prospects, particularly how they will fare alongside strong policy path dependencies. In considering this, our approach to policy change is one that emphasises the role of images of the policy problem and pressures from outside core policy 'venues' that attract the attention of policymakers and hence lead to change in otherwise stable policy states. In this case, plausible pressures might, for example, include policy-level perception of increasing congestion of passenger transport infrastructure. An interviewee at the Finnish Transport Agency cited the reasons for mobility management becoming more important in Finland as being: climate targets and environmental issues; a perception of changing attitudes in Finland; and that the financial resource available for new transport supply infrastructure is decreasing, i.e. economic pressures and the need for co-benefits from pro-environmental policy. This interviewee perceived that colleagues outside of their organisation are increasingly planning in ways that aim to increase employee use of public transport. The interviews indicated that in Finland a further source of this trend is policy diffusion (Walker, 1969) from other countries, with countries cited as influential including specifically the Netherlands, Sweden, UK, other central-European countries and some Arabic countries in terms of 'smart transport'. There may also be a role for policy entrepreneurs (Kingdon, 1995) in this context, i.e. specific, individual policy champions who are able to help catalyse policy change through the introduction of new ideas, though interviewees did not volunteer this view.

In comparative terms, while there is commonality in the central transport innovation themes in Finnish and UK transport and innovation strategies, there are also differences in degree that may, as hypothesised, reflect the different economic significance of the car economy in the two countries. In the UK, the mechanisms of institutional path dependence (North, 1990; David, 1994; Levi, 1997 and Pierson, 2000), particularly the pre-existing commitment to the physical infrastructure of the car economy and the political and economic power that this conveys to various key actors, are reflected in and connected to sustained multi-sector RD&D collaboration. The LowCVP initiative in the UK, for example, referred to below, has continued across the period of several government administrations. In the smaller Finnish innovation programmes, and in a country in which the material underpinning of the bio-economy is more prominent politically, economic interests have played a more supportive role for the development of advanced biofuels, rather than for other parts of the automotive supply chain.

In both countries we see a more engaged situation than one in which government advisors simply help to shape coherent story-lines and future visions, as Hajer (1995) and others posit (Hoppe, 2005). Where government-commercial-academic networks are strong, the actors involved are not only scientific or technological advisors, but also commercial and academic engineers, manufacturers and technology developers. The latter have historically had a strong presence in Finnish innovation policy networks (e.g. Kivimaa, 2007 details multi-sector actor networks in the forestry, pulp and paper sector) and in the UK car manufacturing-related networks are highly market-oriented. Again the LowCVP was established in 2003 as a public-private partnership that "exists to accelerate a sustainable shift to lower carbon vehicles and fuels and create opportunities for UK business" and which comprises some 200 organisations from across automotive and fuel supply chains, vehicle user groups, academia, government departments and others (LowCVP, 2013). Similarly we have referred above to the UK Foresight Vehicle initiative, which ended formally in 2005, in addition to which are Cenex and innovITS, multi-sector initiatives focussing respectively on market development for low carbon transport generally and innovation in the field of Intelligent Transport Systems (ITS) specifically. Both were established by government and are industry-focussed but cross-sector in nature, intended to connect manufacturers, intermediaries, academia and government (TRIP, 2013). The UK also has Knowledge Transfer Networks that complement co-ordinated and collaborative R&D programmes, including those related to vehicle technology, supported by the Technology Strategy Board, an executive non-departmental executive body established by Government in 2007 (TSB, 2013) and an increasingly influential body in UK public sector technology R&D.

For GHG emissions reduction, this determined fostering of technology development networks is of course not problematic per se. Without a doubt, new vehicle types and multi-sector collaborations are urgently required. What we contend *is* problematic, however, is the under-emphasis on policy options intended to help reduce emissions more quickly than is possible through technological development alone. As both interviews and policy documents indicate, future mobility patterns are still seen largely as a continuation of the past, with largely substitutional technological change. The need for actors to mindfully deviate from the dominant socio-technical system, to unlock existing paths (Garud and Karnøe, 2001), is implicitly given some degree of expression in the policy strategy documents analysed. Yet these actors are currently playing a minor, niche role in policy, with very limited reference relative to their potential role in GHG emissions reduction. Moreover their activities are not even conceived of as forms of innovation in their own right. This is despite socio-economic change being axiomatic to the sustainable development literature, in which the premise that change is necessary across a wide swathe of human activity is fundamental. Hence Howaldt and Schwartz (2010) have little difficulty connecting the concepts of social innovation and sustainability – the need for alternative social practices is a natural corollary of sustainability thinking.

In general, this limited interest in demand reduction is likely to reflect the lack of sunk investments and lack of perceived economic gain associated with demand reduction (except in cases when governments need to reduce expenditure in relation to transport infrastructure investments, cf. above). Whereas the economic motives for targeted technological path creation are evident to policy-makers, this is likely less so (though not absent) for demand reduction measures. Moreover, the Finnish interviews suggested that where 'mobility management' is entering policy discourse, it is doing so not so much as a result of indigenous, deviant actors, but more as the result of policy diffusion from other countries and the entry of consultant voices into policy advice. Both the dynamics of this diffusion process and the more limited role of indigenous, deviant actors merit closer attention. There would seem to be a case for strengthening the connections between government and social innovators in the context of transport, but the economic rationale for this is different to that of technology-policy networks. Whereas transport-related innovation policy currently aims to deliver environmental co-benefits alongside exportable technologies, in the case of social innovation aimed at reducing demand for motorised transport, the economic benefits come in the form of avoided costs and negative externalities, environmental and other. To the extent that these costs are bearable and the negative externalities under-valued, so will the value of innovation intended to support behaviour change itself remain under-valued. At the moment it appears unlikely that increasing transport costs or externality valuation will come quickly enough to support the transport behaviour change necessary for emissions reduction consistent with +2 degrees C.

6. Conclusions

Drawing on theories of institutional path dependency, we identify a non-exhaustive group of network-related conditions that are likely to be involved in path dependent contexts. These are: (i) sunk policy and/or socio-technical costs and commitments; and (ii) a set of interconnected, network-related factors: the history of shared expectations; organisational interconnections; shared information sources; and strong collaborations of policy and science and technology actors. We have considered the extent to which these conditions are evident in the transport and related innovation policies of Finland and the UK, using policy document analysis and interviews of organisational actors.

An analysis of the surface passenger policy strategies of both countries reveals an emphasis on innovation in terms of private vehicle and fuel technology rather than on demand-related (social) innovation, a focus that we attribute to the presence of economic path dependency factors. These manifest in the discourse of the policy strategies and materially in the technology development networks that span sectors. Co-existing as niche policy commitments, but not yet as social or policy innovations, we do also find references to measures for demand management. Punctuated equilibrium theories of policy change would suggest that strengthening these alternative visions of the future, bringing them to centrality in terms of expectations, would require the involvement of new voices and agency and a change in perspective on the nature of the policy problem – including a higher valuation of the importance of negative externalities. The importance of social innovation would need to be recognised and demand management measures acknowledged as not only legitimate forms of innovation, but urgently needed forms meriting the resources required to allow them to meet their potential in time to play a real role in mitigating GHG emissions on what is now a very short time scale. The least that one might recommend in this regard would be a more explicit linkage of innovation policy and transport policy, ideally with fuller recognition of the need for transport demand reduction.

Differences between the representations of transport innovation in the two countries do appear to largely reflect economic factors. However this seems to relate less to the relative size and significance of their auto-sectors and more to the significance of other sectors, in particular with biofuels being strongly highlighted as part of the Finnish bio-economy. In contrast in UK policy there is an emphasis on the electrification of transport in the longer term, for reasons that we do not explore here. More generally, as referred to above, in both countries we also note a lack of integration of innovation and transport policies, in terms of both a lack of inclusion of innovation aims in transport policy and of transport-related aims in innovation policy (cf. Kivimaa and Mickwitz, 2006). We cannot yet really observe distinct innovation policy for transport in either country and certainly not an innovation policy for what might be termed meeting mobility services through the variety of means that are possible (Bannister, 2008). Instead what we see are technology-focussed innovation policies designed to achieve environmental and economic co-benefits, which, while likely to contribute to climate targets in the medium to long term, cannot deliver the necessary emissions reductions in the short term. The policy literature suggests that supporting those signs of change that exist may be facilitated by in turn supporting the processes by which such new ideas are entering the policy arena. As this needs to happen much more rapidly, we would suggest that further study of these is warranted.

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References

ACEA, 2012. European Automobile Manufacturers' Association. Country Profiles. Brussels. http://www.acea.be/country_profiles/ (accessed 03.12.12)

Bannister, D. 2008. The sustainable mobility paradigm. Transport Policy 15 (2) 73 – 80.

Baumgartner FR, Jones BD, 1993. Agendas and instability in American politics The University of Chicago Press, Chicago.

Baumgartner FR, Jones B., 2002. (Eds). Policy dynamics. The University of Chicago Press, Chicago and London.

Baumgartner, F. R., Foucault, M., & Francois, A., 2006. Punctuated equilibrium in French budgeting processes. Journal of European Public Policy, 13(7), 1086–1103. doi:10.1080/13501760600924191

BIS, 2011. Innovation and Research Strategy for Growth. Department for Business, Innovation and Skills, London, http://www.bis.gov.uk/assets/biscore/innovation/docs/i/11-1387-innovation-and-research-strategy-for-growth (accessed 03.12.12)

Borrás, S., Conzelmann, T., 2007. Democracy, Legitimacy and Soft Modes of Governance in the EU: The Empirical Turn. Journal of European Integration, 29(5), 531–548. doi:10.1080/07036330701694865

Borup, M., Brown, N., Konrad, K., van Lente, H., 2006. The sociology of expectations in science and technology. Technology Analysis & Strategic Management, 18 (3-4), 285–298. doi:10.1080/09537320600777002

Brown, N., Rip, A., Van Lente, H., 2003. Expectations In and About Science and Technology. A background paper for the 'expectations' workshop of 13-14 June 2003, University of York. http://www.york.ac.uk/satsu/expectations/Utrecht%202003/Background%20paper%20version%2014May03.pdf (accessed 20.06.12)

Budd, R., 1967. Content Analysis of Communications. Macmillan Company, New York.

Calof, J.L. and Smith, J. 2012. Foresights Impact from Around the World: A Special Issue. Foresight (Cambridge), 14(1).

Council of State, 2008. Transport policy guidelines and transport network investment and financing programme until 2020. Government transport policy report to Parliament. Published by Ministry of Transport and Communications, Helsinki. http://www.lvm.fi/fileserver/1708.pdf (accessed 04.12.2012)

Council of State, 2012. Competitiveness and well-being through responsible transport - Government Report on Transport Policy submitted to the Parliament of Finland 2012. In: Communication, M. o. T. a. 2/2012, (Ed.) http://193.166.21.102:9091/servlet/com.trend.iwss.user.servlet.sendfile?downloadfile=IRES-906047748-E4AF8790-27560-27529-86 (accessed 04.12.2012)

Daly, H., 1991. Steady-State Economics, 2nd edition. Island Press, Washington, DC.

David, P.A., 1994. Why are institutions the 'carriers of history'? Path dependence and the evolution of conventions, organizations and institutions, Structural Change and Economic Dynamics 5 (2), 205-220.

Calof, J., Smith, J.E., 2012. Foresight impacts from around the world: a special issue. Foresight 14(1), 5 – 14.

DfT, 2002. Powering future Vehicles Strategy, Department for Transport, London, http://www.lowcvp.org.uk/assets/reports/DfT%20Powering%20Future%20Vehicles%20Strategy%20-%20July%202002.pdf

DfT, 2007. Towards a Sustainable Transport System – Supporting Economic Growth in a Low Carbon World. Department for Transport, London, http://www.official-documents.gov.uk/document/cm72/7226/7226.pdf (accessed 03.12.12)

DfT, 2008. Delivering a Sustainable Transport System: Main report. Department for Transport, London, http://www.letstravelwise.org/files/851931972_Delivering%20a%20Sustainable%20Transport%20System.pdf (accessed 03.12.12)

DfT, 2011. Creating Growth, Cutting Carbon. Making Sustainable Local Transport Happen. Department for Transport, London. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/3890/making-sustainable-local-transport-happen-whitepaper.pdf (accessed 03.12.12)

DfT, 2012. Devolving local major transport schemes: Next steps. Department for Transport, London. https://www.gov.uk/government/consultations/devolving-local-major-transport-schemes-consultation (accessed 24.06.13)

DfT, 2013. Local Sustainable Transport Fund. Department for Transport, London. https://www.gov.uk/government/organisations/department-for-transport/series/local-sustainable-transport-fund (accessed 24.06.13)

EC, 2003. Directive 2003/30/EC of The European Parliament And Of The Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport. Official Journal of the European Union L 123/42, 17.5.2003, (European Commission, Brussels), http://ec.europa.eu/energy/res/legislation/doc/biofuels/en_final.pdf

EC, 2009. Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. European Commission, Brussels

EC, 2009. Directive 2009/30/EC Of The European Parliament and Of The Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC, L 140/88 EN Official Journal of the European Union 5.6.2009.

EC 443/2009. Regulation (EC) No. 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO2 emissions from light-duty vehicles. 5.6.2009 Official Journal of the European Union L 140/1, Brussels.

Garud, R., Karnoe, P. 2001. Path creation as a process of mindful deviation, in: Garud, R., Karnoe, P. (Eds.), Path Dependence and Creation, Earlbaum, Mahwah, NJ.

Garud R, and Karnoe P 2003. Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. Research Policy 32: 277-300.

Geels, F.W., 2006. Major system change through stepwise reconfiguration: a multi-level analysis of the transformation of American factory production (1850–1930). Technology in Society 28 (4), 445–476.

Geels, F., Kemp, R. , Dudley, G. and Lyons, G. (2011) Automobility in transition?: A socio-technical analysis of sustainable transport. Routledge.

Goodwin, P., 2003. Building new roads really does create extra traffic: a response to Prakash et al Applied Economics 35, 1451 - 1457.

Government Bill 231/2006 for the Parliament on the promotion of biofuels in transport.Hajer, M. 1995. The politics of environmental discourse, ecological modernizations, and the policy process. Clarendon Press, Oxford.

Henderson, R and Clark K 2004.Architectural Innovation. In M Tushman, P Anderson (eds). Managing Strategic Innovation and Change, 2nd edition, Oxford University Press, New York. Pp.92-107.

Highways Agency, 2012. Highways Agency Business Plan 2013-14. Highways Agency, multiple UK offices, http://www.highways.gov.uk/

Hoen, A. Geurs, K., de Wilde, H., Hanschke, C., Uyterlinde, M. 2009. CO_2 emission reduction in transport. Confronting medium-term and long term options for achieving climate targets in the Netherlands. Netherlands Environmental Assessment Agency and ECN, Bilthoven and The Hague, http://www.rivm.nl/bibliotheek/rapporten/500076009.pdf

Hood C., 1998. The art of the state. Culture, rhetoric and public management. Clarendon Press, Oxford.

Hoppe, R. 2005. Rethinking the science-policy nexus: from knowledge utilization and science technology studies to types of boundary arrangements. Poiesis & Praxis: International Journal of Technology Assessment and Ethics of Science 3(3): 199-215. Doi: 10.1007/s10202-005-0074-0

Howaldt, J. and Schwarz, M. 2010. Social Innovation: Concepts, research fields and international trends, IMO international monitoring, Dortmund. http://www.internationalmonitoring.com/fileadmin/Downloads/Trendstudien/IMO%20Trendstudie_Howaldt_englisch_Final%20ds.pdf (accessed 19.06.12)

Innovation Unit 2013. Our Story. Innovation Unit, London, http://www.innovationunit.org/our-story

Kemp, R. et al., 2012. Sustainability transitions in the automobility regime and the need for a new perspective. In Geels, F. W. et al. (eds.) Automobility in Transition?, Routledge, pp. 3-28.

Kivimaa, P., Mickwitz, P., 2006. The challenge of greening technologies—Environmental policy integration in Finnish technology policies. Research Policy 35(5), 729-744.

Kivimaa, P., 2007. The determinants of environmental innovation: the impacts of environmental policies on the Nordic pulp, paper and packaging industries. European Environment, 17(2): 92-105.

Kivimaa, P., Mickwitz, P., 2011. Public policy as a part of transforming energy systems: framing bioenergy in Finnish energy policy. Journal of Cleaner Production, 19(16) 1812-1821.

Lenschow, A., 2002. Environmental Policy Integration: greening sectoral policies in Europe. Earthscan Publications, London.

Levi, M., 1997. A model, a method and a map: rational choice in comparative and historical analysis, in: Lichbach, M. and Zuckerman, A. (Eds.) Comparative Politics: rationality, culture and structure. CUP, New York, pp.19-41.

LowCVP, 2013. Members Directory, LowCVP website, LowCVP, London. http://lowcvp.org.uk/

McKinsey and Co, 2009. Pathways to a low Carbon Economy. Version 2 of the Global greenhouse gas abatement cost curve. http://www.worldwildlife.org/climate/WWFBinaryitem11334.pdf

MEE, 2008. The National Innovation Strategy. Ministry of Employment and Economy, Helsinki. https://www.tem.fi/files/19704/Kansallinen_innovaatiostrategia_12062008.pdf (accessed 04.12.2012)

MEE, 2011. Goals of the Innovation Department for 2012-2016. Ministry of Employment and Economy, Helsinki. https://www.tem.fi/files/30745/Innovaatio-osaston_tavoitteet_vuosille_2012_2016pdf.pdf (accessed 04.12.2012)

Mees, P., 2000. A Very Public Solution: Transport in the Dispersed City. Melbourne University Publishing, Melbourne.

Mees, P., O'Connell, G., Stone, J., 2008. Travel to Work in Australian Capital Cities, 1976–2006. Urban Policy and Research 26(3), 363–378. doi:10.1080/08111140802311236

Meeus M, Faber J (2006). Interorganisational Relations and innovation. In J Hage, M Meeus (eds) Innovation, Science and Institutional Change: A Research HIndbook. Oxford University Press, New York. PP. 67-87

Meeus, M.T.H. & Edquist, C., 2006. Introduction. In: Hage, J. & Meeus, M. (Eds), Innovation, Science, and Institutional Change. Oxford University Press, New York, pp.23-37.

Meyer, D. Z., Avery, L. M., 2009. Excel as a Qualitative Data Analysis Tool. Field Methods 21 (1), 91–112. doi:10.1177/1525822X08323985

MTC, 2009. The Climate Policy Programme of the Ministry of Transport and Communication's administrative branch (ILPO). Ministry of Transport and Communications, Helsinki. http://193.166.21.102:9091/servlet/com.trend.iwss.user.servlet.sendfile?downloadfile=IRES-1951811869-E4973EB8-25210-25175-38 (accessed 04.12.2012)

MTC, 2011. Transport Revolution 2011 – Mind Chart. Ministry of Transport and Communications, Helsinki. http://193.166.21.102:9091/servlet/com.trend.iwss.user.servlet.sendfile?downloadfile=IRES-1475081800-110ED918-27560-27529-70 (accessed 04.12.2012)

NAOF, 2011. Ilmastonmuutoksen hillintä (Mitigation of climate change), Performance Audit Draft. National Audit Office of Finland, Helsinki.

Nilsson, M., 2005. Learning, frames and environmental policy integration: The case of Swedish energy policy. Environment and Planning C: Government and Policy 23, 207–226.

North, D.C., 1990. Institutions, Institutional Change and Economic Performance. Cambridge University Press, Cambridge, UK.

OECD, 2012. Trends in the Transport Sector2012. OECD International Transport Forum, OECD, Paris.

Pierson, P., 2000. Increasing Returns, Path Dependence, and the Study of Politics. The American Political Science Review, 94(2), 251-267. American Political Science Association. Retrieved from http://www.jstor.org/stable/2586011

Princen S., 2000. Agenda-setting in the European Union. Palgrave, Basingstoke.

PWC, 2012. Too late for two degrees? Low carbon economy index 2012. PricewaterhouseCoopers, global website, http://www.pwc.com/gx/en/sustainability/publications/low-carbon-economy-index/index.jhtml

Railnews, 2013. ORR sets out £2bn of cuts to Network Rail budget. Railnews, Stevenage, http://www.railnews.co.uk/

RICF, 2011. Research and Innovation Policy Guidelines for 2011-2015. Research and Innovation Council of Finland, Helsinki. http://www.minedu.fi/export/sites/default/OPM/Tiede/tutkimus-_ja_innovaationeuvosto/julkaisut/liitteet/Review2011-2015.pdf (accessed 03.12.12)

Rotmans, J., Loorbach, D. 2009. Complexity and transition management. Journal of Industrial Ecology 13(2): 184-196.

Schwanen, T. Banister D,. Anable J, Scientific research about climate change mitigation in transport: A critical review. Transportation Research Part A 45 (2011) 993–1006

Scrase, J.I., Ockwell, D.G., 2010. The role of discourse and linguistic framing effects in sustaining high carbon energy policy – an accessible introduction. Energy Policy 38, 2225–2233.

TSB, 2013. Technology Strategy Board website, TSB, Swindon, UK.

TRIP, 2013. Transport Research and Innovation Portal, TRIP consortium, http://www.transport-research.info/web/

van der Sluys, J., 1997. Anchoring amid uncertainty. On the management of uncertainties in risk assessment of anthropogenic climate change. Mosterd en van Onderen, Leiden.

van Egmond, S. and Zeiss, R., 2010. Modeling for Policy. Science-based models as performative boundary objects for Dutch policy making. Science Studies 23 (1), 58-78.

van Lente, H., Rip, A., 1998. Expectations in technological developments: an example of prospective structures to be filled by agency. In: Disco, C., van der Meulen, B. (Eds), Getting New Technologies Together. Studies in Making Sociotechnical Order. De Gruyter, Berlin.

van Lente, H., 2000. From promises to requirement. In: N. Brown, B. Rappert & A. Webster (Eds), Contested Futures: A Sociology of Prospective Techno-Science, Ashgate, Aldershot, UK.

Walker. 1969. The diffusion of innovations among the American states. American Political Science Review 63:880-899.

Weber, R.P., 1990. Basic Content Analysis, Second Edition. Sage Publications, Newbury Park, CA.

Weber, M, Hemmelskamp J. (Eds, 2005). Towards Environmental Innovation Systems. Springer, Berlin.

Wells P, Nieuwenhuis, P, Orsato R, 2012. The Nature and Causes of Inertia in the Automotive Industry: Regime Stability and Non-Change. In F. Geels, R. Kemp, G. Dudley, G Lyons (eds). Automobility in Transition? A Socio-Technical Analysis of Sustainable Transport. Routledge, New York. Pp. 123-139.

Wittrock, B. 1991. Social knowledge and public policy: eight models of interaction. In: Wagner, PEA (Ed.) Social sciences and modern states, national experiences and theoretical crossroads. Cambridge University Press, Cambridge.