Developing a business innovation perspective of electric vehicle uptake: lessons from Milton Keynes' electric vehicle programme

Thesis

oro.open.ac.uk

Developing a business innovation perspective of electric vehicle uptake:
lessons from Milton Keynes' electric vehicle programme

Alan Miguel Valdez Juárez, Jul 05, 2014

(79,481 words)

Abstract

Electrification of transport forms a major part of British policy for energy and climate change. The formation of the early market for Electric Vehicles (EVs) has been supported through consumer subsidies, regulatory support, and programmes for the deployment of electric vehicle charging infrastructure, but uptake does not seem to be proceeding at the rate needed for meeting policy objectives.

The approach pursued by policy actors is consistent with the approach of Strategic Niche Management (SNM), which would call for the creation of protected spaces to facilitate the development of new sociotechnical configurations. The Plugged-in Programme (PiP) in Milton Keynes is an example of creating a protective space. A comparison of PiP and other case studies in the literature of sociotechnical transitions identified a gap in SNM that may shed light on the limitations of EV policy in the UK. Traditionally, SNM has been used to monitor and manage interventions in support of prototype or pre-production vehicles. In consequence, there is no precedent for its application in support of early market technologies. The market introduction of innovative technologies can trigger interrelated technological and behavioural changes, affecting the preferences of producers and consumers while altering the demand structure of the sector. However, SNM does not account for the patterns of use and demand implied in what remain largely technological templates for the future.

This thesis begins to develop a framework for the analysis and management of early market strategic niches. Insights from a second discipline, that of social marketing, were sought to complement the analytical tools of SNM. Social marketing is useful for understanding the effect of behavioural and market factors on the adoption of innovative technologies. Social marketing provides a framework for analysing and influencing

behaviour in socially beneficial directions. Behaviour and choice are modulated through the application of a marketing orientation, identifying and addressing needs and creating valuable offerings.

This research is centred on organizational users of electric vehicles (EVs), and explores the effectiveness of the policy portfolio for addressing the needs of early adopters and for building an early market for EVs. Thematic analysis, a form of qualitative content analysis, is applied to evidence from documentary sources, participant observation and interviews with key organizational actors in the community of pioneering and prospective EV users. The analysis draws on concepts from SNM and social marketing to explore previously neglected forces affecting the early market for EVs, with particular focus on the increasing importance of market selection and the competition presented by an entrenched but socially undesirable incumbent.

Contrary to the expectations of policy actors, financial incentives and infrastructure deployment have a limited impact on the choices made by organizational actors. This thesis shows that the processes of learning and embedding that take place within the niche need to be multidimensional. Before a choice can be made, pioneering and prospective adopters of EVs invest considerable effort in the collaborative construction of new patterns of use and demand. This process can be supported by empowering interventions that identify suitable applications (creating multiple sub-niches within the niche) and facilitate the co-construction of new, competitive configurations around them. The models and networks created through this multidimensional, collaborative process translate into capabilities that give distinct advantages to pioneering adopters, allowing them to expand beyond their original niche and outperform the incumbents in mainstream markets.

Acknowledgements

Table of Contents

Index of Tables and Figures

Chapter 1 – Introduction

1.1 Innovation, Sustainability and Competitiveness

The challenge of developing competitive industries and markets around Electric Vehicles, which is central to this thesis, provides a clear example of the conflicting pressures that act on government and industry as they seek to remain competitive during the transition towards a low-carbon economy. The interaction of sustainability and competitiveness has received growing interest in recent policy debates (for instance, in Stern 2007) because policy makers must address apparently conflicting pressures. In order to avert the worst effects of anthropogenic climate change, national policy seeks to foster a transition towards a low-carbon economy, but there are concerns about the negative effects that this transition could have on the economic competitiveness of the nation.

Electrification of transport is an important part of British policy for energy and climate change (DECC, 2009; DECC & OLEV, 2011). Formation of the early market for Electric Vehicles (EVs) has been supported through consumer subsidies, regulatory support, and programmes for the deployment of charging infrastructure. Despite this support, uptake does not seem to be proceeding at the rate needed for meeting policy objectives, casting doubt on the feasibility of challenging the incumbent patterns of automobility based on the internal combustion engine (ICE) (Transport Committee, 2012a).

The predominant innovation policies at the time of this research are based on a perspective of technological determinism, which sees competitiveness as a predetermined function of cost and performance characteristics inherent to technological devices (Heilbroner, 1967; Smith & Marx, 1994). This research is guided by a constructivist

perspective proposing that value and competitiveness of innovative technologies are not determined by technical characteristics, but created from the bottom-up as organizations develop competitive businesses around innovative technologies. This perspective is of particular relevance to the study of sustainable innovations, as they are frequently assumed to be uncompetitive in unprotected markets because of their price and performance characteristics.

The assumption implied by the policy portfolio is that what is beneficial in the short term for individuals and for business organizations is harmful in the long term to society, and that many new technologies with a lower environmental impact cannot be adopted without incurring a significant economic penalty. This assumption is also visible in recent academic works stating that "*most 'sustainable' solutions do not offer obvious user benefits (because sustainability is a collective good), and often score lower on price/performance dimensions than established technologies*" (Geels, 2011, p25).

The possibility of challenging this assumed competitive disadvantage is explored in the context of the Plugged-in Places programme in Milton Keynes, which is designed to "*facilitate the shift from a fossil fuel based transport system to a low carbon one based on electric vehicles*", "*encourage the uptake of electric vehicles*" and "*help build the local, regional and national market for electric vehicles*" (Constantinides, 2009, p ii).

The Plugged-in Programme (PiP) is an example of a learning-oriented protective space. Milton Keynes, the focus of this research, was one of the eight regions selected for participation in the PiP programme. Besides addressing public concerns about "range anxiety" (becoming stranded with a discharged battery in a limited range vehicle), it was expected that these independently-run infrastructure deployments would generate a body of knowledge that could be useful for future development of a national recharging network. The

programme provided a critical mass of infrastructure in a number of lead cities or regions, complemented by consumer incentives and other policy actions taking effect on a national level.

This is exactly the kind of scenario for which transition theory and Strategic Niche Management (SNM) (Hoogma et al., 2002) are expected to provide useful insights, but they seem to have limited usefulness for explaining the poor uptake of EVs, or for charting an alternative course of action. The approach pursued by policy actors in Milton Keynes is consistent with the recommendations of SNM, as the PiP programme contributes to the creation of protected spaces (or niches) to facilitate the development of new sociotechnical configurations (ibid).

A comparison of PiP and other case studies in the literature of sociotechnical transitions identified a gap in SNM that may shed light on the limitations of the framework when it comes to providing guidance on EV policy. Traditionally, SNM has been used to monitor and manage interventions in support of prototype or pre-production vehicles, and to analyse the processes that take place in experimental spaces protected from market forces. There is no precedent for the application of SNM in support of early market technologies.

In SNM, niche protection is expected to enter an endgame stage once the prototypes are ready for the market. According to traditional SNM, the endgame for a niche experiment should consist of a gradual withdrawal of protection. However, now that EVs have entered an early market stage, it is apparent that support is still needed because EVs are not perceived as competitive. In fact, evidence from Milton Keynes suggests that new forms of support must be provided, addressing behavioural and organizational barriers to the formation of early markets. The SNM framework needs to be amended in the light of new evidence produced by such early-market niche experiments.

This thesis begins to address this limited understanding of the early-market stage of niche experiments. Insights from a previously unrelated discipline, that of social marketing, are sought to complement the analytical tools of SNM. Social marketing is defined as the systematic application of marketing, alongside other concepts and techniques, to achieve specific behavioural goals for the benefit of society as a whole (French and Blair-Stevens 2006). The discipline seeks to influence choice and behaviour in socially beneficial direction by identifying and addressing needs and creating valuable offerings. Unlike traditional SNM, social marketing provides a framework for understanding and addressing the competition, as adoption will not take place unless the marketer can demonstrate that the perceived benefits outweigh the perceived costs (Maibach, 1993).

In this thesis, the dual perspective provided by SNM and social marketing is used to explore the interaction of behavioural patterns and sociotechnical configurations, and their contribution to the competitiveness of new technology. Insights on the formation of early-market niches are used to address one of the central concerns in the transition towards sustainability: the apparent tension between short-term interests of individual actors and the long-term societal wellbeing.

1.2 Research Approach

This research follows a constructivist approach in its exploration of the factors that shape the behaviour and decisions of organizational adopters. Thematic analysis is used to provide a systematic deconstruction of the evidence. The coding stage of the thematic analysis draws on SNM and Social Marketing concepts in order to identify key social, technical and market factors that affect decision makers.

SNM provides a framework for analysing and managing the development of new sociotechnical configurations around innovative technologies within a protected environment.

Social marketing uses the principles of commercial marketing to develop valuable, beneficial exchanges to foster the adoption of socially beneficial behaviours. At their core, both fields seek to address socially undesirable but widespread choices made by individuals in order to foster the adoption of socially desirable alternatives. This novel application of two potentially complementary frameworks can provide insights on previously neglected processes that shape emerging sociotechnical configurations. The contribution of social marketing can provide guidance for the design of valuable exchanges to motivate socially beneficial behaviours centred on sustainable technologies.

This research is guided by three main questions:

- *What dimensions, if any, of the niche building process as observed during the early-market introduction of EVs in Milton Keynes are different to those described in the literature on pre-market niches in SNM?*

- *How should the SNM framework be developed to account for any previously unexplored aspects of early-market niche processes?*

- *What are the implications of early-market SNM for innovation and transport policy?*

Socio-technical transitions are multi-dimensional, multi-actor transformation processes in which society changes in a fundamental way over a generation or more. Transitions can be also be described as sets of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems (Rotmans et al., 2001). Different social phenomena become more or less relevant for different phases in the transition process. Because SNM has been predominantly centred on prototype-stage pilots, it is not clear that

the relevant actors and key dimensions of the early-market stage have been identified. Specifically, an initial review of the literature that took place as this research project was being defined revealed that SNM had a narrow understanding of the market. The dominant conception restricts the market to a rational collection of buyers and sellers, rather than as a societal process that enables mutually beneficial exchanges (Araujo et al., 2010). A marketing orientation was considered necessary for developing an updated conception of SNM. The marketing orientation prevalent in social marketing aims to discover the current, future and unspoken needs of a target audience and to create the goods and services to satisfy them (Kotler, 1971; Kohli and Jaworski, 1990).This orientation is reflected in the design of this research under joint supervision of the Engineering and Innovation Department and the Open University Business School.

The objective of SNM is not to profit from the innovation. Rather, innovative sociotechnical configurations are nurtured to foster change in a socially beneficial directions. Owing to this societal focus, the perspective provided by social marketing was found more compatible with the goals of SNM than that of commercial marketing. Social marketing has its bedrock in three basic premises: that social change is required in order to solve the problems of individuals and society, that exchange and persuasion are more useful than force or regulation, and that the advanced persuasion technologies developed by marketers can be readily applied for the promotion of targeted, planned social change (Kotler and Zaltman, 1971; Kotler and Roberto, 1989). By including a social marketing perspective in this analysis of the SNM processes taking place in Milton Keynes, this research sought to provide insight into previously neglected aspects of niche building, like the co-creation of value and competitiveness, and the behavioural aspects of sociotechnical change. The opportunity to observe the PiP programme and related policy measures taking place in Milton Keynes

provided insights into a crucial but neglected stage in the transition towards sustainable road transport.

This research uses qualitative data collected during interviews and participant observation, as well as drawing on documentary sources, to explore the match between the support measures provided by policy actors and the needs of pioneering users within a protected space. Because the local support programmes are expected to provide lessons applicable nationwide, the processes linking local experiments to the national context are also documented. The case study centred on pioneering organizational users and potential users of EVs operating in Milton Keynes and its surrounding areas during the duration of the PiP programme. This case sought also to provide generalizable lessons about the interaction of sustainability and competitiveness considerations, and their effect on shaping the patterns of utilization, consumption and production.

1.3 Research Scope

The design of this thesis seeks to make the most out of a valuable opportunity to observe a programme supporting pioneering Electric Vehicle (EV) adopters in the town of Milton Keynes. Milton Keynes is one of the eight locations selected nationwide for the first round of the Plugged-in Places (PiP) programme for the deployment of EV charging infrastructure. The duration of this doctoral research closely matched that of the PiP programme, which took place between the years 2011 and 2013. The Milton Keynes PiP programme is studied in the context of a series of nationwide policy measures that sought to foster adoption of Electric Vehicles (EVs) to reduce the carbon emissions produced by ground transport.

The PiP programme provided support to consumers as well as to organizational users. However, this research concentrates on organizations because the link between

competitiveness and adoption is more clearly defined for organizational users. Individual consumers, if they are affluent enough, may adopt sustainable technologies at an economic loss. Organizational decision makers, on the other hand, cannot embrace sustainability at the expense of competitiveness without breaking their fiduciary duties. If they desire to adopt innovative, sustainable technologies they must develop new practices and configurations that make a competitive use of the new elements. The decision to concentrate on organizational decision makers was also motivated by their impact on the availability of sustainable technologies for consumers and business users.

This research is concerned with the configurations and behaviours that develop around innovative products, with the development of the products themselves falling outside of the research scope. Thus, the research does not look at the firms in the industrial supply chain, but at organizations whose operations and offerings make use of the innovative products. Particular attention is paid to the decision makers responsible for integrating the new products into their operations and offerings, making them available to consumers or to organizational users downstream.

1.4 Thesis Structure

This thesis is organized in seven chapters, plus appendixes and a references section, as follows:

Chapter 1, Introduction, introduces the subject and general research problem, describes the approach pursued in this research, and outlines the thesis structure.

Chapter 2, Setting and Research Context, establishes the setting and context for the research, documenting the global and national policy trends and societal concerns leading to the situation being studied. This chapter also describes the state of EV technology and its

market at the beginning of the programme, as well as the developments taking place in Milton Keynes leading to its participation the Plugged-in Places programme.

Chapter 3, Literature Review, reviews the literature of several fields that were identified as relevant for understanding the phenomenon under study. The framework used for this research draws on two distinct bodies of literature, those of socio-technical transitions and social marketing. The literature of a third field, innovation studies, was also reviewed because of its enduring influence on policy design. After looking at the historical development and state of knowledge in the relevant fields, this review identifies gaps to be addressed by this research.

Section 3.1 looks into the literature of technological innovation, paying particular attention to the literature developed around a linear technology push model that still holds considerable influence over technology policies in the UK. In this model, basic research is seen as a starting point that will naturally lead towards applied research and then technical development, with innovation eventually occurring at the end of the chain. The implication is that by supporting research in the beginning of the process, out of the other end will come contributions to wealth, well-being and national competitiveness. Although the model still holds considerable influence, more recent literature indicates that this lineal model tends to omit or stylize[1] the social aspects of technology.

Section 3.2 explores the literature of socio-technical transitions, a relatively recent field that frames the interplay of technology and society in terms of evolutionary processes, where mechanisms analogous to those of natural selection lead to the successful reproduction of the fittest configurations. The broad field of transition studies encompasses several

---

[1] One important difficulty in research is to find an appropriate level of abstraction. The model should be parsimonious enough to avoid distraction by minor details and at the same time rich enough to capture the relevant aspects of the phenomenon. In this context, "stylization" refers to the simplified presentation of an empirical findings concentrating on broad tendencies and ignoring individual detail.

frameworks that can be used for understanding or managing socio-technical transition processes. Strategic Niche Management is a framework of particular relevance for this research. SNM seeks to modulate the selection process in a socially beneficial direction, identifying and reinforcing protective spaces to support promising technologies. Several gaps were identified during the review of SNM literature. The analytical aspect of the SNM framework is highly developed, but its practical operationalization has not been defined systematically, and recent literature (e.g., Smith and Raven, 2012; Raven et al., 2010; Smith et al., 2010) identifies several areas that would benefit from the development of a practitioner toolkit, including that of policy evaluation and monitoring. The SNM framework has been used predominantly in the management of sustainable transport pilot studies. Most of the pilot studies described in the literature are based on prototype or limited-production technologies that were not ready for widespread market deployment. In consequence, the SNM toolkit as it stands is of limited use for analysing a situation like the one found in Milton Keynes, where the pilot is built around a more developed technological innovation that has reached an early market stage.

In order to address this gap, Section 3.3 explores the literature of social marketing. This field makes use of the theories and tools developed by commercial marketers in order to foster socially beneficial behaviours, and it has its bedrock in three basic premises: that social change is required in order to solve the problems of individuals and society, that exchange and persuasion are more useful than force or regulation, and that the advanced persuasion technologies developed by marketers can be readily applied for the promotion of targeted, planned social change (Kotler and Zaltman, 1971; Kotler and Roberto, 1989). The literature review also revealed a growing interest in the factors within the social environment (or "upstream factors") that constrain and shape individual choices. The scope of social marketing has expanded beyond its original public health focus, and applications related to

other societal problems including sustainability and environmental issues are being developed. Nonetheless, the literature reviewed identified a need for theoretical tools relevant to the analysis of the upstream environment, particularly for sustainability related behaviours.

Section 3.4 discusses the potential conceptual bridges and common goals uniting social marketing and SNM, as well as the application of their complementary perspectives to provide direction in a multi-disciplinary analysis of early-market niches in sustainable transport.

It should be noted that the literatures discussed in this chapter are undergoing a rapid evolution and are subject to lively academic discussion. This literature review examines the state of the field at the time that the analysis took place. Relevant literature published after the analysis took place is addressed in the discussion chapter, Section 7.5 (Epilogue).

Chapter 4, Research Design and Methods, describes a research design based on a case study that builds on a qualitative analysis informed by SNM and social marketing perspectives. Section 4.1 develops the research questions at the core of this research design, which are refined after examining the general research problem through the lens of the literatures discussed in Chapter 3. Section 4.2 explains and justifies the design of this research, and establishes the scope and unit of study for this revelatory case study drawing on qualitative thematic analysis. This research design is based on an abductive logic of enquiry, confronting theory and evidence to perform successive modifications of the original framework. Modifications are introduced partly as the result of unanticipated empirical findings, but also of theoretical insights gained during the process. Because it is based on a confrontation of theory and evidence, an abductive research design may appear similar to one based on a deductive logic of inquiry. In the case of abduction, however, the aim is not

hypothesis testing but theory-development. A research based on abductive logic is justified because the SNM framework has not been applied in support of early-market innovations, making theory-development necessary. The application of SNM in this new situation calls for an expansion of the framework, and has the potential for development of the underlying theories. Section 4.3 provides a description of the data sources used in this research, based on the analysis of trade literature and policy documents, as well as on interviews with organizational decision makers and participant observations that took place during business user workshops organized by the Open University in the context of the Plugged-in Places programme. This section also documents the procedures followed for the selection and collection of evidence.

Chapter 5, Data Gathering and Analysis, details the implementation of the analytical method used in this thesis, showing the procedures followed for producing a thematic analysis of the discourses of actors involved in the processes of organizational EV adoption. Section 5.2 describes the contents of the different data sets feeding into the analysis. Section 5.3 describes the operations performed for each of the six steps in thematic analysis as outlined by Clarke and Braun (2006). Preliminary results produced by each step are also provided, when pertinent. Sections 5.4 and 5.5 introduce the overarching patterns identified during the thematic analysis.

Chapter 6, Results , reports the results of the thematic analysis. Section 6.2 provides a description of the overarching themes identified in Chapter 5 and of their prevalence in the various actor categories that contributed to the experiment. Section 6.3 recontextualizes the results, linking them back to the context of Plugged-in Places in Milton Keynes through the application of the SNM case study format. Application of the SNM format also contributes to drawing attention to the core niche processes that took place within the experimental space

created by the PiP programme, providing a springboard for discussing the practical and theoretical contributions of this research.

Chapter 7, Discussion and Reflection, draws on the insights developed through the application of thematic analysis and the SNM framework to reflect on the original research questions and on the practical and theoretical contributions of this research.

Section 7.2 looks back at the questions that shaped this research project. Section 7.3 addresses the contributions of this thesis, with different sub-sections discussing the contributions of this research to SNM and social marketing, and the contribution that the combined application of both fields can make to innovation and transport policies.

Section 7.4 provides a critical reflection and suggests future directions for this research. Because socio-technical transitions can take several decades to develop in full, this thesis can only provide a snapshot of a particular stage of the process, owing to the limitations inherent to a three-year PhD project. Section 7.5 provides a discussion of recent developments in Milton Keynes that illustrate the ongoing impact of the niche experiment, and that exemplify the holistic approach towards SNM that was developed in this thesis.

Mainly, evidence from PiP suggests that policy measures based on financial incentives and narrowly defined infrastructure deployment projects are not sufficient to support niche formation processes. Those processes are identified as crucial to the design of valuable exchanges at the interface between consumption and production, in the form of competitive business models that empower pioneering users.

Recent literature (Mazzucato, 2013; Wells, 2013) also suggests a growing interest on the role of innovative business models and entrepreneurship in socio-technical transitions, an interest that is also seen in high-level policy makers in the United Kingdom. This is exemplified by the speech by Baroness Kramer in her first official appearance after being appointed Transport Minister: "*While government is providing significant funding to develop*

the technology, expand the infrastructure, and reduce the cost of electric vehicles to buyers, ultimately building the market requires initiative and entrepreneurial flair at a local level"(Kramer, 2013). This research aspires to contribute to a better understanding of the role of local entrepreneurs and innovative organizational actors play in shaping innovation, as they develop new business and operational models, contribute to the collective creation of value, and integrate sustainable technologies into socio-technical configurations that work better.

Chapter 2 - Setting and Research Context

2.1 Introduction

Chapter 2 establishes the setting and context for this research, documenting the global and national policy trends and the societal concerns leading to the situation being studied. This chapter also describes the state of Electric Vehicle (EV) technology and its market as well as the situation in Milton Keynes at the launch of the Plugged-in Places (PiP) programme. This description of the state of technology includes a discussion about the competing pressures affecting the competition between Electric EVs and those powered by Internal Combustion Engines (ICEs). Transport technology choices available in the market seemed to make environmental sustainability and economic competitiveness mutually exclusive. In consequence, EVs were seen as a socially desirable choice that required government support in order to compete in the market. Because the design of pro-EV interventions was a subject of interest to national and local policy makers, the Milton Keynes implementation of the Plugged-in Places programme must be discussed in relation to national policy. The setting and national context examined in this chapter will be revisited in the SNM case study in Section 6.2, benefiting from the perspective developed after the research.

Section 2.2 of this chapter reviews policy documents produced between the years 2000 and 2012 to identify the trends in British policy leading to the current portfolio of measures in support of EV adoption. Section 2.3 describes the situation in Milton Keynes at the beginning of the PiP programme, as well as national and global factors of relevance to local actors (e.g., the state of technology and the market).Section 2.3 also provides an overview of the management structure and objectives of the team behind the implementation of PiP in Milton Keynes. The chapter concludes by identifying potential gaps in the models

implied by national and local policies, outlining a framework for addressing said gaps. The literatures related to the proposed framework are discussed in the following chapter (Chapter 3, Literature Review).

2.2 Sustainable Transport in British Policy

This section reviews key policy documents related to the reduction of greenhouse emissions for ground transport in the United Kingdom, focusing on the period between the years of 2000 and 2012. The body of policy literature discussed on this section consists of White Papers, reviews and reports issued by or addressed to policy makers at high levels in national government. It must be noted that, because discussion of specific documents is central to this chapter, full titles are used where needed for clarity in addition to standard references by author and year of publication.

The main objective for this review is to provide a context for understanding how the Plugged-in Places EV infrastructure programme, as implemented in Milton Keynes between the years 2011-2013, was related to strategies for low-carbon transport at a national level. The historical review unpacks the assumptions and models implicit in the strategies pursued by policy makers. The documents reviewed provide evidence of the priorities and expectations of the actors and institutions shaping national policy on low carbon transport. This research can shed light on the effectiveness of policy interventions in achieving the objectives identified in policy literature related to the PiP programme.

The PiP implementation in Milton Keynes built upon and coexisted with several other policy instruments related to sustainable transport in the United Kingdom. Its objective appeared to be straightforward: to fund the deployment of on-street charging points for electric vehicles. This simple goal, however, built on a series of assumptions, models and

expectations. The documents reviewed in this chapter paint a complex picture. On one hand, they show that policymakers are aware of the social and technical factors affecting the transition towards a low carbon society. Policy discourse reflects a growing awareness of the importance of learning, communication and network-building in that transition. On the other hand, policy measures display a limited toolkit restricted to R&D funding, infrastructure deployment and supply side networking.

2.2.1 Innovation and Sustainable Transport in the UK, 2000 – 2009

There are many potential starting points for a discussion of the policy literature relevant to sustainable transport in the United Kingdom. For the purposes of this thesis, however, only documents published between the years 2000 and 2012 are considered, as this is the period in which the promotion of electric vehicles emerged onto the policy agenda.

Fig. 2.1 provides an overview of the policy documents that are discussed in this chapter, and how they are linked to each other. The arrows represent the influence that each document had on the publications that followed it, as newer documents referenced existing literature. The figure also illustrates how current transport policy has been influenced by multiple departments, parliamentary bodies, and high-level actors in national government. The year 2000 was selected as the starting point for this review because of the enduring influence that the report "*Energy: The Changing Climate*" (RCEP, 2000) has had on British energy policy and, by extension, on transport policy. It is for the same reason that the report is the starting point for the review.

The flowchart contains the following boxes and connections:

Energy, the Changing Climate (RCEP 2000)

The Energy Review (PIU 2002)

Powering Future Vehicles (DFT 2002)

Our Energy Future (DTI 2003)

The Eddington Transport Study (Eddington 2006)

The Stern Review on the Economics of Climate Change (Stern 2007)

The King Review of Low Carbon Cars (King 2007, 2008)

Low Carbon Transport- A Greener future (DfT 2009)

The UK Low Carbon Transition Plan (DECC 2009)

The Carbon Plan: Delivering our Low Carbon Future (DECC 2011)

Making the Connection: The Plug-In Vehicle Infrastructure Strategy (DfT & OLEV 2011)

Plug-in Vehicles, Plugged in Policy? (Transport Committee, 2012)

Figure 2.1: Chronology of key EV-related policy documents.

"Energy: The Changing Climate" was the twenty-second report by the Royal Commission on Environmental Pollution (RCEP), an independent body tasked with identifying and reporting on crucial environmental issues faced by the UK and the world. Upon analysing the energy prospects for the 21st century, the Commission concluded that the threat of climate change made the existing level of carbon emissions unsustainable. A 60% reduction in carbon emissions relative to the 1990 baseline was proposed. The report called for comprehensive policy changes in order to meet it:

> *To bring this about will require government to give much higher priority to energy efficiency, a change in public attitudes, with people linking their own day-to-day use of energy with fossil fuel consumption and the threat of climate change, and a new cultural and institutional framework within which individuals will feel that they can make a difference. To these ends, government should build on its existing energy efficiency policies and campaigns and introduce new ones. Further incentives are required, as are new and strengthened regulations. (RCEP, 2000, p4)*

The 60% target was widely accepted and eventually made into law (the Climate Change act, HMSO, 2008), thus affecting the energy policy of the United Kingdom in the long term. The report also discussed the need to balance economic and environmental concerns. This preoccupation about industrial competitiveness is shared by all the policy documents discussed in this chapter.

The RCEP report was concerned with the broader topic of energy policy, but it singled out improvement in transport as a pressing concern, reporting that energy consumption by the transport sector had risen from 2l% to 34% between 1973 and 1998 largely due to rising volumes of road traffic. Transport concerns continued to play a

prominent role in energy policy during the period studied in this chapter, as the impact of transport on energy consumption kept growing. Transport accounted for 36% of the total energy consumption in the UK in 2012, as reported by the Department of Energy and Climate Change (DECC, 2013).

"The Energy Review" (PIU, 2002) provides another example of a policy document discussing transport in the context of a wider energy policy. The report was produced by the Performance and Innovation Unit, a strategic, cross-departmental advisory body based in the Cabinet Office. It was intended as a report to government, and as such was not a statement of government policy. It had the intention of setting the agenda for discussion and it effectively did so. While previous proposals for cutting down on transport related emissions were based on incremental improvements to existing technologies, policy documents after the Energy Review were based on expectations of an oncoming disruptive change. In the long term, hydrogen and fuel cells were expected to provide a substitute for oil.

The RCEP report and the Energy Review were oriented towards outlining a vision and setting and agenda. In contrast, the "*Powering Future Vehicles*" strategy (DFT, 2002) was intended as a more actionable framework for decision making. The strategy it detailed had a short term focus on high-efficiency petrol engines and biofuels, but long term plans called for a transition to carbon-free transport technologies. Electric technology was discussed as a niche application and a potential stepping stone in the transition towards fuel cells. (Commercial availability of hydrogen- powered clean vehicles was expected by 2015.)

"*Powering Future Vehicles*" had a predominantly techno-centric approach towards transport policy, in which environmental concerns almost explicitly take a secondary role relative to technological development and industrial competitiveness. The two strategic goals

stated in the document do not have any explicit links to sustainability nor to environmental considerations:

> ...*Setting out the right framework for the future will build competitive advantage for UK industry in the global shift to a low carbon transport economy. The objectives of the Powering Future Vehicles strategy are:*
>
> • *to promote the development, introduction and take-up of new vehicle technologies and fuels;*
>
> • *and to ensure the full involvement of the UK automotive industry in the new technologies.*(DFT, 2002, p 4)

The strategy was based on a multi-stakeholder approach, drawing on actors from the automotive, energy and other sectors, with the explicit goal of maximising the potential for UK business to gain competitive advantage from the shift to low-carbon vehicles and fuels. It listed the following stakeholders as relevant to the transition: the automotive industries (including component suppliers, technology providers, and the vehicle sales and after-sales support sectors), the fuel and energy industries, motoring and consumer interest groups, transport operators, environmental interest groups, the finance and investment community, local government, the R&D and academic communities, and other governmental bodies such as the Energy Saving Trust and the Carbon Trust.

As previously stated, "*Powering Future Vehicles"* was specifically concerned with technological and industrial development, and this focus had a visible effect on the stakeholders that were considered relevant. The techno-centric approach focusing on industrial actors was still visible in the 2003 Energy White Paper "*Our Energy Future"* (DTI, 2003).

In principle, White Papers are used as a means of presenting government policy preferences prior to the introduction of legislation, testing the climate of public opinion on controversial policy issue gauging its probable impact (Chapin and Deneau, 1978). In the case of the UK, however, it is not uncommon for White Papers to report on actions that are already in process of implementation. In the case of "*Our Energy Future*", the 60% reduction in GHG emissions suggested by the Royal Commission was made into a hard target, and multiple institutional innovations supporting the new goal were announced. The new organizations were centred on the supply-side, including Fuel Cells UK (a coordinating body and point of contact for the fuel cell industry), the employer-led Sector Skills Council for the energy industry, and the Low Carbon Vehicle Partnership, a cross-sector stakeholder network focused on research and demonstration of low-carbon vehicles and fuels.

The policy documents discussed so far had been based on the expectation of a very gradual transition towards the new technologies. The "*Eddington Transport Study*" (Eddington 2006), which examined the impact of transport decisions on the economy and the environment of the United Kingdom at the request of the Chancellor of the Exchequer, assumed that oil-based transport would predominate at least until 2050.

This assumption made behavioural change a key component of Eddington's strategy. As technology was expected to change very slowly, widespread behavioural changes would be needed in order to make a significant dent on carbon emissions. The behavioural model implied by the policies recommended by Eddington was, however, rather limited. The behavioural changes sought were limited to type and quantity of travel undertaken, and behaviour change tools were limited to information campaigns and simple financial incentives such as carbon pricing. His approach was based on the assumption that rational and price sensitive actors would promptly alter their behaviour in response to economic

signals. In consequence, his policy portfolio did not have tools for behaviour change beyond simple economic incentives.

Policies and strategies made after 2006 followed a similar pattern, focusing on narrowly defined behavioural aims. Technological expectations, however, were changed after publication of the *"Stern Review"* (Stern, 2007). Stern's analysis on the economics of climate change concluded that the 60% reduction in greenhouse gas emissions that had been seen as the target so far would not be sufficient to avoid the worst effects of climate change, and called for a reduction of 80% relative to the 1990 baseline.

While the reductions of 60% proposed by the RCEP could have been achieved with incremental technical innovations, the 80% figure recommended by Stern made radical changes necessary in many fields, including that of transport. In March 2007 the Chancellor of the Exchequer commissioned *"The King Review of Low Carbon Cars"* (King, 2007, 2008), looking for vehicle and fuel technologies which could help to meet the new targets set in Stern by decarbonising road transport over the next 25 years.

"The King Review" concluded that hydrogen and biofuel technologies would not be ready for deployment in time to avert the worst effects of climate change. Widespread deployment of battery electric and hybrid vehicles was seen as a more achievable target. In consequence, technological expectations changed and attention turned towards EV policy.

Publication of the King Review came at a time when high-level institutional changes in the United Kingdom were ready to take place. The Climate Change Act was enacted in 2008, which made into law the 80% target for reduction in greenhouse gas emissions that had been recommended by Stern. Several new institutions were created around this new mandate, including a new ministerial department, the Department of Energy and Climate Change. In 2009 the newly created department published a major White Paper, the *"UK Low Carbon*

Transition Plan" (DECC, 2009), which acknowledged the complexity of the challenge posed by the transition to low carbon transport.

> *Our existing vehicles, fuels and infrastructure are very well established and our economy and lifestyle have built up around them. There are strong links between transport and people's lifestyle choices. Many people see little reason to make greener travel choices. Others may wish to do so, but may not have or be aware of lower carbon ways to travel. (DECC, 2009*, p137*)*

There was a parallel understanding of the complexities of the transition within the Department for Transport, as can be seen in the "*Low Carbon Transport Strategy"* (DfT, 2009).

> *It takes time to change people's perceptions of the performance and reliability of new low carbon vehicle technology. And it takes time to develop the technology to the stage where it is ready to bring to market. Our frameworks must therefore consider the need for a shift in attitudes of individuals and business, as well as the product development cycles for industry. (DfT, 2009,p 39)*

The objective of the "*Low Carbon Transport Strategy*" was to deliver a transformative shift to low carbon road transport by 2022. The strategy outlined several broad action points which included

- leading research, development and demonstration of low carbon vehicles;
- making ultra-low carbon vehicles more competitive for consumers; a
- and supporting the adoption of ultra-low carbon vehicles in lead cities and regions (ibid, p 37).

The guidelines in the "*Low Carbon Transport Strategy*" were related to a series of announcements regarding policy actions that included pilot programmes, financial incentives, research funding and infrastructure deployment programmes (ibid, p 42). Different departments operating on a national scale provided funding for networking groups and events intended to stimulate technical innovation, transfer knowledge from research centres to the industry, and integrate technology providers into the supply chain. Some notable examples are provided in Table 2.1, but a full discussion of those initiatives falls outside of the scope of this chapter because they were not explicitly linked to the PiP programme and they were predominantly centred on the needs of the supply chain.

Because of its importance for understanding the Plugged-in Places Programme, the following section will concentrate on a discussion of the Office for Low Emission Vehicles (OLEV), formed shortly after publication of the "*Low Carbon Transport Strategy*".

Of the new institutions created after the 2008 Climate Change Act, the OLEV is particularly relevant to this research. The office was formed in 2009 in order to coordinate the efforts of the Departments for Transport; Business, Innovation and Skills; and Energy and Climate Change. Because of the importance of this cross-departmental team in the design and management of the PiP programme, Section 2.2.3 is focused on the role of OLEV in British policy.

Table 2.1 – Groups and initiatives related to low carbon transport not covered in this chapter

LowCVP

The Powering Future Vehicles Strategy, published in 2002, outlined official targets and policies for cutting greenhouse gas emissions from the UK's road transport sector. The strategy made provisions for the establishment of a stakeholder partnership intended to provide a structure through which to accelerate the shift to low carbon vehicles and fuels.

The Low Carbon Vehicle Partnership (LowCVP) was established in 2003 as a public-private partnership to accelerate a sustainable shift to lower carbon vehicles and fuels and create opportunities for UK business. Around 170 organisations are engaged from diverse backgrounds including automotive and fuel supply chains, vehicle users, academics (including The OU), environment groups and others.

CENEX

Cenex – the Low Carbon and Fuel Cells Centre of Excellence – was established in April 2005 with support from the Automotive Unit of the Department of Trade and Industry(DTI) to allow the UK automotive sector to respond competitively to the challenges posed by the transition to low carbon and fuel cell technologies. Cenex helps companies develop projects and leverage Government funding, supporting the early market development for low carbon vehicles including electric, hybrid, bio-methane and hydrogen powered vehicles.

EST/PiFi

The Energy Saving Trust, formed in 1992, is a social enterprise predominantly funded by the British Government in order to help fight climate change by promoting the sustainable use of energy, energy conservation and to cut carbon dioxide emissions. This objective is pursued through the provision of evidence-based advice to communities, organizations and households.

In February 2012, the Energy Saving Trust launched the 'Plugged-in Fleets' report, which concluded that EVs can make business sense under the right circumstances when whole life costs are considered. As a result of this report, the EST received funding from TfL and DfT to identify applications where EVs can work practically to fulfil and maximise the needs of the business.

Knowledge Transfer Networks

The launch of the Knowledge Transfer Network (KTN) programme followed the publication of the Renewables Innovation Review (DTI, 2003). The report identified access to networks and sources of new knowledge as two of the most important determinants of business innovation performance. The KTNs were created with the overall objective of accelerating the rate of technology transfer into UK business through several mechanisms, like encouraging the knowledge transfer between the supply and demand sides of technology-enabled markets; encouraging the flow of people, knowledge and experience between industry and the science base, and providing a forum for a coherent industry voice to inform government policy making. There is a growing number of KTNs addressing areas of strategic interest to the UK including, for example, bioscience for business, chemistry innovation and electronics-enabled products. Some of the KTNs are relevant to the transition towards sustainable mobility, particularly the resource efficiency and environmental services KTN (originally, environmental sustainability) and the transport KTN

It must be noted that this list is not exhaustive, as there are many other groups and initiatives with varying degrees of relevance to the transition to low carbon transport, including The Low Carbon Innovation Co-ordination Group , the Energy Technologies Institute , the UK Hydrogen and Fuel Cell Association, the Low Carbon Vehicle Plan, the New Automotive Innovation and Growth Team and the Technology Strategy Board's Ultra low carbon vehicle demonstrator programme, among many others.

2.2.2 Low Carbon Policy and the OLEV, 2009-2012

Discussion of low carbon policy as implemented by the OLEV is of particular interest to this doctoral research, as the Plugged-in Places project in Milton Keynes is directly supported by this organization. OLEV's programme portfolio seems to be a direct answer to King's conclusion that *"in addition to making plug-in vehicles more affordable and stimulating technological innovation, having the right infrastructure in place to support plug-in vehicle owners is the other critical component in maintaining the UK's favourable market position"* (King, 2008, p14).

The initial £400 million budget assigned to the OLEV is divided among the programmes thus:

• £300m for consumer incentives (the plug-in car and van grants)

• £30m for infrastructure deployment (Plugged-In Places programme)

• £82m for research (channelled through the Technology Strategy Board)

This budget implies a relatively simple model. On the supply side, policy actions are mainly focused on fostering technological innovation, with technologies developed by niche actors eventually being incorporated in products by major manufacturers with the support of innovation integrators. (E.g., the LowCVP, a public-private partnership for the development of low carbon vehicles that includes automotive and fuel supply chains, vehicle users, academics, and environment groups). On the demand side, high initial costs and range anxiety[2] are assumed to be the major barriers for adoption. Those barriers were addressed through a two-pronged approach based on financial incentives and infrastructure deployments.

---

[2] Anxiety experienced by EV drivers concerned about the possibility of becoming stranded with a discharged battery in a limited range vehicle (Tate et al., 2008).

"The Carbon Plan" (DECC, 2011) discussed the different components of the long term carbon budgets from the UK. Besides transport, it discussed expected developments in industry, agriculture, housing, and all aspects of the low carbon transition. The approach outlined in the plan was predominantly technocentric, particularly when it came to transport strategy. The transition was expected to be driven by gradual technological improvements rather than by rapid social change. In the short term, increased use of biofuels and improvements in conventional ICES were expected to be sufficient to meet carbon budgets. Consumer incentives, infrastructure deployment and support for research and development activities were proposed as means to achieve near 100% adoption of ultra low emission vehicles, but this was not expected to take place until 2050. A mass market rollout of ultra low emission vehicles was not expected to take place until the 2020s or even 2030s.

"Making the Connection: The Plug-In Vehicle Infrastructure Strategy" (DFT and OLEV 2011) outlined a policy portfolio designed to support the early market for EVs. Previous documents had discussed EVs in rather non-committal terms, as one of several possible alternatives for transport decarbonization in the long term. In contrast, *"Making the Connection"* had the concrete aim of supporting a rapid adoption of Electric Vehicles. The strategy sought to prove the viability of EVs to motorists, while making the UK attractive to the motoring industry. The role for government according to the strategy was tackling infrastructure, tackle vehicle cost and encourage the development of new technology, with the expectation of seeing tens of thousands of plugged-in vehicles on the roads by 2015. The strategy acknowledged that this rapid rate of adoption would involve changes in established practices and preferences of industry, consumers and markets. Engaging with a wide range of stakeholders was considered crucial to ensure success of the transition to low-carbon, including engagement with local leaders and local initiatives (DFT and OLEV, 2011, p 10).

The success of the plugged-in strategy was reviewed by the Transport committee of the House of Commons in the report *"Plug-in Vehicles, Plugged in Policy"* (Transport Committee, 2012a). Although the report was published when this doctoral research was nearing conclusion, it is discussed as part of this background chapter because it provides an accurate picture of the policy environment in which PiP took place. The committee found that the approach followed by the OLEV had yielded mixed results. In one hand, the growth of the EV industry in the UK was considered satisfactory:

The total investment over the course of the last 18 months is around £5.6 billion. Over the course of the next two to three years there will be 15,000 new jobs, tens of thousands of existing jobs safeguarded and a huge opportunity down and through the supply chain in the UK to create a genuine centre of excellence around Europe for low and emerging ultra-low-carbon technologies. (Transport Committee, 2012b, p71)

In contrast, success of the programme on building a market for EVs was rather modest:

Consumer demand has increased since the Government introduced the plug-in car grant, but remains relatively small. In 2011, 1,052 vehicles eligible for the plug-in car grant were registered. We have heard mixed messages from the department of transport about whether this demand is lower than expected or progressing according to forecasts. (Transport Committee, 2012a, p 3)

The 1,052 vehicles registered constitute a definite improvement over the 167 electric vehicles sold in 2010, but they are not enough to make a dent on the emissions produced by the nearly two million new vehicles bought yearly in the UK. Figures for 2012 improved

slightly, and by the end of that year a total of 3,293 eligible vehicles had been registered over the two years of the grant scheme (SMMT, 2013).

The imbalanced results shown by the parliamentary group, with a supply side willing to invest £5.6 billion and a demand side unwilling to buy more than about 1,500 cars a year, might be expected to excite curiosity. It did not. When Norman Baker, Parliamentary Under Secretary of State for Transport, was interviewed in the evidence section of the report, he declared that understanding consumer behaviour was something that they expected motor manufacturers to do, and not a job for the government (Transport Committee, 2012, p 17 of Oral Evidence appendix).

Manufacturers interested in learning more about their consumers and stakeholders would have to do the research on their own, however. The OLEV made provisions for funding of technical research, but market research was not supported. The same applied to those responsible for implementation of OLEV funded programmes, from technology developers to city managers deploying infrastructure. Witnesses consulted by the parliamentary committee lamented that recipients of OLEV funds were not allowed to use their grant in activities related to public engagement or user understanding (Transport committee, 2012b, p 8 of Oral Evidence appendix).

The documents reviewed in this section suggest that there is a mismatch between the stated objectives of national transport policy and the tools available to achieve them. On one hand, they show that policymakers have a clear awareness of the complexity of the transition towards a low carbon society and of the importance of learning, communication and network-building in that transition. On the other hand, the approach pursued by the OLEV displays a limited toolkit, restricted to R&D funding, financial incentives and infrastructure deployment.

The following section, introducing the PiP programme as implemented in Milton Keynes, shows similar patterns taking place on a regional level.

2.3 Milton Keynes and the Plugged-in Places Programme

This chapter introduces the background to the implementation of the Plugged-in Places implementation that took place in Milton Keynes. Most of the measures enacted by the OLEV, like the consumer incentives and the research programme, were applied at a national level, but infrastructure deployment was concentrated in selected areas to provide a critical mass of infrastructure in a number of lead cities or regions. Provision of infrastructure was expected to address range anxiety, and was designed to increase adoption of EVs in participating regions. Additionally, it was expected that these independently-run regional deployments would generate a body of knowledge that could be useful for future development of a national recharging infrastructure. Interested consortia were invited to apply for participation in the Plugged-in Places programme.

Milton Keynes, the focus of this research, was one of the eight regions selected for participation in the first round of the Plugged-in Places programme (Fig 2.2). This section provides the background information required for understanding the developments that took place in Milton Keynes between 2011 and 2013. Subsection 2.3.1 outlines the local and national situation before the launch of the PiP programme, with emphasis on the state of technologies and markets. The subsection contrasts the factors that made the introduction of EVs in Milton Keynes feasible, and those that made support necessary. Subsection 2.3.2 provides a discussion of the project management, describing the actors involved in the implementation of the programme, as well as the goals and metrics that gave it direction.

Figure 2.2: Sites selected for the PiP programme
East of England, Greater Manchester, London, Midlands, North East England, Northern Ireland, Scotland, and Milton Keynes.

2.3.1 Situation before the EV programme

For purposes of this research the scenario taking place in Milton Keynes can be framed as a competition between an entrenched but problematic incumbent (the Internal Combustion Engine, or ICE), and a socially desirable alternative in need of support (the

Electric Vehicle, or EV). The intensification of several pressures acting on ICEs seemed to create a window of opportunity during which change could be encouraged. The PiP programme was part of a portfolio of policy actions intended to encourage adoption of a socially desirable form of alternative transport.

Replacing the ICE as the predominant transport technology may appear unfeasible because fossil fuels are integral to current social and productive practices (Bannister, 2005). The early advantages developed by dominant technologies produce vested interests that prevent the adoption of alternatives, even if they are better performing or more societally beneficial. Users become unwilling to switch technologies because they have invested time and money in the technology that dominates, and producers benefit from production economies of scale. This phenomenon has been labelled "lock-in" (Cowan and Hulten, 1996; Witt, 1997). However, PiP benefitted from a window of opportunity as several pressures that contributed to weakening the position of transport technologies based on fossil fuels (see Table 2.2 for examples of the pressures acting on the ICE regime, as classified using the taxonomy of counter-balancing factors in Cowan and Hulten, 1996).

Despite the presence of definite pressures on the incumbent technology, there were not any available alternatives that could replace it without significant support. In the case of EVs, the automotive industry did not perceive them as functional products because their performance characteristics were not an exact match to those of cars based on ICEs. Adjustments in expectations and traditional motoring habits were required (SMMT, 2010), and the industry often advocated for incremental improvement of the existing system, claiming that improvements in conventional technology were contributing to falling rates of CO2 emissions for new cars(ibid).

Table 2.2: Counterbalancing factors for ICE "lock-in"
Trends that contribute to weakening the technological incumbent advantage, with examples related to transport technologies based on fossil fuels (the incumbent technology in the United Kingdom during the period covered in this research)

Counterbalancing factors (Cowan and Hulten, 1996, p 65):	Examples relevant to the ICE lock-in and EV adoption :
Crisis in the existing technology	*If current energy intensity rates are maintained, within the next 30 years the fuel based economy will face a crisis without precedent.* (Grazi and van den Bergh, 2008, p 633)
Regulation	*It is the duty of the Secretary of State to ensure that the net UK carbon account for the year 2050 is at least 80% lower than the 1990 baseline.* (HMSO, 2008, p 1)
Technological break-throughs	*Technological advances have made electric vehicles more cost competitive. In 2007 lithium ion batteries were running over $1,000 per kWh. The EV manufacturer Better Place has a contract to receive batteries for $400 per kWh in early 2012, a 60% reduction in three years, which is illustrative of continuing price/performance advances in EV batteries* (Dunn et al., 2010, p 1)
Changes in taste	*A research survey of European multinationals found that 92 per cent had changed their products to address green concerns...A Forrester Research report of major firms found that 84 per cent of the organisations have environmentally conscious or socially responsible products in development or in the marketplace which are energy efficient, recyclable, made with renewable materials or Fair Trade.*(Vaccaro, 2009, p 316)
Emergence of niche markets	*Hybrid-electric vehicles (HEV) are in their ascendancy, having established a small but growing niche in the US auto market...hybrid vehicles have begun to penetrate across vehicle platforms: while early sales were driven largely by sales of the Toyota Prius, in 2006, there were 10 different hybrid models available for purchase...it becomes easier and easier for consumers to adopt.* (Kromer and Heywood, 2007, p 22)
Scientific advancement	*Lithium-ion cells have become a commercial reality after the initial announcement by Sony in the early 1990s because of an intense world-wide activity on lithium insertion compounds (electrode materials) during the past three decades* (Kerr, Nazri and Pistoia, 2004, p 3)

When the PiP and related support measures were put in place, the only widely available vehicle was the Reeva/G-Wiz. It had a very low market penetration, with yearly sales in the low hundreds (313 units were sold in the UK in 2007). However, there were several major manufacturers getting ready to make electric vehicles available on the mainstream market (See Table 2.3 for a partial list of the vehicles available at the time of this research).

Table 2.3: Cost and performance of EVs in the UK between 2010 and 2013						
	Launch date (UK)	**Powertrain**	**Form factor**	**Price (Before subsidies)**	**Range**	**Top speed**
Reeva G-Wiz	2003	Lead-acid battery	Mini (Quadricycle)	£8,995	40 miles	40 mph
Nissan Leaf	2011	Li-Ion battery	5-door hatchback	£28,350	109 miles	93 mph
Vauxhall Ampera	2011	Series hybrid, with ICE plus plug-in Li-Ion	5-door hatchback	£32,250	52 miles (in pure electric mode)	100 mph
Renault Kangoo Z.E.	2011	Li-Ion	Panel Van	£16,990 (Not including battery lease)	110 miles	81 mph
Twizzy	2012	Li-Ion	Mini (Quadricycle)	£6,990 (Not including battery lease)	62 miles	50 mph
Tesla Motors Model S	2013	Li-ion	4-door hatchback	£82,000	310 miles	130 mph

The most popular car in the UK for 2010 was the Ford Fiesta, with a recommended sales price of £13,000 and a top speed of 105 mph. Range is not seen as a significant issue for conventional ICE cars, as they can refuel in a matter of minutes. As the comparison with the vehicles on Table 2.3 shows, straight comparisons of price and performance appeared to be unfavourable to EVs. In consequence, demand for the vehicles newly introduced into the market was uncertain, and several policy measures were put in place in order to foster adoption of the newly available cars. The high cost of EVs was partially addressed by instituting a Plugged-in Car Grant, available nationwide to consumers and to business fleets. The grant, available since January 2011, covered 25% towards the cost of the vehicle up to a maximum of £5,000 when purchasing a qualifying ultra-low emission car. Performance issues, particularly the limited range afforded by battery technology, were addressed by deploying charging infrastructure in selected regions in a series of pilot programmes managed by local actors.

2.3.2 The Plugged-in Places Programme in Milton Keynes

While the consumer incentives and the research programme were applied at a national level, it was decided that infrastructure deployment would be concentrated in selected areas, providing a critical mass of infrastructure in a number of lead cities or regions. Interested consortia were invited to apply for participation in the Plugged-in Places programme. Besides addressing range anxiety, it was expected that these independently-run infrastructure deployments would generate a body of knowledge that could be useful for future development of a national recharging network.

Several factors make Milton Keynes a favourable setting for the study of sustainable transport, and for the deployment of sustainable transport experiments. First of all, perhaps, is the unusual design of the city, not amenable to more traditional approaches to sustainable transport.

... in the 1970 Plan for Milton Keynes, consultants Llewelyn-Davies

designed a town around the operational requirements of the private car, so that

people could be free to use the car as much as they chose (Potter, 2008, p 2)...*As*

well as Milton Keynes' design being inherently hostile to public transport, it is

hostile to pedestrians and cyclists as well (ibid, p 6).

For the purposes of this research this dependence on automobility was beneficial, as successful EV adoption would become a clear example of escape from a technology well entrenched in the socio-technical system (Cowan and Hulten, 1996). Furthermore, Milton Keynes has made green living a priority since its origins, leading the way on a number of green initiatives such as the introduction of the UK's first solar powered house in 1972, the first to adopt high energy standards in buildings, and the UK's first kerbside recycling collection in 1992 (PRP Architects, 2010).

The programme was a good fit for the existing citywide Low Carbon Living agenda. Early visioning was set in place in a resolution by the Milton Keynes council:

The council therefore proposes that a low carbon living strategy and action plan

be developed under leadership of the council, which should

(a) be ambitious and place Milton Keynes at the forefront of low carbon

living nationally and internationally;

(b) be broad based, covering sustainability objectives for housing, energy,

water and transport;

(c) build on existing and emerging initiatives such as the electrification of transport, low carbon housing development, retrofitting insulation in older properties, "smart" power grids, local green power generation and new waste reduction and treatment facilities;

(d) engage local communities and be a partnership project that draws on local expertise and capacity, including

(e) achieve economic advantage for the borough through its high profile and support the development of the "green" economy and jobs; and

(f) ensure an integrated approach to the borough's rural and urban areas.
(Davies, 2010, pp 1-2)

The council resolution was followed by publication of the Milton Keynes Low Carbon Living Programme guided by the following objectives:

...re-establish the city as a place where new ideas can be tested, and innovation incorporated into daily living. A range of projects are proposed to support and encourage residents to embrace the low carbon agenda and offer a business environment which welcomes companies working in the 'green' economy. The programme aims to demonstrate, test and evaluate how reductions in carbon emissions can be delivered in an integrated and meaningful way, focusing on substantial, longer term goals which local people can own and pursue. (PRP Architects, 2010, p11).

It was within the context of this low-carbon living programme that Milton Keynes became a member of the "Joined-Cities Plan". The £11m electric vehicle plan, announced Sept 2009, supported nine cities -Birmingham, Coventry, Glasgow, London, Middlesbrough, Milton Keynes, Newcastle, Oxford and Sunderland – with the rollout of a single national cost-effective and compatible network of recharging points. This push for innovation in low carbon transport was continued with a successful bid requesting OLEV funding for participation in the PiP programme. The bid was put in place by cross-sectorial team for ELectric Vehicle InfraStructure (ELVIS). Discussion of the complete working structure of the ELVIS team falls outside of the scope of this thesis, but it can be conceptualized as a network of partnerships. The network was coordinated by the Milton Keynes Partnership (a meeting point for the Milton Keynes Council, Homes and Communities Agency (HCA), and local strategic representatives from the health, community and business sectors). ELVIS was also supported by the Renault-Nissan alliance, the vertically integrated utility company Central Networks/E.On, and the University Centre Milton Keynes.

The University Centre Milton Keynes, in partnership with the Open University and Cranfield University, contributed to the study of technical performance and user behaviour. From the perspective of this doctoral research, collaboration with this rich network of industry and policy-making actors translated into access to information and perspectives available to a very varied group of actors.

The bid by the ELVIS team requested £2.3 million in matched funding out of a total project cost of £4.9m, to be applied towards the following goals: exploring the relationship between electric vehicle use and other aspects of low-carbon living, building local, regional and national market for electric vehicles; and identifying, through practical use, factors that help or hinder the introduction of available technologies (Constantinides, 2009).

In contrast to the multi-dimensional goals set for ELVIS, the key performance indicators suggested a much narrower conception of the project. The PiP application submitted by the Milton Keynes team states that only three performance indicators were to be used to measure progress, learn, and improve performance. Those indicators were as follows:

- Number of charge points installed against delivery plans,
- operational availability of installed charge points, and
- driver utilisation of charge points (Constantinides, 2009, p 25)

The first charging points installed under the PiP programme in Milton Keynes were switched on in March 2011. Information about the operation and the aftermath of the PiP programme falls outside of the scope of this background chapter, but can be found in the case study in Section 6.3.

2.3 Summary

This thesis seeks to explore implications of early-market niche processes for innovation and transport policy. Chapter 2 supported this exploration by reviewing the relevant policy landscape in the United Kingdom. All policies involve assumptions about what governments can do and what the consequences of their actions will be. These assumptions are rarely spelt out, but policies nevertheless do imply a theory (or model) of cause and effect (Hogwood and Gunn, 1984). By reviewing documents that shaped national policies for sustainable transport, it is possible to identify the social, technical and market factors considered relevant by policy makers, as a precondition for the identification of neglected dimensions in transport and innovation policy.

If polices are conceptualized in terms of simple "if X, then Y" theories, policy objectives may be unmet because of a failure to do X, or because X fails to have the expected consequences (Hogwood and Gunn, 1984). Accounting for this, the literature review provided in this chapter sought to provide parallel insight on policy discourse and on policy actions related to the transition towards sustainable transport. Gaps between policy discourse and policy actions were visible in low-carbon transport policy at a national level, and this tension was reflected in documents related to the design and management of the Plugged-in Places programme in Milton Keynes.

The discourse of national policy actors shows a definite awareness of complexity of the challenge and acknowledges the importance of social factors, market factors and public engagement. The importance of learning and developing best practices around the new technologies is also acknowledged. When it comes to policy measures, in contrast, the problem is framed in much narrower terms. Strategies are centred on financial and technical metrics, as policy actors do not seem to have access to analytical tools for understanding complex socio-technical systems, nor practical tools to affect them and modulate them in socially beneficial directions.

Sociotechnical transitions are multidimensional phenomena, and a policy framework limited to economic and technical dimensions is very likely to neglect important factors affecting the development and diffusion innovative systems. This research seeks to address the gap between policy objectives and tools by looking at the literatures of innovation diffusion, socio-technical transitions and social marketing, to be discussed in the following chapter. This particular combination of frameworks has not been explored before, but the combination proved useful for identifying previously neglected dimensions of the processes of niche co-creation, as different disciplines look at the same phenomenon of interest from significantly different and complementary perspectives.

Chapter 3 - Literature Review

3.1 Introduction

This chapter discusses the academic literature guiding this thesis. It is structured as follows:

Section 3.1 is the introduction, describing the scope and structure of the chapter. Section 3.2 provides a historical overview of the early models of technology development and innovation diffusion, which were based on a linear model that still holds considerable influence. This section also provides and overview of the period of rapid development in innovation theories that took place during the late 1970s and 1980s. The combined effects of a series of energy and financial crisis spurred the emergence of systemic, socially constructed and evolutionary conceptions of the innovation process. Section 3.3 describes the latest developments and current state of the theory of socio-technical transitions and the related frameworks, particularly the Multi-Level Perspective and Strategic Niche Management, and their relationship to ongoing sustainability concerns. Section 3.4 explores an apparently unrelated body of literature that was identified as relevant to the study of sociotechnical transitions. This section provides an overview of the literature of social marketing, looking for tools that can be used for understanding market forces in order to create value around sustainable emergent technologies, using valuable exchanges to influence behaviours in socially beneficial directions.

Section 3.5 looks back into the review, discussing the way in which the models discussed can contribute to a better understanding of the practical project on which this thesis is based. Where gaps in the state of knowledge are identified, strategies for addressing them in the context of the practical project are proposed. The complementary perspectives

provided by the different literatures shed light on several dimensions of the processes behind the co-construction of early markets for innovations within protected learning spaces, setting the stage for a re-examination of the research questions in light of the literatures.

3.2 Linear Models of Innovation

The processes leading to the development and adoption of new technologies has been subject to particularly intense scrutiny since the years following WWII. This field is intrinsically multi- or inter-disciplinary, and draws on a range of social science disciplines: economics, management, organizational studies, sociology, history, geography and psychology. Because of this, several research approaches have been developed around the issue, bringing some aspects to the foreground with exclusion of others. What originated as an off-branch of economics was formalized as "science policy research", "research policy", or even "R&D management" in the 1960s. In the 1970s and 1980s the word "technology" was often inserted into the terminology (Martin 2012). Literature relevant to transition theory can be found and today it bears an ever-growing number of labels, including "innovation studies", "new evolutionary economics" and "science policy and innovation studies".

While some of those fields may be seen as outdated, or out of vogue in academia, a review of their literatures is relevant to this research because outdated models still can hold significant influence over policy and industry decisions. One particularly persistent approach, that has shaped policy since the industrial revolution, is based on the logic of "command-and-control", which makes use of regulations to enforce top-down rational decisions. Rationalising organisations exhibit a tendency towards hierarchies, reductionism and the maximisation of efficiency, predictability, quantification and control (Walker et al., 2008). The nearly automatic functioning of command and control approaches may be seen as an effort to replace human judgement with the dictates of rules, regulations and structures (Ritzer, 1993). Policy actors will seldom, if ever, acknowledge the influence of the

"command-and-control" mindset on policy design, but features of this way of thinking keep resurfacing in early discussions of innovation policy. Organizations have certain inertia, and old institutions will seldom redefine themselves in accordance with the latest theories:

> *Organizations and institutions often reflect the culture and the times at which they were formed. Their values, norms, ways of thinking and ways of acting (or 'routines') tend to live on. The field of innovation studies is now some 50 years old. As a result, 'innovation' tends to be commonly conceptualised, defined and measured in terms of the dominant forms of innovation from several decades earlier* (Martin, 2012, p 5).

In the case of EV policy, this cultural inertia is demonstrated by Fig 3.1, (originally, diagram 5.1 in King 2008, p 82). The model of innovation for low carbon transport in King's review would have been very familiar to innovation thinkers of mid 20-th century. Technical change is assumed to proceed as a unidirectional flow from R&D to demonstration and pre-commercial projects, and then to a protected commercial launch in anticipation of a commercial, unsupported market.

The innovation 5.8 Innovation is a complex process. Success relies on the coming together of a variety of
process players, including suppliers, customers, universities, research and technology organisations and other intermediaries. Successful technologies usually pass through several stages within a development process from basic R&D through to commercial deployment. The process can be influenced by government, investors, academia and business, as progress through the stages is subject to a number of driving (and potentially inhibiting) forces.

Diagram 5.1: The R&D Innovation Chain
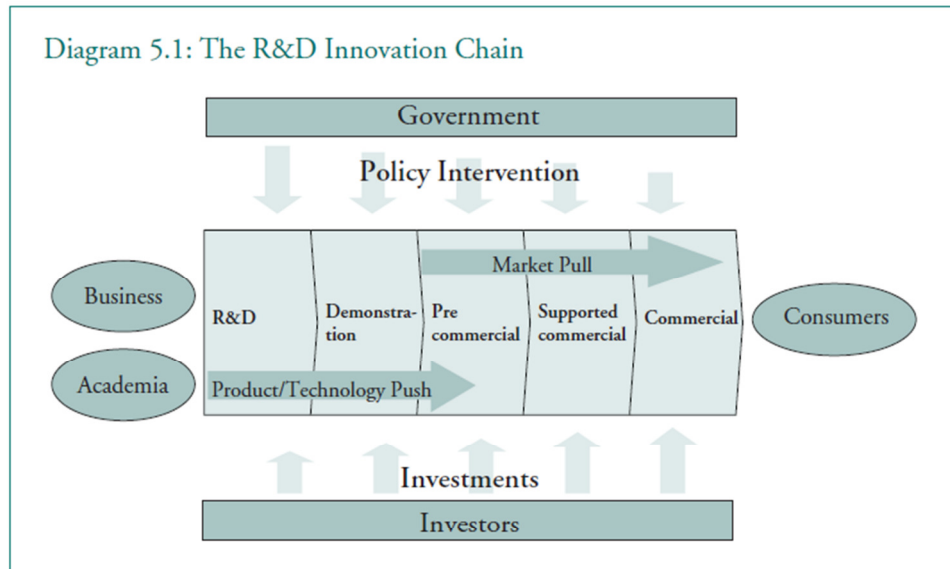
Figure 3.1: The innovation process in King's Review (King 2008, p 82)

3.2.1 Schumpeter: Innovation as an Economic Concern

Much of the current thinking in innovation theories is indebted to the early evolutionary views of Joseph Schumpeter. He was one of the few economists in the first half of the twentieth century to be interested in innovation and technology, as he saw that the prevalent economic models were avoiding the most relevant feature of economic competition.

The essential point to grasp is that in dealing with capitalism we are dealing with an evolutionary process...Capitalism, then, is by its nature a form or method of economic change and not only never is but never can be stationary....The fundamental impulse that sets and keeps the capitalist engine in motion comes from the new consumer goods, the new methods of production or

transportation, the new markets, the new forms of industrial organization that

capitalist enterprise creates.(Schumpeter, 1943, pp 82-83)

Schumpeter also contributed to the current understanding of innovation as he pointed out that innovation seemed to be moving from the individual entrepreneurs of the 19th century to collective innovative activities in large firms and elsewhere. He also provided an early distinction between invention and innovation, with the latter being the successful introduction into the market or into widespread social use of an invention (Schumpeter, 1934; Schumpeter, 1939; Schumpeter, 1942).Those two sides of the coin, invention and innovation, were studied as separate and nearly independent phenomena in the decades following WWII.

3.2.2 Vannevar Bush and Ev Rogers: Linear Push/Pull Models

The R&D policies of many developed countries during the second half of the 20th century were strongly influenced by the work of Vannevar Bush, head of the U.S. Office of Scientific Research and Development (OSRD) during World War II. Bush was, in effect, the first presidential science advisor. In *Science, The Endless Frontier*, his 1945 report to the President of the United States, Bush called for an expansion of government support for science. He saw research as the pacemaker of technological progress. "*New products and new processes do not appear full-grown,*" he reported. "*They are founded on new principles and new conceptions, which in turn are painstakingly developed by research in the purest realms of science!*" (Bush, 1945, sec 3, pp 3-4)

In his linear model of innovation, the starting point is basic research, which generates applied research and then technical development, and then eventually at the other end of the chain comes innovation. The implication is that by supporting research in the beginning of the process, out the other end of the chain eventually will come contributions to wealth, health and national security. Proponents of the science-push theory hold that it is change on

the supply side which determines (or in weaker versions, permits) changes in the composition of output and the way in which it is produced (Freeman, 1979). This linear science-push model was predominant until the late 60s and early 70s, when the role of market demand in shaping innovation (market pull model) was acknowledged.

Ev Rogers is one of the most influential figures more in current thinking about market demand for innovation. His model considers adoption of technology not as a single point, but as a gradual process of diffusion. Rogers (1962) describes diffusion as a social process by which an innovation is communicated over time among the members of a communication network or within a social sector. As different groups of people adopt new technological innovations at different times and at different rates, the market share of innovations follows a predictable pattern described as an S-curve that begins with slow change, is followed by rapid change as it is accepted by a majority of adopters, and ends in slow change as the product matures (Fig 3.1).
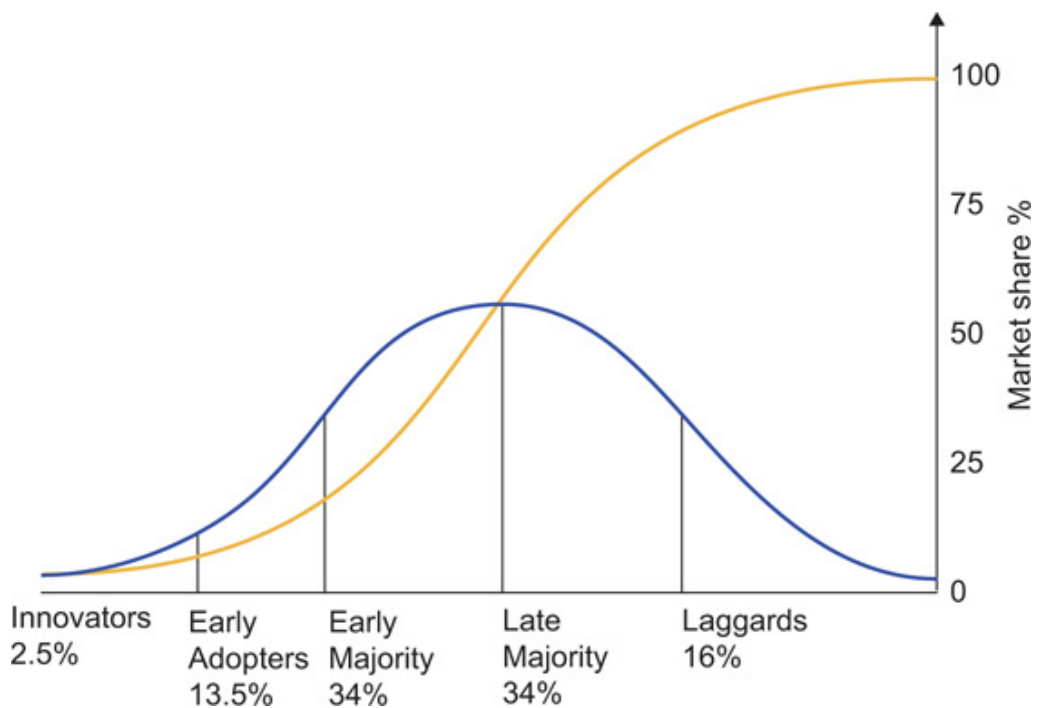
Figure 3.2: The S-curve of innovation diffusion (Rogers 1962)

In Rogers' model, innovations are communicated verbally, by one person telling another, and in many ways such as via magazine advertisements and personal observation. Commonly, awareness of innovations comes through impersonal mediated communication channels, but the decision to adopt an innovation takes place after asking the opinion or observing the behaviour of someone who is known, trusted or consider an expert. Rogers labelled those people "opinion leaders". The social influence of opinion leaders either by talking or by example-setting is what drives the diffusion curve up, giving it its characteristic "S" shape. Opinion leaders are also responsible for innovations not diffusing, by ignoring an innovation or speaking against it.

"Diffusion of Innovations" (Rogers, 1962) is based on empirical observation of the adoption of agricultural innovations, and was inspired by the resistance of Roger's father regarding the adoption of hybrid, drought-resistant corn seed. The s-curve and the diffusion of innovations framework were readily adopted by practitioners in many other fields, such as agriculture, health, family planning and marketing (Singhal and Dearing, 2006). The versatility of Rogers' model came from his very open conception of innovation. To him, an innovation can be any idea, knowledge, belief or social norm, product or service, technology or process, or even a culture, as long as it is perceived to be new.

In contrast to the post-war conception of innovation, with a one-sided conception of the science push as the main engine of innovation, academics in the 60s and 70s often made a symmetrical omission as they saw market demand as the dominant influence (Rosenberg, 1979). The conception of technology remained very thin and stylized. Empirical innovation researchers complained about this simplistic conception of technological complexity (most notably Rosenberg, 1983, 1994). According to Rosenberg, technology studies had been centred on the breakthroughs that took place in research labs, while neglecting the cumulative effect of small, pedantic modifications in product and process design. The competitive

process and the "pedestrian", "grubby" skills required to produce commercial success had been "black boxed", that is: "*threated in a highly abstract way as a collection of activities going on inside a black box, the contents of which are never subjected to systematic examination*" (Rosenberg, 1994, p 202). It took a long time and a series of global crises before the new complexity was embraced by the mainstream.

3.2.3 New Conceptions of Innovation

3.2.3.1 Crisis and Innovation

Many of the leading frameworks for understanding innovation in use today were developed in a relatively narrow timeframe that started in the late 70s and concluded in the mid 80s (Lundvall 2005; Mytelka and Smith, 2002). Complacent conceptions of innovation, developed in the post-war economic boom, were shaken up by series of financial and energy-related crisis (e.g., peak production of oil in the US in 1973, the Iranian revolution of 1979 and the ensuing 1980s recession).

The energy crisis brought into stark relief the impact that environmental factors can have on the feasibility of specific technological paths. For instance, it became evident that transport systems developed in an age of cheap petrol would be unable to cope with the changing landscape. This nascent awareness can be seen, for instance, in "*The Effect of the Energy Crisis on the Private Car in the US*" (Shinnar, 1975) and in "*Strategy for the Energy Crisis: the Case of Commuter Transportation Policy*" (Roberts, 1976). The impact of this wake-up call was not limited to specific sectors, but brought forth a wider re-evaluation of the role of innovation, as well as of its mechanisms. This is evidenced by titles such as "*Innovation and the Productivity Crisis*" *(*Baily and Chakrabarti, 1988*), or *"*Invention and Innovation Incentives to Meet the Energy Crisis: Playing It Safe is Too Risky*"; (Gambrell, 1978). Financial stagnation also brought to the forefront the importance of institutional

innovation for business organizations, as well as the role of knowledge as a competitive resource (see for instance Nonaka and Takeuchi, 1995).

In aggregate, the complex economic crisis created an opening for the development of evolutionary, socially-focused theories of the innovation process. Shaken out of their complacency, policy agencies became open to heterodox ideas concerning objectives and instruments of public policy. Policy-makers, particularly in Europe, came to see innovation policies not just as important arenas of action in themselves, but as instruments towards more wide ranging policy objectives. The theory-policy link provided new impetus for the intellectual development of the field (Mytelka and Smith, 2002).

An important, through negative starting point for the new wave of innovation thinking was to criticise the technological determinism of the predominant models. This technological determinism was built on two implicit assumptions: that technology develops autonomously, and that technology determines to an important degree societal development.

Negation of the first assumption led to a shift away from models that conceived of technical change as a rational, goal-directed activity, and towards models that saw technical change as a process of trial and error, often the cumulative result of small, contingent modifications. The seminal framework in this line of work was provided by the evolutionary models of Nelson and Winter (1977, 1982).

Negation of the second assumption of technological determinism led to a greater interest regarding the social construction of technology. The constructivist research programme created three (frequently overlapping) lines of work: the Social Construction Of Technological systems (SCOT), the Actor-Network Theory (ANT) and the systems approach.

A linear narration cannot do full justice to the rich intellectual dialogue that took place in the period under review. Key innovation works authored in that period integrated ideas from each other while keeping their distinct perspective. For the sake of clarity and brevity, however, the following discussion of evolutionary and constructivist models of innovation is presented in rough chronological order. It begins with an overview of the evolutionary models of Nelson and Winter (1977, 1982), followed by the Actor-Network Theory first outlined in Callon and Latour (1981) and the Social Constructionist view of Pinch and Bijker (1984) and Hughes (1986). Discussion of this period is closed with an overview of the Systems of Innovation approach originating in Lundvall (1985).

3.2.3.2 Evolutionary Economics

The driving tensions behind the wave of innovation thinking that took place in the late 70s, produced by gap between the high expectations and the limited usefulness of the available tools, was succinctly expressed by Richard Nelson and Sydney Winter's "*In Search of a Useful Theory of Innovation*".

> *The current dialogue regarding policy toward innovation rests on two premises. The first is that technological advance has been a powerful instrument of human progress in the past. The second is that we have the knowledge to guide that instrument toward high priority objectives in the future. The first premise is unquestionable: the latter may be presumptuous...Prevailing theory of innovation has neither the breadth nor the strength to provide much guidance regarding the variables that are plausible to change, or to predict with much confidence the effect of significant changes.* (Nelson and Winter, 1977, p 38)

The paper set up the basis for an evolutionary, institution-centred approach that would be further fleshed out in their book "*An Evolutionary Theory of Economic Change*" (Nelson

and Winter, 1982). Innovation, which so far had been glossed over as "communication of new products or ideas", was re-framed as complex web of social phenomena. The new definition encompassed the wide range of processes by which technologies evolve over time. The hunt for policy instruments capable of influencing the innovation process, formerly seen as the province of the economist, became a concern of anthropologists, sociologists, and political scientists. The key policy problem became the improvement or redesign of institutions, rather than the management of particular resource allocations.

This new definition of the problem called for an inquiry into the nature of institutional change. Nelson and Winter went back to the conception, explicit in the writings of 19th and early 20th century economic theorists such as Schumpeter, that market competition in a sector operates like a Darwinian selection environment.

In their neo-Schumpeterian evolutionary system, informed by the notion of bounded rationality, Nelson and Winter argued that organizational routines, rules of thumb, and regular patterns affect firms' overall performance. Different routines and different decisions lead to differences in firms' growth.

Because of this mechanism, institutional routines (including production planning, calculation, price setting, technological choices, and the allocation of R&D funds) become part of a process analogous to natural selection. On the assumption that routines which successfully contribute to growth are not changed, the actual expansion can be understood as an increase in relative frequency of those gene-routines, while routines causing a deteriorating performance are unlikely to expand.

Evolutionary mechanisms do not always lead to socially desirable outcomes. The intended application of the evolutionary model is the coordination of transitions towards new, more socially beneficial institutions. A coordinated transition reduces or avoids the losses

connected to incompatible strategy choices. To be successful and help trigger institutional change, policymakers have to change individuals' selective perceptions of feasible choices and their attributes.

The space delimited by the prevailing perceptions and routines of a given institution received the label "technological regime". This concept, which expands on the Kuhnian concept of "scientific paradigm" (Kuhn, 1962), is used by Nelson and Winter in reference to "*a frontier of achievable capabilities, defined in the relevant economic dimensions, limited by physical, biological, and other constraints, given a broadly defined way of doing things*" (Nelson and Winter, 1982, p 258), with particular focus on cognitive elements relating to technicians' beliefs about what is feasible, or at least worth attempting (ibid).

To achieve their goal, the agents of collective action have to convince a critical number of population members that the transition will come about - a belief that can become self-fulfilling. Social forces become at least as important as technical and scientific capabilities in defining the space of the technologically possible, linking the evolutionary model to the constructionist approach to technological innovation.

3.2.3.3 Constructivist Approaches

The 1980s saw the emergence of several constructivist frameworks for understanding technology in society. They were based on a rejection of the premise that technology determines societal development. This rejection provides the central premise of Actor-Network Theory (ANT), a framework mostly associated with the work of Michel Callon, Bruno Latour and John Law.

Actor-Network theory holds that there is no reason to assume, a priori, that either objects or people in general determine the character of social change or stability. Likewise, it

refuses to take for granted the possibility of analysing the macro-social system on the one hand, and bits and pieces of derivative micro-social detail on the other (Law, 1992).

As it is based on negatives, and it eschews traditional categories of thought, Actor-Network Theory is notoriously difficult to summarize, define or explain. Broadly speaking, ANT sees technological societies as heterogeneous societal networks that cannot be fully analysed by traditional methods that "*give precedence to a certain type of association, for example associations of men with men, iron with iron, neurons with neurons.... Sociology is only lively and productive when it examines all associations with at least the same daring as the actors who make them*" (Callon and Latour 1981, p 292).

Everything, then, from persons and institutions to artefacts and texts, is both an actor and a network. This duality is symbolized by the hyphen in "actor-network". Even the smallest element within a network is "*reducible neither to an actor alone nor to a network…An actor-network is simultaneously an actor whose activity is networking heterogeneous elements and a network that is able to redefine and transform what it is made of*" (Callon 1987, p 93).

An interesting feature of Actor-Network Theory is that technological change is explained by the same mechanism that creates technological stability. As new technological configurations take shape,

Weak, reversible interactions are replaced by strong interactions. Before, the elements dominated by the actor could escape in any direction, but now this is no longer possible. Instead of swarms of possibilities, we find lines of force, obligatory passing points, directions and deductions. (Callon and Latour, 1981, p 287)

Like many innovation thinkers, Callon and Latour directed their attention to the problem of automobility. Their discussion of the failed introduction of Electric Vehicles in France during the 1970s is of particular relevance for this PhD thesis. According to their analysis, Electricity of France (EDF) temporarily managed to redefine the petrol-driven car as a symbol of the deadlocks of growth for its own sake, a doomed legacy of the all-out consumption characteristic of the post-war. By jointly addressing technological and social issues, EDF's vision galvanized a network of scientists, technologists and policymakers. This vision, however, was undermined by a strong incumbent that managed to cast doubt about the capabilities of the EV technology and about the feasibility of deploying the supply and service networks required by the new technology (Ibid, p 291).

In the end, as no actor is powerful enough to single-handedly re-define technical reality, but innovations can be introduced (or held back) by a process of "heterogeneous engineering" in which bits and pieces from the social, the technical, the conceptual and the textual are fitted together in order to "*stabilize a particular state of power relations by associating the largest number of irreversibly linked elements*" (ibid, p 293).

The conception of innovation as an act of heterogeneous engineering is shared by the other major constructionist approach to the study of socio-technical systems, the closely related Social Construction Of Technology (SCOT). Some of the leading proponents of SCOT, like Wiebe Bijker and Thomas P. Hughes, published together with leading ANT thinkers, and the frameworks tend to share similar concepts even if they differ in methods. SCOT conceptualizes engineers, managers and intellectuals as creators of "seamless webs" in which the technical, scientific, economic, political, social, etc., become overlapping, soft categories that cannot be disentangled from each other. A recurrent theme in SCOT is that, in looking at the history of successful system builders, they are revealed to be "*no respecters of knowledge categories or professional boundaries*" (Hughes, 1986).

A defining characteristic of SCOT is its interest in the interpretive flexibility of technology. A central adage for constructivist research is that one should never take the meaning of a technical artefact or technological system as residing in the technology itself. Instead, one must study how technologies are shaped and acquire their meanings in the heterogeneity of social interaction (Bijker, 1997). The description of an artefact through the eyes of different social groups produces different descriptions (and thus different artefacts), demonstrating the interpretative flexibility of the artefact. Over time, however, interpretive flexibility diminishes because some artefacts gain dominance over the others and the meanings converge.

Bijker provides an example of this interpretive flexibility of the artefacts by discussing the shifting conceptions of the bicycle as the high-wheeled "penny-farthing" and the "safety bicycle" competed for dominance (Pinch and Bijker, 1984; Bijker 1997). Counterintuitively, high-wheeled bicycles were initially successful because they could easily topple over, were difficult to mount and dismount, and were risky to ride. Young and often upper-class men could display their athletic skills and daring by showing off in the London parks. This interpretation transmuted those dangerous bicycles into working "macho machines", as opposed to non-working, unsafe commuting devices. Nevertheless, this paradoxical "success" severely limited their general appeal. The technology only gained widespread acceptance once the original interpretation was challenged, as the low wheeled, "safety bicycle" became an accepted conveyance for getting to social and business engagements, in addition to its use for sports, racing, touring and circulating through the park.

The contrast between the cycling example selected by Bijker and the automotive one discussed by Callon and Latour serves as illustration of a significant methodological difference between ANT and SCOT. ANT, as has been previously mentioned, pursues an expanded conception of ethnography. SCOT, meanwhile, finds its roots in the history of

science. One of its landmark texts, *"Networks of Power"* (Hughes, 1993), is grounded on an analysis of the evolution of power systems in late 19th and early 20th century. Another key text, *"The Social Construction of Facts and Artefacts"* (Pinch and Bijker, 1984), provides the previously discussed analysis of historical interpretation of the bicycle. (The topic would be revisited in *"Of Bicycles, Bakelites and Bulbs"* (Bijker, 1997).

Neither ANT nor SCOT, however, are amenable to providing actionable guidance to policymakers. Their ethnographic and historical approaches were readily suited to producing conceptual insights but, arguably, they cannot be readily translated to the language of economic development expected in policy circles. This gap was filled by a third constructivist line of inquiry, that of Systems of Innovation.

3.2.3.4 Systems of Innovation

Up to the early 1990s policy instruments designed by economists tended to rely on simplistic assumptions, as technical change was outside of the specialized competence of most economists and had to be tackled by engineers and scientists. Expanding on Rosenberg (1982), Freeman (1998) retrospectively suggests that technological complexity was black boxed, that is, treated as exogenous "manna from heaven" that need not be examined in depth for most purposes (Freeman, 1998, p 16).

The aftermath of the crisis of the 70s and 80s, in conjunction with the challenges of the information revolution, brought renewed attention on differences in innovation rates between countries. This was motivated in part by long-term empirical research on the innovation performance across countries (e.g., the project SAPPHO, described in Rothwell and Teubal, 1977; Curnow and Moring, 1968). Interest was also stoked by the marked differences in industrial growth and technology adoption across countries in the wake of the

70s' crises and the information revolution, which went beyond what could be explained by models in use at the time.

For instance, the case of Japan made evident that the relationship R&D spending and industrial growth was not as linear as traditionally thought. The technological capabilities of the Japanese industry experienced growth disproportionate to the financial support for industrial R&D provided by the government. Studies like Freeman (1991) shone light on their policies, which provided support through loans and benefits strongly geared towards collaborative networking projects. The apparent success of the strategy led to widespread imitation in Europe and the US, and to renewed interest in research related to innovation networks.

The environment was conducive to the emergence of the Systems of Innovation approach, a framework for analysis of innovation systems that departed from an economic–centred approach familiar to policymakers, while expanding its field of analysis into economic policy, economic interdependence and radical economic change (Lundvall et al., 2002).

In the Systems of Innovation framework, innovation is conceptualised as learning, since innovation is—by definition—novelty in the capabilities and knowledges which make up technology. It sought to understand the nature and dynamics of learning via three basic concepts: the organised market, interactive learning, and the institutional framework (Mytelka and Smith, 2002).

As evidence on the processes of market formation interactive learning was gathered, the importance of linkages in the flow of information became apparent. The knowledge necessary for innovation was found to originate not only from universities and research

centres, but rather from other sources like production, engineering and marketing, or even from competitors, and from the users themselves.

Purely economic indicators such as prices and quantities of goods were found incapable of transmitting crucial qualitative information between users and producers. Relationships and interactions between actors had to involve non-price relationships. These relationships were presented as organised markets with elements of power, trust and loyalty (Lundvall, 1985). These relationships of co-ordination and co-operation were identified as the only possible solution to the conundrum of product innovations.

An important component of the research on Innovation systems has been the tracing of material, financial and cognitive flows, building conceptual maps of the actors participating in the system, and the connections between them (Fig.3.3).

One notable characteristic of the Systems of Innovation approach is the degree to which it has been shaped by its relationship with policy organizations. Its adoption by organizations like the OECD and the European commission has proved to be two-edged (Lundvall et al, 2002, 2005). The theory-policy link has been central to the intellectual development of this field, which would have been impossible within the constraints of existing disciplinary structures and university funding systems. At the same time the analytical achievements have permitted a wide expansion in the conceptualization of policy targets and in the design of instruments available to policy-makers (Mytelka and Smith, 2002). This collaboration, however, has introduced certain biases in the research on the field. Most of the innovation policy efforts at the national and European level operate on the basis of the narrow definition of innovation system where the focus is on an innovation mode based in scientific progress.
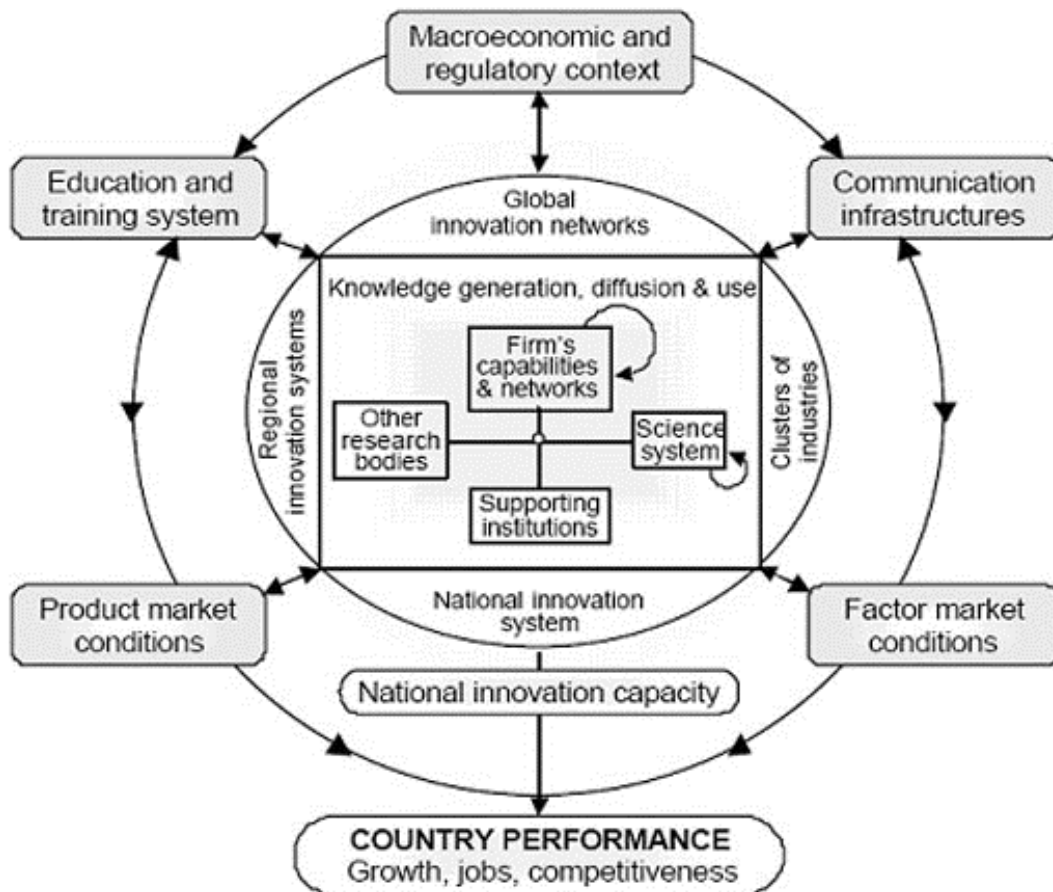
Figure 3.3: Structure of the Innovation System (OECD 1999, p 23)
The innovation capabilities of firms, research bodies, science systems and supporting institutions is affected (and has an effect on) systemic factors like market conditions, infrastructure, and the macroeconomic and regulatory context. The alignment of those factors affects the national innovation capacity and, through it, the growth and competiveness of the country.

> *The narrow definition [of the innovation system] would include organisations and institutions involved in searching and exploring—such as R&D departments, technological institutes and universities. The broad definition … includes all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring—the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place.* (Lundvall, 1992, p 12)

Another criticism is that traditional methods in the Systems of Innovation approach have focused on the structure of the innovation system, making further research into functions and processes necessary (Hekkert et al., 2007).

3.3 Literature of Socio-technical Transitions

This section provides a review of the literature of socio-technical transitions, including the analytical and practical tools associated with its theoretical framework. The study of socio-technical transitions explores the interplay of technology and society, conceptualizing it in terms of evolutionary processes. Technological and institutional characteristics of socio-technical systems are analysed jointly because they co-determine each other. Because technology is embedded in society, substitution of one technical artefact by another may involve significant social (or rather, socio-technical) change (Geels, 2005). Social and technical elements contribute to the formation of "configurations that work" (Rip and Kemp, 1981). Successful configurations become a "state of the art" in a societal domain and get to be taken for granted by engineers, managers, users and policy makers alike (Rip and Kemp, 1998). When a firm observes another firm making more money by producing a better product, or by producing a standard product more cheaply, the envious firm will then attempt to duplicate this imperfectly observed success. Firms that fail to keep up with the competition stagnate or disappear. The patterns of reproduction, mutation and selection produced by this process can be seen as analogous to those of natural selection (Nelson and Winter, 1982, pp 122-124).

In the context of socio-technical transitions, a transition is defined as a process of evolution and transformation leading to fundamental changes in society over a generation or more (Rotmans et al., 2001). Transitions can also be defined as "regime shifts" (Geels, 2010), that is, changes in the prevailing set of routines used by the actors in a particular area of

technology (Foxon, 2007). The goals of a transition are ultimately arrived at by society, and cannot be directed or predicted. Because of this, any attempt at their management involves sensitivity to existing dynamics and regular adjustment of goals to overcome the conflict between long-term concerns and short-term ambition (Rotmans et al., 2001).

In the literature, regime shifts are usually illustrated with historical examples like the transition from horse-carriages to automobiles that took in American urban passenger transport between 1860 and 1930 (Geels, 2002, pp 250-320). In 1860 large horse-tram companies operated fleets of thousands of horses. The operation of those companies shaped society and was shaped by it. Large stables were created to accommodate those horses. Stable regulations were issued, thousands of stable-boys, blacksmiths and carriage manufacturers were employed. Whole institutions emerged, like sanitation departments or organizations that collected of excrement for sale as fertilizer.

In contrast, transportation by 1930 was based in automobiles and electric trams. The emergence of new markets was stimulated by technical innovations (steel body, suspensions, transmissions, electric starter) but also by a tremendous expansion of publicly funded road infrastructures. Again, society and technology shaped each other, as exemplified by the development of traffic rules, the creation of sidewalks and the construction of playgrounds to keep children away from the street. The function of the street changed from social meeting place to transport artery, and new expectations about individual, private, flexible transport went hand in hand with the apparition of auto-camps, motels, restaurants, petrol stations and highways.

The study of sociotechnical transitions attracted attention in policy and academic circles starting in the late 1990s, when the limitations of the influential linear models of innovation discussed in Section 3.2.2 (particularly Bush, 1945) prompted a re-evaluation of

research and innovation policies in Europe. Several studies revealed that, contrary to previous assumptions, research funding did not always translate into socially and economically beneficial technologies (Tijssen and Van Wijk, 1999). In 1995 the European Commission funded a range of studies to assess the impact of EU Framework programmes (Luukkonen 1998). In what would become known as "the European paradox", European scientists were found to be producing world class science, but the impact of these developments was not found in European enterprises (Tijssen and Van Wijk, 1999; Dosi et al., 2005, 2006). The main recommendation from this evaluation was that "*the next framework programme must be based on the twin pillars of scientific excellence and social and economic relevance*" (McCarthy, 2000, 22; Davignon, 1997, p 12). In consequence, the fifth framework for R&D in the European Union called for demonstration projects that would transfer research from the laboratory to real-life applications, assessing the developments needed for and the risks associated with scaling up (European Commission, 1999).

As a result of this growing interest in demonstration projects, several joint efforts from transition scholars and policy makers took place in the late 1990s (see, for example Weber et al., 1999 and Hoogma et al., 2002). This new wave of collaborative projects built upon the lessons learned from previous failed experiments like the unsuccessful introduction of electric vehicles in Europe during the 1970s. These had revealed that sustainability could not be introduced by means of regulation alone (Orsato, Djik et al., in Geels et al., 2012).

The collaboration fostered by those demonstration projects contributed to the development of new models for understanding the mutual shaping of technology and society. These new models do not describe the adoption of innovations in terms of unidirectional chains providing a linear connection between supply and demand-side actors. The diffusion of innovations depends on the actions of a complex network of actors interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse and utilize

technology. Thus, niche-management models are concerned with user-producer interactions, knowledge flows, network dynamics and co-evolutionary processes (Carlsson and Stankiewicz, 1991; Geels and Kemp, 2007). Additionally, the new framework took into consideration a previously neglected evaluation criterion, that of social–political feasibility (Van den Bergh et al., 2011). This non-linear conceptualization of the innovation journey, as described in the literature of socio-technical transitions, is central to this doctoral research.

The approach described in this chapter is the product of intellectual linkages between several originally unrelated research lines that underwent rapid development during the late 1990s and early 2000s. The separate lines of research, which would eventually converge into the field of transition studies, coalesced around the evolutionary theories of Nelson and Winter (1982). The concept of "technical regime", originally defined as "*the cognitive routines shared in a community of engineers which guide R&D activities in particular directions*"(ibid), plays a central role in the theory of socio-technical transitions, and scholars in the field have significantly expanded the scope of the concept. The original narrow conception of the regime assumed that technology was shaped almost exclusively by R&D departments, technological institutes and universities. Further developments expanded the definition to include all parts and aspects of the economic structure and the institutional set-up affecting learning as well as searching and exploring—the production system, the marketing system and the system of finance present themselves as subsystems in which learning takes place (Lundvall, 1992; Mytelka and Smith, 2002).

This broader conception of the socio-technical regime brought previously neglected factors to the forefront, including consumer adoption and selection as well as regulations, markets, infrastructures and cultural symbols, affecting the broader process of societal embedding (e.g., in Rip and Kemp, 1998). The different lines of research that were developed around this expanded conception of the regime share a constructivist ontology where

technology is shaped by a confrontation between innovations and incumbent systems (Geels, 2010). The struggle between innovators and incumbents is enacted by interpretive actors that negotiate, learn and build coalitions (Rotmans et al., 2001). Transitions are conceptualized as quasi-evolutionary processes, and the causal agent behind the process of variation, selection and retention is a population of heterogeneous actors who try to make rational, optimal choices with limited information processing capabilities (Geels, 2010). Actors therefore use routines, heuristics, and standard operating procedures from the regime in decision-making and day-to-day problem solving (ibid). This perspective led to the development of several analytical and practical frameworks that fell under the broad label of transition studies. The approaches that constitute this broad field have been classified as follows (Van den Bergh, 2011):

- The innovation systems approach to transitions (Jacobsson and Bergek, 2011);

- Transition management (TM) based on complex systems analysis (Rotmans and Loorbach, 2009 and Grin et al., 2010);

- Evolutionary-economic views and multi-agent modelling of transitions (Van den Bergh et al., 2006 and Safarzynska et al., 2011); and

- The multi-level perspective (MLP) (Rip and Kemp, 1998, Geels, 2002 and Geels, 2011) and the closely linked approach of Strategic Niche Management (SNM) (Kemp et al., 1998).

Because of the particular relevance that MLP and SNM have for this doctoral research, the following section provides an overview of some key works in the development of both approaches.

3.3.1 Chronology of Key Literature

This section provides a chronology of key literature on MLP and SNM. It follows the development of the two approaches to show how they came to complement each other, tracing their interplay in order to best understand their contributions to the whole. Also, as this is a recent field that is still developing, the study of its trajectory might shed light on areas where further research might be needed. As the focus of this chapter is on the development of the field, the concepts introduced in each paper are discussed only briefly, as required to provide an image of the main intellectual milestones. A deeper discussion of those key concepts is provided in Subsection 3.3.2.

Because this section is focused on specific influential works, full titles of the discussed books and papers are used in addition to the standard reference format.

This discussion of transition literature begins with "*A Quasi-Evolutionary Model of Technological Development and a Cognitive Approach to Technology Policy*" (Rip, 1992). This paper was a predecessor of the SNM approach. Rip introduced the idea of creating protected niches for learning about a new technology and for facilitating its widespread deployment. However, some crucial components of SNM were undeveloped. This "proto-SNM" discussed the role of pilots as tools for learning about new technologies in order to facilitate their introduction, but it did not take into consideration the wider socio-technical context.

The term "Strategic Niche Management" was introduced in "*Strategies for Shifting Technological Systems: the Case of the Automobile System*" (Schot, Hoogma and Elzen, 1994). This paper discussed previous attempts to foster adoption of electric vehicles. Because transport technology is tightly enmeshed with societal practices and economic development, sustainable transport was (and still is) one of the central concerns of the field. It must be

noted that at this stage the research agenda for SNM was already concerned with change at a society level rather than with technology in isolation. Strategic considerations discussed went beyond the technical aspects and included regulations, industrial capabilities, economic and political factors.

In its initial conception, SNM was a practice-oriented tool still unlinked to the formal theory on socio-technical transitions (which was not sufficiently developed at the time). Early versions of SNM relied instead on a somewhat eclectic combination of evolutionary economics, social construction of technology, and STS concepts (Geels, 2007). The theory of socio-technical transitions as it is in use today can trace its origins to a chapter titled "*Technological Change*" (Rip and Kemp, 1998). This paper discussed various possible conceptualizations of technology, of which one of the most famous (and arguably the most influential in STS circles) was that of technology as a configuration that works (ibid). This view of technology as a working configuration captured aspects that had been neglected or "black boxed". Rip and Kemp explored the linkages and skills necessary to make and manage the situations in which technology can be operated productively and therefore, work. In order to explore the dynamics that lead to the evolution of working configurations, Rip and Kemp looked at the pressures brought by changes in the socio-technical landscape, and explored the way in which niche technical novelties and rules could be integrated (or not) into a working configuration, affecting the prevailing socio-technical regime in response to environmental pressures. This model, which would later be called the Multi-Level Perspective of socio-technical transitions (MLP), would become one of the core components of the field of transition theory (Geels, 2002b).

The link between SNM and MLP was established with the publication of "*Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management*" (Kemp, Schot and Hoogma, 1998). This paper was the result of

collaboration between researchers working in SNM (Schot, Hoogma) and MLP (Kemp). Returning to the problem of sustainable transport, this paper explored the possibility of using SNM as a tool for inducing socio-technical shifts within the larger context, making a complementary use of the MLP for analysis and guidance of the niche experiments.

"*Experimenting with Sustainable Transport Innovations: A Workbook for Strategic Niche Management*" (Weber, et al., 1999), provided a hands-on operationalization of SNM on the basis of three core processes: alignment and coupling of expectations, support of first and second order learning, and network formation. The methodology presented in this handbook was developed and tested in 16 independent practical projects related to the introduction of new technologies by members of the European Science and Technology Observatory (ESTO). The related "*Experimenting for Sustainable Transport: The Approach of Strategic Niche Management*" (Hoogma, Kemp Schot and Truffer, 2002) provided a book-length discussion of SNM as a tool for fostering sustainable transport. Many of the main concepts and case studies discussed came straight from Weber et al. (1999), but the publications differed in their intended public. While Weber et al. (1999) produced a hands-on, practitioner oriented introduction to the subject, Hoogma et al. (2002) offered a more academic perspective, providing a theoretical basis for the new orientation of SNM.

"*More Evolution than Revolution: Transition Management in Public Policy*" (Rotmans, 2001) discussed the role of transition theory in informing management strategies for collaboration between public decision makers and private actors. In the approach advocated by Rotmans, policy-makers use the opportunities for transformation present in the existing systems, joining ongoing dynamics rather than forcing changes. Government can play a role in bringing about structural change, but the goals of a transition are ultimately arrived at by society. Because of this, Rotmans brought attention to the role played by local and regional governments.   Local authorities are close to the people, and benefit from local

conditions that enable radical experiments (e.g., car-free city centres) for which there is no wider political mandate. Rotmans also introduced awareness of the importance of engaging the public in exercises of collaborative visioning and learning, leading to complementary bottom-up and top-down approaches.

"*Understanding the Dynamics of Technological Transitions: a Co-Evolutionary and Sociotechnical Analysis*", Frank Geels' (2002) doctoral thesis came at a crucial time in development of the theory of socio-technical transitions. In his thesis, supervised by Rip and Schot and informed by joint work undertaken with Kemps and Rotmans, Geels pulled together several complementary and somewhat overlapping strands of the Dutch research portfolio. The result of this synthesis was a form of transition theory that already had most of the features of current approaches. By 2002 the field was starting to develop a shared vocabulary and research agenda, and the growing interest of the academic community was evidenced by a growing number of articles in research journals like "*Research Policy*" and "*Technology Analysis and Strategic Management*", and by the launch of dedicated journals like "*Environmental Innovation and Societal Transition*").

"*Transitions to Sustainable Development: New Directions In the Study of Long Term Transformative Change*" (Grin et al., 2010), presents a very mature and through exposition of the transition approach as it stands today. Several of the main exponents of the approach decided to put their work together, providing a rich explanation of the theory, while drawing on historic and contemporary examples to illustrate the practical aspects of the governance of transitions. This text provides one of the more detailed explanations of the links between transition theory and Strategic Niche Management available, particularly in Chapter 1.5, "*Managing Sustainable Innovation Journeys*" (op. cit., p 80).

As the field is still maturing, discussion defining its scope and agenda is still ongoing, as exemplified by papers like "*CAUTION! Transitions Ahead: Politics, Practice and Sustainable Transition Management*" (Shove and Walker, 2007), "*Detour Ahead: A Response to Shove and Walker about the Perilous Road of Transition Management*" (Rotmans and Kemp, 2008), or "*The Multi-level Perspective on Sustainability Transitions: Responses to Seven Criticisms*" (Geels, 2011). See also Genus and Coles (2008), Shove and Walker (2010), Markard, Raven and Truffer (2012) and Smith and Raven (2012). A recurrent concern in recent discussions is whether research in the field has been conducted in a sufficiently systematic manner to enable fully developed accounts of the nature and dynamics of transitions and their effective governance (Genus and Coles, 2008). Other aspects concern the operationalization of the MLP in relation to the organisation of data collection and analysis (Genus and Coles, 2008, Smith and Raven, 2012). There is growing interest in development of the tools for monitoring qualitative indicators that include new coalitions formed, emerging networks, changes in perspective, behaviour, and actions of actors involved, long-term and short-term objectives, vision, outcomes, and different forms of learning (Rotmans and Kemp, 2008; Raven et al., 2010).

The nature of the interaction between niches and regimes is also subject to further development, including research on how "bottom-up" activities in niches contribute to "transitional" technologies breaking through into the mainstream (Genus and Cole, 2008), and about the nature of the protective and empowering measures required so that initial technology niches can give way to more conventional market niches (Smith and Raven, 2010).

A further criticism comes from the focus on the introduction of new technologies and systems of supply and the consequent neglect of the dynamics of demand (Shove and Walker 2010). Commentators take for granted that policy and corporate actors are key players,

obscuring the central role that practitioners themselves play in generating, sustaining and overthrowing everyday practices (ibid). The field might benefit from more in-depth studies on how system and regime structures are created and changed through the strategic interplay of different types of actors, including strategic and managerial actors in firms as well as consumers (Musiolik and Markard, 2011; Shove and Walker, 2010). Further development of this aspect could potentially create linkages to existing approaches in management studies (e.g., Musiolik et al., 2012).

Having introduced an overview of key works in the literature of the field that included a discussion of the current research agenda, the following section discusses some core concepts in transition theory, MLP and SNM that are of particular relevance to this doctoral research. Unless otherwise indicated, the concepts below are in accordance to the theory of socio-technical transitions as presented in Geels (2002), Hoogma et al. (2002) and Grin et al. (2010).

3.3.2 Core Concepts in Transition Literature

This section provides an overview of the evolutionary process of socio-technical transition. The field provides several analytical and practical tools that link localized pilot studies (or experiments) to generalized social changes, making it particularly relevant for analysing the Plugged-in Places Programme in Milton Keynes.

Transitions are defined as multi-actor, radical, long term macroscopic processes of transformation in the prevailing set of routines used by the actors in a particular area of technology (Foxon, 2007). In other words, transitions involve regime shifts (Grin, Rotmans and Schot, 2010), or changes in the rule-set or grammar embedded in a complex of engineering practices; production process technologies; product characteristics, skills and

procedures; ways of handling relevant artefacts and persons; ways of defining problems; all of them embedded in institutions and infrastructures (Rip and Kemp, 1998).

Technology and society are studied simultaneously because the evolution of technology and that of society cannot be separated and should be thought of in terms of co-evolution. Configurations that work cannot be demarcated from the rest of society in a simple and obvious way. Things and skills are part of routines, or patterns of behaviour, of organizations. They work only because they are embedded in this way (Rip and Kemp, 1998). Because a change in technology implies unpredictable change in the rules and routines of the users, adoption of novelties is an active process that has elements of innovation itself. Individual behaviour, organizations and society have to rearrange themselves to adopt and adapt to innovation. This process cannot be dictated top-down in a command and control fashion, but it is possible to influence the direction of that co-evolution by modulating the three basic elements in the evolutionary theory of socio-technical change: variation, selection and retention (Rip, 2002; Foxon, 2011).

Variation is provided by the range of possible new designs available, coming out of R&D processes, user contexts and subsequent user–producer interactions. Performance feedback, often via market selection, ultimately determines which innovations are retained and reproduced (Geels, 2010). In quasi-evolutionary models the definitions of "better adapted" and "fitness" crucially depend on what is required in the selection environment. Nelson and Winter (1982) see markets as the main selection environment and emphasize profitability in their evolutionary theory (Schot and Geels, 2007). Other possible selection criteria include relative product quality, after-sale servicing, speed of delivery, marketing networks, etc. (Dosi and Nelson 1994). The importance of non-economic criteria can be exemplified by Apple products like the iPod, whose influence on industry has made it subject of much academic research. The iPod was not the first entrant in the market, and was not

competing on price. Its success has been attributed to its design, its usability, and the seamless integration of the product to the service and to the ecosystem constituted by computers, networks, and music distribution channels (Peterson, 2006; Abel, 2008).

It must be stressed that the premises of evolutionary economics are incompatible with the command and control approaches (summarized in Section 3.2) that rely predominantly on regulation to introduce new technology. While command and control approaches may try to influence the process of variation and selection (for example, by funding R&D in particular areas), innovative socio-technical configurations are retained and reproduced only when they are better adapted than the incumbent configuration. In consequence, command and control interventions are unlikely to succeed as they do not build on an understanding of the needs of the potential adopters. This is exemplified by the contentiousness of regulation-based biofuel policies. Biofuel policy development in the UK has arguably been unduly non-responsive to critical opinion, and compliance with the regulations has brought undesirable societal effects (e.g, increasing the strain on agricultural resources, and encouraging the use of fuels that comply with the letter of the regulation but that do not contribute to genuine emission reductions) (Upham et al., 2011; Boucher, 2012).

The quasi-evolutionary model described above, first outlined by Rip and Kemp (1998), has been highly influential in the broad field of transition studies, giving rise to several frameworks that can be used for analysing or managing socio-technical transition processes.

Because a complete transition can have a timespan of decades, analytical perspectives are often based on the analysis of documentary evidence related to long-term developments. *"Understanding the Dynamics of Technological Transitions"* (Geels, 2002), for instance, relied on historical documents to study the transition from sailing ships to steamships in

British oceanic transport (1780-1914) and the transition from horses to automobiles in the US (1860-1930). *"Transitions to Sustainable Development"* (Grin, Rotmans and Schot, 2010) drew evidence from the modernization of Dutch agriculture between 1886 and the late 2000s.

Given the long timescales involved in transitions, transition theory draws on heuristics and concepts adapted from the field of history (Grin, Rotmans and Schot, 2010). Most notably, the Multi-Level Perspective (MLP) that is central to transition theory draws on a conception of multiple scales of historical time pioneered by French historian Braudel (1982).

Braudel's interpretation of history is based on three temporal levels. Besides short-term events measured in days, months or years, history is influenced by changes of institutions, cultural repertoires and market structures, which last years or decades, and hence operate on another temporal level. Furthermore, there are slow-changing structures whose development is measured in decades or even centuries, as is the case for deep-seated trends such as economic growth, demographic change or social processes. Those deep-seated trends are beyond the direct influence of individual actors, but they can be punctuated by major events, such as wars or natural disasters. Since knowledge of the scales relevant to a given phenomenon of interest cannot be assumed, it is necessary to continually play different temporal and geographic scales off against each other (Ames, 1991).

MLP draws on Braudel's notion of different levels of historical time, and starts from three levels: A) Technological niches; b) socio-technical regimes; and c) socio-technical landscape. The relationship between levels is intended to be that of nested hierarchies, meaning that regimes are embedded within landscapes and niches within regimes. Each level is conceptualized as a heterogeneous socio-technical configuration, and they differ in terms of stability and size (Table 3.1).

Table 3.1: Levels in the Multi-Level Perspective of Socio-technical Transitions (Geels, 2002)

Technological niches ("micro"-level):

Protected spaces in which actors search and learn in various ways about new technologies and their use; niches are precarious and require work by protagonists to be upheld.

Socio-technical regimes ("meso"-level) :

Rule-sets that are built up around a dominant technology and grant it stability; "common sense" activities of actor groups.

Socio-technical landscapes ("macro"-level)

Contextual factors that influence technological development but that cannot be changed directly by actors.

Shifts in socio-technical configurations do not follow deterministically from technological advancements, but depend on the interplay of the three levels. The landscape exerts changing pressures on the incumbent regime, while innovations challenge the regime from below (Fig 3.2).

The success of technological innovations (or, rather, innovative socio-technical configurations) is predicated on their allowing adopters to better respond to environmental pressures. On the assumption that routines which successfully contribute to growth are not changed, the actual expansion can be understood as an increase in relative frequency of those gene-routines, while routines causing a deteriorating performance are unlikely to expand (Witt, 2003). Because niches provide the locus for the generation of radical novelties, niche level interventions can be used for the modulation of innovation processes.
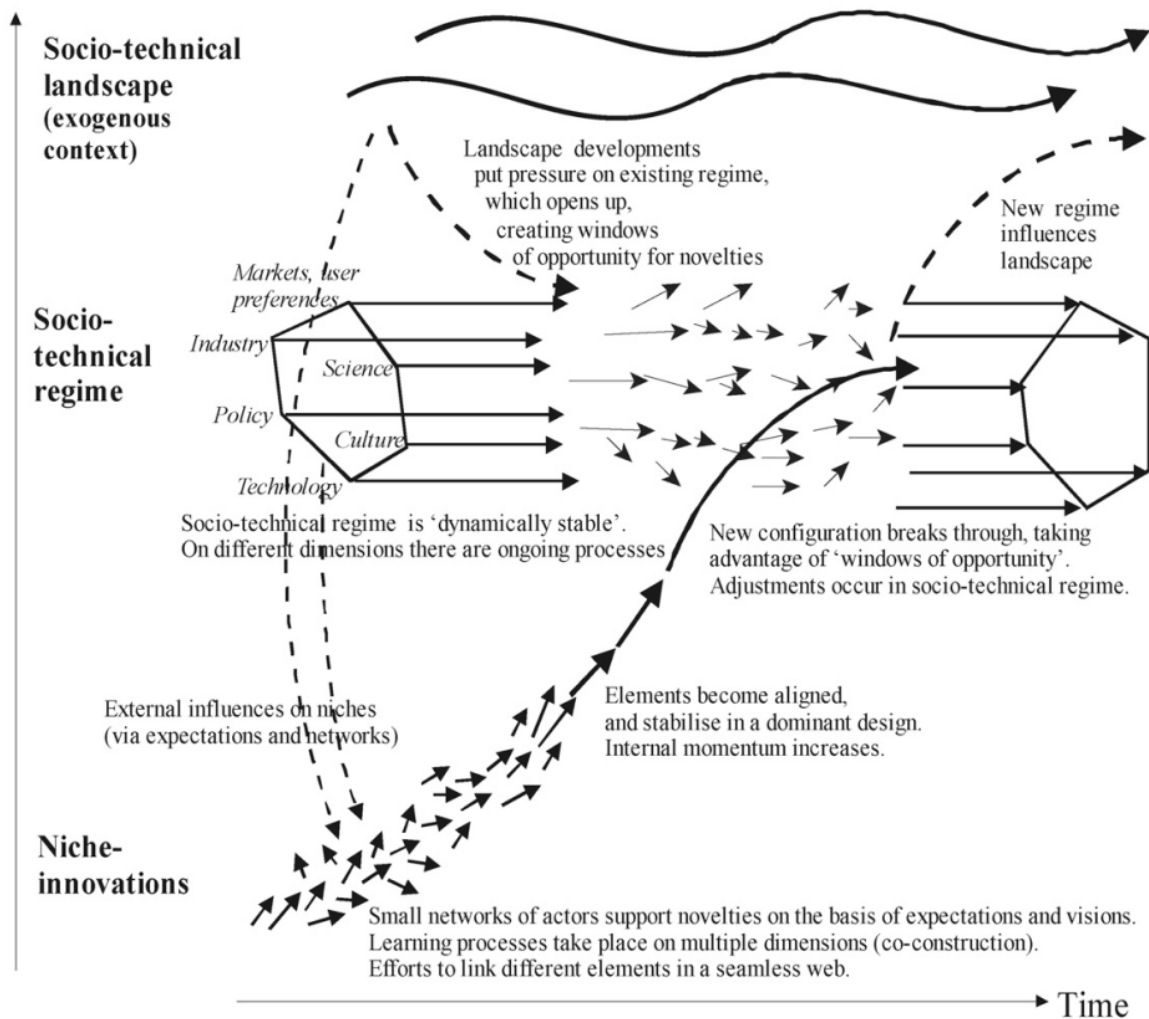
Figure 3.4: The multilevel perspective on transition (Geels, 2002, p110).
"Niche-innovations" develop in protected spaces with the support of a small network of actors. If the dominant regime is under pressure from large scale structural and environmental "landscape" factors, a window of opportunity is created and innovations break out of their protective spaces and challenge the dominant configuration or "socio-technical regime". In the case of this research, EVs can be seen as niche-innovations developing within protected spaces such as the PiP cities, with anthropogenic climate change acting as a landscape force that exerts pressure on the dominant road transport regime based on ICE-powered transport. This creates a window of opportunity where EV technologies may create a new regime.

Landscape pressures are, by definition, beyond agency of individual actors, and exerting change at the regimes level is difficult because regimes are, by definition, stabilized by incumbent actors. Niches can be shaped and reinforced by supporting interventions

because their social networks are small, unstable and precarious, consisting of entrepreneurs and innovators willing to take a chance. Actors need to put on a lot of effort to uphold the niche. Because the rules (search heuristics, guidelines and visions) are diffuse, there is much uncertainty and fluidity (Smith, Voss and Grin, 2010).

Strategic Niche Management (SNM) is an approach closely related to MLP (Van den Bergh, 2011). SNM refers to the managing of the process of niche creation, development and breakdown to enable regime shifts. SNM seeks to modulate the co-evolutionary processes of variation, selection and retention in a socially beneficial direction, identifying and reinforcing protective spaces where promising technologies can be tested and developed for competition in unprotected mainstream markets.

One of the premises for SNM is that for many innovations, especially with sustainability potential, market niches and user demand are not readily available because the innovations are not minor variations from the prevailing set of technologies, but differ radically from them (Schot and Geels, 2008). SNM was thus developed to serve the management of a particular type of innovations that are:

(1) socially desirable innovations serving long-term goals such as sustainability;

(2) radical novelties that face a mismatch with regard to existing infrastructure, user practices, and regulations (ibid).

The introduction of radical novelties is facilitated in "experimental spaces" afforded by technological niches, defined as loosely defined sets of formal and informal rules for new technological practice, explored in societal experiments and protected by a relative small network of industries, users, researchers, policy makers and other involved actors (Raven, 2006).

Technological niches are not affected by the prevailing market forces, with this protection preventing the rejection of the innovation because of a too harsh selection environment (Raven, 2006).The protection must be removed gradually, creating a market through a process of co-evolution of technology and market. A related concept, that of market niche is used among others by Levinthal (1998). In his view, a distinct application domain (a different selection environment) can trigger the development of a new technological trajectory, because functionality and price sensitivity are likely to differ substantially across domains. Eventually, after a learning period within the distinct application, the innovation may invade other application domains or even the mainstream market.

The process of niche development is exemplified by the trajectory of photovoltaic solar technology (PV). PV energy generation was originally developed for use in satellites, as this application was not sensitive to cost. In the 1980s, PV technology for satellites was well established and feasible. Later, it entered mainstream markets in specific applications (e.g., handheld calculators) for which the relatively low performance was not an issue. From 1980 to 2000 there was tremendous progress in research, development and demonstration, driven by investment aimed at employing PV technology for terrestrial use. Pilot projects were followed by market activities in remote areas where PV was found to be cost-effective for many applications. USA, Japan and Germany provided support for the industry (industrial policy, feed-in tariffs), facilitating its gradual introduction into mainstream markets (Hoffmann and Waldmann, 2009).

The relevance of niche processes to transport policy is abundantly documented by SNM scholars, for example, the Coventry EV project (CVEP) described by Ieromonachou et al. (2003). The project, partially funded by the Energy Saving Trust (EST) intended to stimulate the UK market for Battery electric Vehicles, confirming environmental impact and evaluate economic viability within a UK market. In 1997-98 a fleet of 14 Peugeot 106e

Electric cars and vans were introduced to replace existing petrol and diesel vehicles for five organizations in the West Midlands (see Fig 3.5 for a depiction of the network of partners).

The project raised the profile of battery powered electric vehicles in the UK, attracting media interest and enthusiasm of local authorities. CEVP allowed the partners to widen their experience of BEVs, and many of the partners decided to purchase electric vehicles to user as part of their fleets in addition to the vehicles used within the project. Knowledge acquired during this niche experiment informed EV programmes later on, with actors associated with the CEVP contributing to follow-up projects related to EV policy. For example, the EST built on the lessons from CEVP to coordinate the Plugged-in Fleets initiative. ARUP, a technology consultancy that supported the deployment of charging infrastructure in Milton Keynes, benefited from the experience acquired during its collaboration with the Low Emission Demonstrators in Coventry and Birmingham.
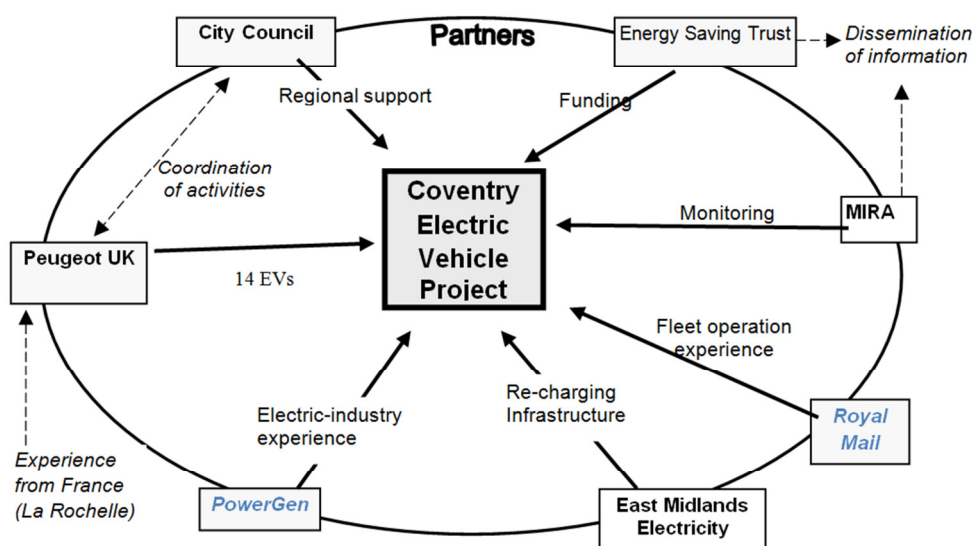
Figure 3.5: Example of niche actors in an EV-related experimental space (Ieromonachou, 2005, p 112)

Given the rich network of actors involved in the development of the niche, engagement is crucial. According to SNM, the usefulness of the experiments made possible by these protected spaces goes beyond technical learning; it involves learning about user needs, technological options and regulatory requirements (i.e. forecasting) but also learning to question existing preferences and ways to build new ones (Hoogma et al., 2002).

Traditional pilots are often not geared towards exploring and exploiting how new technological opportunities can offer new ways of meeting the needs of potential adopters (Hoogma et al., 2002) Instead, demonstration of fancy new technology seems to be more central. Moreover, demonstration projects often remain isolated events. When the experiment is finished, there is no follow-up activity. The new technologies do not seem to create a larger market or niche (ibid). In contrast, success in SNM can be defined as the transformation of a technological niche into a market niche, setting the stage for an eventual regime shift.

To stress the idea that learning is central in SNM the notion of experiment is preferred over notions such as demonstration or pilot projects (Hoogma, Weber and Elzen, 2005). As illustrated in Fig 3.6, the expectation is that the experiment will create a space where private actors can share knowledge and form a support network. Repeated, linked experiments may develop enough momentum to challenge the incumbent technology, leading to a reconfiguration of the dominant sociotechnical regime.
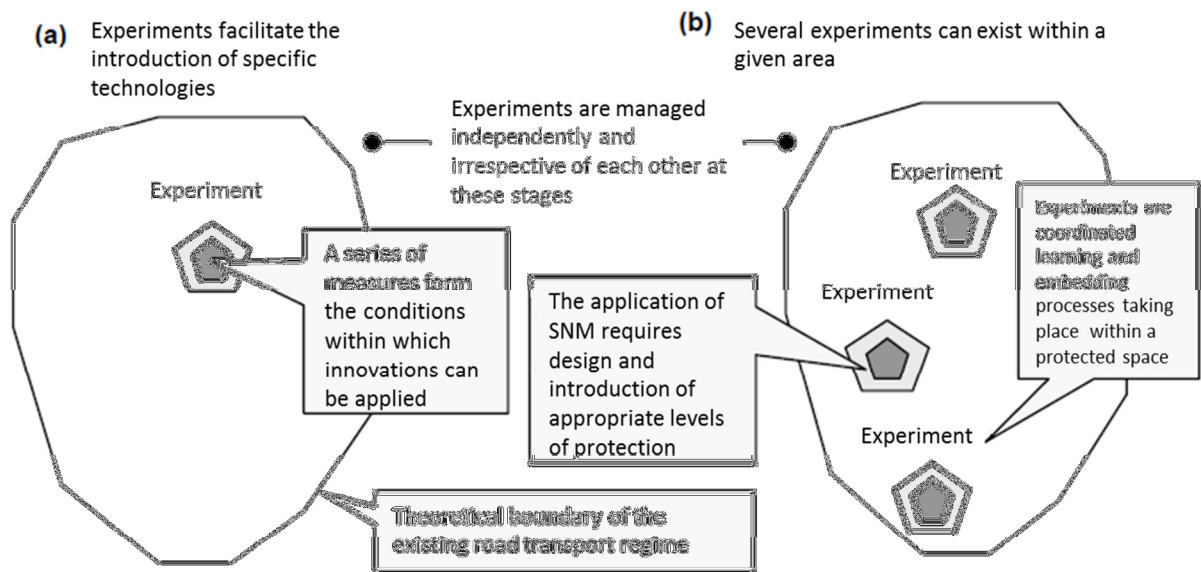
Figure 3.6 (i): Niche transformation/reconfiguration process, pre-market stage
(Adapted from Ieromonachou, 2005). Experiments documented in SNM literature have focused on the early stages of the reconfiguration process because sustainable transport technologies were only available as prototypes or limited production runs (e.g., Weber et al 1999, Ieromonachou and Potter, 2003, Elzen et al., 2003).
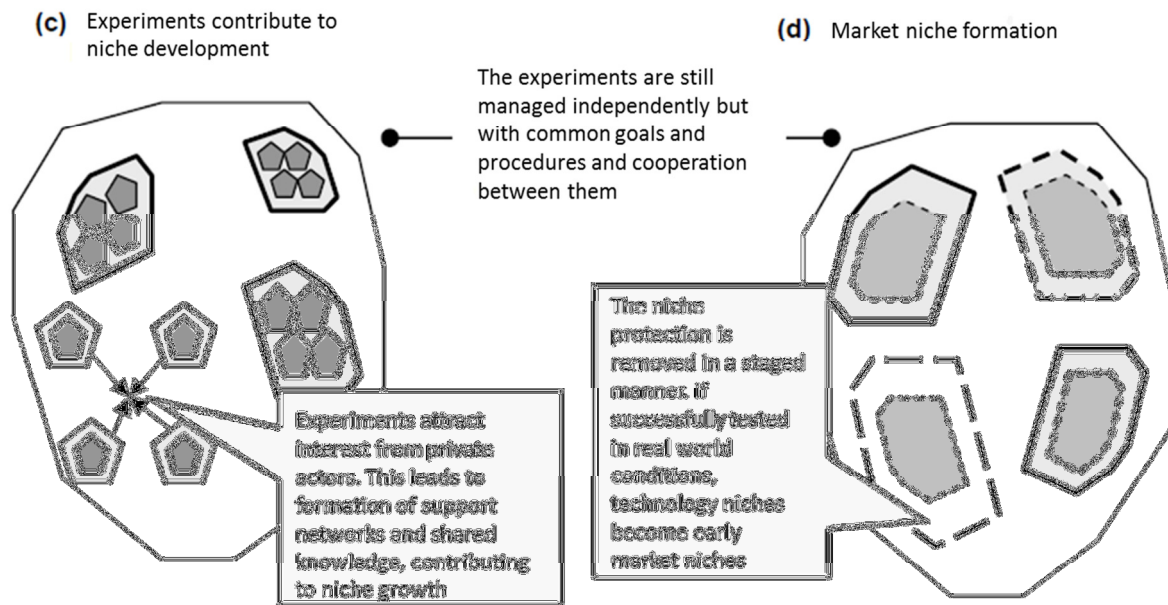
Figure 3.6 (ii): Niche transformation/reconfiguration process, early market stage
EVs are currently available in mainstream markets, but are not perceived as competitive. Interventions supporting the development of the niche are required before protection can be realistically withdrawn (Adapted from Ieromonachou, 2005).

(e) Growing niches challenge dominant transport regime

Market niches stabilize, develop momentum and outcompete incumbent technologies, challenging the dominant regime. Existing practices are replaced

(f) Transport regime transformation

When a regime shift occurs, traditional technologies together with other alternatives can continue to co-exist along the long-term benefit solutions.

Figure 3.6 (iii): Niche transformation/reconfiguration process, regime shift
Meeting policy targets require substitution of ICEs by zero-emission transport technologies by 2050. ICEs are expected to remain in use only for specific applications (Adapted from Ieromonachou, 2005).

SNM draws on a range of insights from innovation studies, including STS, evolutionary economics and history of technology, to identify three processes that contribute to the successful development of a technological niche, increasing its potential to induce widespread change (Elzen, Hoogma, and Schot, 1996; see also Kemp, Schot, and Hoogma, 1998). The processes are:

(1) The articulation of expectations and visions. Expectations are considered crucial for niche development because they provide direction to learning processes, attract attention, and legitimate (continuing) protection and nurturing.

(2) The building of social networks. This process is important to create a constituency behind the new technology, facilitate interactions between relevant stakeholders, and provide the necessary resources (e.g., money, people, and expertise).

(3) Learning processes at multiple dimensions: technical aspects and design specifications, market and user preferences, cultural and symbolic meaning, infrastructure and maintenance networks, industry and production networks, regulations and government policy, societal and environmental effects.

Because of the multiple dimensions and networks involved in these processes, definition of the unit of analysis is not straightforward. The unit of analysis in SNM is the "experiment", defined as an open-ended search and learning process taking place within a niche, working towards societal embedding and adoption of the new technology (Hoogma et al., 2002, p 4). Each experiment is studied within its context, including regional and national developments, competing technologies, and related experiments. PiP, as originally designed, matches the characteristics of a SNM experiment. The programme is expected to create a protected space where learning can take place, contributing to the development of the market and the industry. Because of this, the design of this research builds on concepts from SNM literature, and the results section of this thesis includes a SNM case study report (Section 6.3) is informed by the format in Table 3.2.

Because previous SNM cases have not reached this early market stage, research based on the PiP programme as implemented in Milton Keynes offers possibilities for theory development. According to the policy literature reviewed in Chapter 2, the process of market niche formation in Milton Keynes was expected to follow a previously unexplored pattern like the one depicted in Fig. 3.6 (ii). The following section provides an overview of recent and future directions in the research agenda for the field, unpacking the areas in which the PiP programme in Milton Keynes can contribute to the body of knowledge about socio-technical transitions and Strategic Niche Management.

Table 3.2: Case study format for Strategic Niche Management (Hoogma et al.,2002, p 66)
1-Setting and context of the experiment: Description of background, main initiators, and their motivations to carry out the experiment, along with a brief history of the niche development.   **2-Objectives and project organization:** Description of the actual project plan, objectives, the main actors associated with the experiment organization, the choice of location and the main funding sources.   **3-Project management:** Discussion of relevant developments in the experiment and project management, including whether the goals were formally achieved, the major difficulties encountered, how the experiment was overseen, and its outcomes communicated to external constituencies.   **4-Contribution to learning in the niche:** Analyses of niche development, including focusing first on the nature of the learning process. Questions include: what kind of learning took place, and on which aspects? Are there any signs of second-order learning (and coevolutionary dynamics), for example, the emergence of new ideas about future mobility? If so, how were these outcomes captured by the project management? In this area in particular, it is important to look at how users were integrated into the project.   **5-Contribution to institutional embedding in the niche**: Institutional embedding refers first of all to the quality of network development and is targeted at answering the following questions. Who was involved, only insiders or were outsiders also welcome? What did these actors contribute to the process? To what extent did actors enact a highly aligned network? This section discusses whether expectations became more widely shared. It's also important to explore the development of new infrastructure and production sites that may provide a set of complementary assets to aid in further development of the niche.   **6-Epilogue discussing future prospects.**

3.3.3 Future Directions in Transition Literature

The field of socio-technical transitions is relatively young and is undergoing rapid evolution, (Grin, Rotmans et al., 2010, Van den Bergh et al., 2011), but there is a definite research agenda, with general agreement on future directions and lines of work. There is particular interest in the following points: elaborating and specifying the conceptual frameworks and methodological underpinnings, improving the understanding of the politics and policies of sustainability transitions, and understanding the agency and strategies of firms

and other organizational actors, as well as the role of strategic alliances (Grin et al., 2010; Markard et al., 2012).

Additionally, several gaps were identified during this review of SNM literature, particularly in Section 3.3.1. The analytical aspect of the SNM framework is highly developed but, despite its practical orientation, its operationalization has not been defined systematically. Although SNM was intended to provide an instrumental view on managing transition experiments, little has actually been done for practitioners involved in social innovation projects (Mourik and Raven, 2006; Caniels and Romijn, 2006). Recent literature (e.g., Raven et al., 2010; Smith et al., 2010; Smith and Raven, 2012) identifies several areas that would benefit from the development of a practitioner toolkit, including that of policy evaluation and monitoring.

One concern about SNM comes from the emphasis it places on the importance of the technological artefact, which can lead to relative neglect of the process of social change (Witkamp et al., 2011). The managerial dimension of SNM is likewise underdeveloped (Raven et al, 2010). A major part of reduction of emissions in the coming decades is unlikely to come from improvements in technological performance, but instead from institutional change that changes decisions about inputs and outputs by producers and consumers, which will alter the sector and demand structure of the economy (van den Bergh, 2001). However, the literature of transitions makes almost no reference to the patterns of use and demand implied in what remain largely technological templates for the future (Shove and Walker, 2007).

A related gap comes from the limited toolset provided by SNM when it comes to the management of market factors affecting a transition. The SNM framework has been used predominantly in the management of sustainable transport pilots. The bulk of the pilots

described in the literature (e.g. Weber, 1999; Hoogma, 2006) took place between the late 1990s and early 2000s and, given the state of transport technology at the time, were based on prototype or limited-production technologies that were not ready for widespread market deployment. In consequence, the SNM toolkit as it stands is of limited use for analysing a situation like the one found in Milton Keynes, where the pilot is built around a more developed technological innovation that has reached an early market stage.

One problematic assumption in recent literature, reflective of the pre-market mentality, is that value depends on objective measures of cost and performance, and that "sustainable" solutions do not offer obvious user benefits because they score lower on price/performance dimensions than established technologies (Geels, 2011). From the perspective of SNM this assumption is problematic because, according to evolutionary economics, innovations that have a negative effect on the performance of adopters are not expected to spread. Market competition in a sector operates like a Darwinian selection environment, with different routines and decisions (including behavioural and technical decisions) leading to differences in the performance of a firm (Nelson and Winter, 1982). Innovations that improve the performance of the firm are more likely to be reproduced, while changes that have a negative effect are not expected to spread (ibid).

The impact of a given invention on organizational performance is seldom evident. Benefits are not determined by the cost and technical specifications of an artefact, but by the fit between innovative socio-technical configurations and the prevailing patterns of use, production and demand. Because of this, an important task in studying environmental innovations, and adequate policy to stimulate them, is obtaining a good understanding of environmental innovators and their incentives (van den Berg, 2011). Because large-scale technological templates command so much attention, commentators take it for granted that policy and corporate actors are the key players in the transition towards sustainability, but

there is a growing awareness of the diversity of firms and industries involved (Shove and Walker, 2007). A pressing concern in the agenda for research on transitions is the identification of relevant determinants for diverse settings and industries, and the development of insight on how policy can connect to particular determinants (van den Bergh, 2011).

Many of the problematic areas in SNM are already addressed by other disciplines (e.g., organizational theory, corporate strategy). For this research, social marketing was selected as it showed promise for addressing many of the identified gaps, and was found useful for resolving the tension caused by the supposed low performance of sustainable solutions identified by Geels (2011). Social marketing uses the tools and methods of commercial marketing to influence the voluntary behaviour of target audiences in order to improve their personal welfare and that of society, and is usually applied in situations where short-term self- interest appears to be in conflict with long term societal well-being (Stead et al., 2007). While social marketing is not linked to evolutionary economics, they share the recognition that there must be a clear benefit for the customer if change is to occur (Bagozzi, 1975; Houston and Gassenheimer, 1987; Stead et al., 2007). Social marketing resolves the tension between short-term self-interest and long-term societal well-being by using the tools of commercial marketing to identify and meet people's needs (Stead et al., 2007).

This research explores the possibility of using social marketing to develop the SNM framework. Social marketing has developed a toolkit for identifying the needs, drivers and barriers of a target population, and it provides a framework for understanding the behavioural, social and market dimensions of social change that are neglected by SNM. The possibility of using a marketing approach to align individual and societal wellbeing, thus challenging the assumed undesirability of sustainable technologies, is explored within the

context of specific case study centred on the Plugged-in Places (PiP) programme in Milton Keynes.

The following section looks at the literature of social marketing, identifying social marketing tools that can be used for understanding market forces in order to create value around sustainable emergent technologies. This discussion is centred on the aspects of social marketing that are more relevant for the development of the SNM framework, setting the basis for the introduction of a dual perspective of sociotechnical change in Section 3.5

3.4 Literature of Social Marketing

This section provides a review of social marketing literature, that is, the literature related to the application of marketing knowledge, concepts and techniques to enhance social as well as economic ends (Lazer and Kelley, 1973). As discussed in Section 3.3, there is a gap in the toolset for analysing market dimensions of socio-technical transitions. Sustainable transport pilots have been predominantly based on prototype or limited-production technologies that were not ready for widespread market deployment. In consequence, the existing framework is of limited use for analysing a situation like the one found in Milton Keynes, where the pilot is built around a more developed technological innovation that has reached an early market stage. This research draws on social marketing concepts to address this gap. Because of its particular relevance for this research, the review concentrates on the literature relevant to the design and analysis of social marketing interventions targeting the social context (or "upstream factors", as explored in Subsection 3.4.3).

This review of the literature of social marketing is divided into three sections: Section 3.4.1 explores several definitions of social marketing and sheds light on some common misconceptions about its definition and domain. Section 3.4.2 discusses several recent trends in social marketing that make it very relevant for the design of policies supporting socially

beneficial technological innovations: The scope of social marketing has expanded beyond health interventions; it has evolved beyond its initial focus in individual behaviour; and, particularly in the case of the United Kingdom, social marketing is playing an ever growing role in the policy maker's toolkit. Section 3.4.3 outlines future directions in the agenda of social marketing, with particular emphasis on the areas where social marketing has the most potential for providing insights about the specific case study in Milton Keynes. Although the Plugged-in Places programme has not been specifically designed as a social marketing programme, its design fulfils most of the criteria for legitimate social marketing identified in the literature. Social marketing can shed light on some of the underdeveloped aspects of transition theory that were identified in Section 3.3.4, providing practical guidance for situations where societal well-being calls for an integrated approach towards behavioural and sociotechnical change.

3.4.1 Scope and Definition of Social Marketing

The effectiveness of the increasingly sophisticated tools developed within the field of commercial marketing became evident in the latter half of the 20th century, generating interest about the possibility of using those powerful tools for socially beneficial causes. This trend was most famously exemplified by the question "*Why can't we sell brotherhood like we sell soap?"*(Wiebe, 1951, p 679), and by Wiebe's argument that efforts to "sell" social objectives cannot be successful unless the essential conditions for effective merchandising exist, or can be made to exist (ibid). Several attempts to address the challenge within the frameworks that were available at the time can be found in the literature (see for instance Klapper, 1960; Niehoff, 1966; Bennis et al., 1969), but the question eventually gave rise to a new field with its own distinct vocabulary, concepts and tools. Social marketing is a relatively recent discipline, with the work of Kotler and Zaltman (1971) often acknowledged as a key contribution to its emergence as a distinct field of study.

The National Social Marketing Centre (NSMC) defines social marketing as the systematic application of marketing, alongside other concepts and techniques, to achieve specific behavioural goals for the benefit of society as a whole (French and Blair-Stevens 2006). Social marketing has its bedrock in three basic premises: that social change is required in order to solve the problems of individuals and society, that exchange and persuasion are more useful than force or regulation, and that the advanced persuasion technologies developed by marketers can be readily applied for the promotion of targeted, planned social change (Kotler and Zaltman, 1971; Kotler and Roberto, 1989).

Social marketing is rooted in commercial marketing and shares several core concepts with it even as it develops its own distinctive vocabulary, ideas and tools (Lefebvre, 2000; Peattie and Peattie, 2003). Because of this, it is important to identify the common ground and the key differences between the two closely related fields. Marketing is a management process for creating, delivering and communicating valuable exchanges. In the case of commercial marketing, exchanges are of an economic nature and they benefit the customer, the company and its shareholders. In the case of social marketing, complex exchanges are created for the benefit of society as a whole (NSMC, 2011 p8).

The exchange process is central to commercial and social marketing. In both cases, marketing does not occur unless there are two or more parties, each with something to exchange, and both able to carry out communications and distribution (Kotler and Zaltman, 1971). In order to increase the readiness to change, social marketers must provide something beneficial in exchange. The theory postulates that if social marketers can demonstrate that the perceived benefits outweigh the perceived costs voluntary adoption is most likely (Maibach, 1993). In practice, however, the term social marketing is sometimes used quite loosely. Social marketing misconceptions are exacerbated because most social marketing managers come from a public health or mass communications background, and few have had broad

training in marketing (Rotschild, 1999). For many self-described social marketing interventions, social marketing is conceptualised fairly narrowly as a largely communications-based approach (McDermott et al., 2005). In particular, the term "social marketing" is sometimes erroneously used to refer simply to the promotional aspect of multi-component interventions or to campaigns that are purely communications-based (McDermott et al., 2005).

Social marketers may find themselves locked into marketing a given social behaviour that cannot be modified or changed. This could occur if partners or sponsors, particularly in the government, might approve of only one way of doing the behaviour (Bloom and Novelli, 1981). The "tell and sell" approaches cannot be called social marketing because they are narrowly designed as societal advertising campaigns for "selling" a social product. Social marketing is not limited to "selling" existing social products developed by experts. A sales orientation considers the job as one of finding customers for existing products and convincing them to buy these products. The marketing concept, on the other hand, calls for most of the effort to be spent on discovering the wants of a target audience and then creating the goods and services to satisfy them (Kotler, 1971). Marketing is not solely concerned with influence processes, whether these involve manufacturers influencing consumers or policy makers influencing society. Marketing is concerned with meeting existing needs and anticipating future needs (Bagozzi, 1975).Because of this need for bidirectional engagement, social marketing must go beyond mere societal advertising, but many policymakers and social marketing managers seem to be unaware that the core concept of marketing resides in the exchange (Andreasen, 1994).This limited conception of social marketing has led to complaints about the lack of relationship between marketing theory and social marketing practice (ibid).

There is a need for clearer agreement among social marketers on the key defining features of a social marketing approach. Several writers have recently attempted to resolve some of this misunderstanding (e.g., Andreasen, 2002; MacFadyen et al., 2003). In particular, Andreasen (2002) introduced a set of benchmarks which, after further developed by McDermott et al. (2005), can be used as criteria for identifying interventions that misuse the social marketing label, or to identify legitimate social marketing interventions that did not necessarily label themselves "social marketing" but which are of potential relevance to the discipline. Meeting two or more of those benchmarks is considered sufficient for legitimate social marketing approaches (Stead, Gordon et al., 2007).

Table 3.3: Criteria for Identifying a Genuine Social Marketing Programme (Stead et al., 2007.)
1-**Behaviour change**: Intervention seeks to change behaviour and has specific measurable behavioural objectives.
2-**Audience research**: Formative research is conducted to identify target consumer characteristics and needs. Intervention elements are pre-tested with the target group.
3-**Segmentation**: Different segmentation variables are considered when selecting the intervention target group. Intervention strategy is tailored for the selected segment/s.
4-**Exchange**: Intervention considers what will motivate people to engage voluntarily with the intervention and offers them something beneficial in return. The offered benefit may be intangible (e.g., personal satisfaction) or tangible (eg. incentives for participating in the programme and making behavioural changes).
5-**Marketing mix**: Intervention consists of promotion (communications) plus at least one other marketing "P" ("product", "price", "place"). Other Ps might include "policy change" or "people" (e.g., training is provided to intervention delivery agents).
6-**Competition**: Intervention considers the appeal of competing behaviours (including current behaviour). Intervention uses strategies that seek to minimise the competition

3.4.2 Trends in Social Marketing

During its formative years social marketing was primarily concerned individual health and well-being, but there is a growing interest on understanding the interaction of societal structural factors and individual behaviours. Another trend, which is explored from the perspective of the United Kingdom, is the rising importance of social marketing in the policy maker's toolkit. This section provides an overview of those trends and developments in social marketing, which are relevant to policy design for transport and sustainability applications..

The scope of social marketing has expanded beyond its original focus on individual wellbeing. The discipline was originally defined as the application of marketing to the solution of social and health problems (Kotler and Zaltman, 1971; Hastings, 2006). For decades, social marketing was primarily concerned with individual health and wellbeing. Its potential applications in other areas like social development, civic engagement and environmental issues were acknowledged (Andreasen, 1994, French, 2011), but it was recognized that the main achievements of social marketing were within the sphere of public health (Peattie and Peattie, 2009). Social marketers worked in close collaboration with public health experts during the formative years of the discipline (Gordon et al., 2006), and their influence in the concepts and methods of the field is still visible.

There has been a gradual expansion in the scope of social marketing, with the literature discussing applications related to crime prevention, civic engagement, social development and environmental protection (Andreasen, 1994; French, 2011). In recent years this trend has been spurred by a growing awareness of the need for significant societal changes in order to avert the worst consequences of rising carbon emissions. Social marketing approaches are becoming increasingly popular among governmental and non-governmental actors seeking to engage the public on environmental issue (Peattie and Peattie, 2009; Corner and Randall, 2011; McKenzie-Mohr, 2000; McKenzie-Mohr, 2011). The scale

of the challenge, in turn, has led to concerns about the limitations of social marketing. Motivating a proportional response to climate change (i.e. more than piecemeal changes in pro-environmental behaviour) requires a very deep level of engagement, a willingness to face the constant tension with the depiction of climate change as a shared, collective problem and the individualised focus on behaviour (Corner and Randall, 2011).

Social marketing has been predominantly focused on individual-level behaviour change, or what is now described as downstream social marketing (Gordon et al., 2006, Helmig and Thaler, 2010, c). This approach regards behaviour change as voluntary. However, focus on individual behaviour overlooks environmental factors that influence the decisions made by individuals (Hastings et al., 2000). By promoting individual behaviour change, downstream social marketing campaigns risk reinforcing the impression that consumers themselves are responsible for their own choices, irrespective of the powerful stimuli that promote and reinforce these (Hoeck and Jones, 2011). Finding downstream sources of social problems is a first step. However, social marketers must be willing to employ tactics to ameliorate structural, upstream causes of social problems (Wymer, 2011).

For example, individual decisions can be influenced by structural influences that include regulation, mass media, and economic or technological considerations (Hastings, 2007). The approach focused on ameliorating the structural causes of social problems has been called "strategic social marketing" (French and Blair-Stevens, 2010), "macro-social marketing" (Wymer, 2011; Domegan, 2008, Kenny and Parsons, 2012), or "up-stream social marketing". The use of the term "up-stream" comes from a vignette, introduced in Wallack et al. (1993) and popularized by Golberg (1995), about bystanders on a river bank who notice growing number of people swept by the river's current and clearly in trouble. While some interventions go "downstream" to concentrate on individuals already swept by the river, a complementary approach calls for exploration of the "upstream" to identify the structural

factors (e.g., broken bridges!) that contribute to getting people into the river in the first place . The story concludes with the argument that these upstream factors are the ultimate source of the problem, even if these problems must then be linked with downstream conditions because it is the person, in the end, who will or won't change their behaviour (Christmas, 2009).

Despite a growing awareness of the importance of upstream influences, the majority of social marketing programs and research is focused on influencing an individual to change his or her behaviour (Helmig and Thaler, 2010). Upstream social marketing is given little space in social marketing texts in comparison with traditional downstream social marketing that focuses on individual behaviour change (Wymer, 2011). While social marketing scholars recommend dealing with both downstream (individual) and upstream (structural) problems, there is little guidance regarding how to develop and implement upstream social marketing programs (Smith, 1998). The literature related to the use of theories and models in social marketing is very well developed in areas related to individual behaviours and healthy choices (see, for instance, Lefevbre 2001, or Luca and Suggs, 2012), but behavioural theories for upstream social marketing need further development (Smith, 1998; Wymer 2011; Hoeck and Jones, 2011; Gordon, 2013).

Because environmental factors are outside of the direct control of the social marketer, upstream interventions require the collaboration of actors capable of altering the structural environment (Gordon, 2013). Upstream social marketing still involves behaviour change, but among industry and policy actors and those who make the decisions that affect individuals, groups and organizations in society (Hastings and Donovan, 2002; Gordon et al., 2006). In the case of the United Kingdom, social marketing has made a distinct contribution in the design of British policy, a contribution that has been made particularly explicit since the early 2000s.

The initial drive for the application of social marketing in British policy came from health concerns (NSMC, 2006), but this was followed by growing interest in applications within other fields, including climate change and sustainability (DEFRA, 2008; French and Blair-Stevens, 2010). Recent policy toolkits specifically address the application of social marketing in transport issues. "*The Behavioural Insights Toolkit*" (DfT, 2011), for example, was designed as a practical tool for use by the Department for Transport and delivery partners (including local authorities) wishing to apply behavioural insights for the development and support of transport policies. The implementation of social marketing programmes is delegated to delivery partners at a local level (ibid), but there is support at high levels in government, suggesting that local experiments are intended to build into a national strategy (PMSU, 2007).

3.4.3 Future Directions in Social Marketing Literature

Despite the importance that the behavioural component has in recent policy thinking related to transport and climate change (e.g., BIT and CO, 2011; DfT 2011) it is clear that social marketing by itself is not sufficient to provide a full analysis of the issues involved. One salient gap identified in this review is the underdevelopment of the theoretical frameworks for the analysis of the socio-technical influences on behavioural choices. The behavioural insight toolkit in use by the Department of Transport suggests several theories that can be used for understanding the behavioural component of transport policy: Neoclassical economics, behavioural economic, psychological and sociological theories (DFT, 2011 pp 8, 44), but their exploration of the technological component and its interaction with the behavioural factors is very limited.

This limitation is related to areas that are already attracting the attention of social marketing scholars. The literature related to the use of theories and models in social marketing is very well developed in areas related to individual behaviours and healthy

choices (see for instance Lefevbre 2001; or Luca and Suggs, 2012), but behavioural theories for upstream social marketing need further development (Gordon, 2013) and there is a lack of theoretical frameworks that can be used for understanding the interaction of technologies and individual choices in the context of sustainable behaviour (Corner and Randall, 2011).

This gap in the literature of social marketing, in conjunction with the gaps in the literature of transitions discussed in Section 3.3.4, suggest that there is potential for a study benefiting from a dual perspective benefiting from the strengths of each field. The following section discusses some potential bridges between social marketing and SNM, highlighting their potential for providing complementary insights on the different dimensions of the Plugged-in Places programme in Milton Keynes.

3.5 Summary: A Multi-Disciplinary Perspective

This subsection discusses the different dimensions of the Plugged-in Places project in Milton Keynes made visible by applying the complementary perspectives that have been discussed in this review chapter. The discussion brings together three bodies of literature relevant to the challenge of sustainable transport, namely, the literatures of innovation, socio-technical transitions and social marketing. The complementary perspectives provided by the different disciplines can contribute to a richer understanding of the challenges of sustainable transport.

Traditional literature on innovation, as reviewed in Section 3.2, still has an enduring influence on transport policy in the Great Britain, as can be seen by looking back at the policy literature discussed in Section 2.2. Decisions leading to the adoption of sustainable technologies are often conceptualized in terms of a very limited set of economic and technical factors, with price and performance receiving particular attention.

The literature on SNM reviewed in Section 3.3 is proposed as an alternative to traditional models of innovation diffusion because it can provide a richer, multi-dimensional picture of the processes that make adoption of sustainable technologies feasible. SNM takes into account social and technical factors, and provides heuristics for understanding their interaction. Most of the case studies in SNM literature, however, drew evidence from processes related to pre-market trials and prototype products. As discussed in Sections 2.2 and 2.3, EVs were available in the market at the beginning of this research, but there was not a market for them, or rather, the market was not large enough to justify investment by the industry or to meet the legally mandated emission targets for the UK. According to SNM orthodoxy, the one thing left to do after market launch is a gradual withdrawal of protection so as not to create "mama's boys" (Hoogma et al., 2002). However, low EV sales during the period covered by this research suggest that protection is still needed, even if the concept of protection itself must be adapted for early market innovations.

In order to address those potential limitations, Section 3.4 looked into the literature of social marketing, which provides a framework for understanding the effect of commercial and non-commercial dimensions of value on the perceived desirability of socially beneficial offerings.

This Subsection suggests potential interdisciplinary bridges that can be explored in the context of the PiP programme in Milton Keynes, contributing toward the development of a dual perspective informed by social marketing and Strategic Niche Management. This interdisciplinary approach is needed to understand and influence situations where behaviour and choice are closely linked to the structural forces exerted by the prevailing socio-technical environment, and where coordinated change in choices, behaviours and socio-technical structural factors is deemed socially beneficial.

The PiP programme is not specifically designed around the literatures reviewed in this chapter, but a comparison of research and policy literatures suggests a close match between the strategies driving transport policy and the research agendas of SNM and social marketing. For example, the relevance of transition theory for the analysis of transport policy on a national level is suggested by the transformational aspirations that shape transport and energy policy in the United Kingdom. The objective of the Low Carbon Transport Strategy is the delivery of a "transformative shift" to low carbon road transport by 2022 (DFT, 2009, pp 19, 37, 39). Likewise, there is a growing interest on the behavioural component of transport policy on a national level, as exemplified by the Behavioural Insights Toolkit published by the Department of Transport (DfT, 2011). The toolkit states that "*enabling behavioural choices is a central part of much of what DfT and other government departments do*" (DfT, 2011, p 1), and integrates many social marketing elements, making provisions for monitoring, analysing and influencing the behaviour of potential adopters (OLEV, 2011, pp 27, 28, 33 and 36).

The importance of achieving a joint understanding of sociotechnical transformations and behavioural choices is also visible on a regional level, as made evident by the strategic items that shaped the implementation of the PiP programme in Milton Keynes (Table 3.4). The use of a dual perspective to study the implementation of the PiP programme in Milton Keynes can be justified because of its strategic goals, even if the programme was not explicitly designed as a social marketing intervention nor as a Strategic Niche Management project.

Table 3.4: Strategic items for public engagement for Milton Keynes PiP (Constantinides, 2009)

1. Visioning and scenario exploration in support of the development of a low carbon 2050 vision for Milton Keynes.

2. Support the practical delivery of the Low Carbon Living programme as a whole and its component sector initiatives through research that provides insights into both low carbon technologies and systems and of the economic and social aspects involved in the uptake and use of these systems and technologies;

3. Support to the Public Engagement programme by providing an understanding of how all types of users perceive, trial, learn and explore low carbon technologies and systems;

4. Identify characteristics and needs of different user groups for the successive stages of diffusion in the low carbon programme;

5. Monitor the uptake, user behaviour of low carbon systems and services and user attitudes towards these;

6. Actively involve users and stakeholders in the research process (research will not be on them but with them)

7. Support the development and delivery of new academic curriculum and vocational training courses required to equip people with the skills necessary to take advantage of developing opportunities

The programme as designed would have fulfilled most of the criteria for legitimate social marketing (compare social marketing criteria in Table 3.3 to PiP engagement strategy in Table 3.4). Additionally, the PiP programme implicitly supported the three core SNM processes of network building, expectation management and learning support (Elzen, Hoogma, and Schot, 1996) that were discussed in Section 3.3.3. Visioning and scenario exploration (point 1 in Table 3.4) can be analysed in terms of expectation management. Active involvement of users and stakeholders (point 6 in Table 3.4) contributes to the core process of network-building. Support for academic learning, user insight and understanding

of technologies and systems (points 2, 3 and 7 in the table) contribute to the different dimensions of the core process of learning support.

For purposes of this research, the two fields informing its literature are expected to complement each other as follows (Fig 3.7): SNM is used to analyse the structural sociotechnical factors that shape the choices of organizational adopters of EVs. SNM can also contribute to the analysis of the learning, visioning and networking processes that facilitate effective utilization of new technologies by actors on the supply side. Social marketing is used for understanding the role of choices and individual behaviours on organizational demand for EVs, and to provide insights about how an understanding of the needs of potential adopters can contribute to the co-creation of value, providing a resolution for the tension between short-term individual interest and long-term societal well being.

	Production	Consumption
Upstream (Socio-technical/Structural Factors)	STRATEGIC NICHE MANAGEMENT	
Downstream (Individual behaviour and choice)		SOCIAL MARKETING

Figure 3.7: Social marketing and SNM complementarities in the analysis of early-market niches

This approach is not meant to suggest absolute and unbridgeable dichotomies between the phenomena of interest for each field. For instance, the decision to use SNM for analysing upstream factors does not imply a lack of social marketing tools for addressing that dimension. However, SNM was seen as more useful for addressing that dimension in this

particular research project, as the upstream side of social marketing interventions, particularly those related to sustainability issues, is underdeveloped (Hoeck and Jones, 2011; Gordon, 2013; Corner and Randall, 2011). Likewise, SNM acknowledges the role of market forces and behavioural elements within the socio-technical, but social marketing is used instead for that dimension of this research because SNM lacks practical tools for analysis and management of interventions (Raven, 2010).

The literatures reviewed in this chapter contribute to a deeper understanding of the research questions first stated in Section 1.2. The research objectives called for an exploration of the niche building process as observed during the early-market introduction of EVs in Milton Keynes. This, in turn, would lead to a comparison between the observations from Milton Keynes and the processes described in the literature on pre-market niches in SNM.

This review of academic literature complements the policy review performed in Chapter 2, and reveals a gap in the toolkit for the management of sustainable innovation. Historically, the innovation toolkit has emphasized the development of technology and the construction of networks on the supply side. When the needs of the potential adopters were addressed, there was a tendency to pursue a "sales" approach (finding customers for existing products and convincing them to buy these products), as opposed to a "marketing" approach (discovering the present, future and unspoken needs of a target audience and then creating the goods and services to satisfy them) (Kotler, 1971; Kohli and Jaworski, 1990).

This research draws insights from social marketing to develop an understanding of SNM that is not centred on a protectionist mindset. Instead of spending effort on finding customers for existing products, optimizing the supply chains behind them, or subsidizing unpalatable alternatives, the new approach should articulate the needs of a target audience and support the co-creation of the products and services that satisfy them. Concepts from

social marketing are used to address an identified gap in the theory and methods associated with Strategic Niche Management (SNM).

By using marketing principles in order to address and outperform the competition, SNM can go beyond its current focus on protection. While SNM is currently seen as a framework for the creation of protected spaces (Hoogma et al., 2002), recent literature suggests that by setting the conversation in terms of protection, more empowering measures could be tacitly left out. In this regard, Smith and Raven (2012) argue that this focus on protection has led to underdevelopment of the mechanisms by which path-breaking innovations escape their protective spaces and confront the incumbent system. The literature of social marketing begins to suggest aspects of market building of particular relevance for the understanding of empowering interventions that facilitate the alignment of individual self-interest and societal well-being. This perspective, developed after this review of the literatures, will guide the research design developed in the following chapter.

Chapter 4 - Research Design

4.1 Introduction

4.1.1 Overview and Chapter Structure

This chapter provides a description of the research design that guided this thesis. The research methodology is a crucial aspect of the design of a study. It implies a series of choices regarding the best means to collect the evidence needed to answer the research questions under investigation.

A research design is an integrated statement of and justification for the more technical decisions involved in planning a research project. In practice, social research is an often messy process, because it is not possible to anticipate all eventualities, and not every aspect can be controlled. Ideally, however, designing social research is the process of making all decisions related to the research project before they are carried off, reflecting decisions about the priority given to a range of dimensions of the research process, and providing a framework for the collection and analysis of data (Ackoff, 1953; Blaikie, 2000).

This chapter is structured as follows: Section 4.1 describes the objectives and structure of the chapter and provides an overview of the research design followed in this thesis. Sections 4.2 to 4.6 provide the justifications for crucial methodological choices taken in the course of this research. Section 4.2 explains the rationale for the selection of a qualitative approach. Section 4.3 explains the selection of a constructivist position, and Section 4.4 justifies the selection of an abductive logic of enquiry. Section 4.5 presents the research design that resulted from the decisions made in the preceding sections, which can be

described as an abductive, qualitative case study. Section 4.6 describes the scope of the case and its unit of analysis.

Some authors (e.g., Bryman and Bell, 2003) consider that the case study is not a research method, but rather a research approach. Once a case has been selected, a research method or research methods are needed to collect data. Sections 4.7 to 4.9 explore the use of thematic analysis drawing on multiple data sources as a method for operationalizing and developing the SNM case study. Section 4.7 justifies the selection of thematic analysis, a method for qualitative analysis of textual content, as a suitable method for analysis in the preparation of case studies. Section 4.8 describes and justifies the data sources selected for this research, while Section 4.9 outlines the data selection strategy followed and describes the procedures followed for data collection, with subsections focused on documentary sources, participant observation and interviews. Section 4.10, describes the quality criteria used to evaluate this research design. The final section of this chapter, 4.11, addressed the ethical considerations potentially raised by this research design.

4.1.2 Research Questions and Relationship to Research Design

A key focus of this thesis is the exploration of behavioural patterns and sociotechnical configurations, their interaction, and their contribution to the competitiveness of new technology. This is presented as a counterpoint to the belief, implicit in policy, that value depends on objective measures of cost and performance, and that *"sustainable solutions do not offer obvious user benefits (because sustainability is a collective good), and often score lower on price/performance dimensions than established technologies"* (Geels, 2011, p 25). The positivist foundations of this assumption can be challenged by pursuing a constructivist approach. Value and competitiveness are conceptualized as emerging from a bottom-up process of co-creation and configuration, as organizations develop competitive businesses around innovative technologies. The co-creation of value and co-construction of competitive

configurations is explored within the context of specific case study centred on the Plugged-in Places (PiP) programme in Milton Keynes, which was designed to "*facilitate the shift from a fossil fuel based transport system to a low carbon one based on electric vehicles*", "*encourage the uptake of electric vehicles*" and "*help build the local, regional and national market for electric vehicles*" (Constantinides, 2009, p ii).

The Plugged-in Places programme provides support to consumers as well as to organizational users. However, this research concentrated on organizational use because the link between competitiveness and adoption is more clearly defined in organizations, and because the choices of organizational decision makers can have a strong effect on the availability of sustainable technologies for consumers and business users downstream. The research seeks to explore factors affecting the behaviour and decisions of organizational adopters, and to evaluate the usefulness of the existing approach for encouraging the adoption of sustainable technologies.

This research seeks to identify the assumptions behind policy actions intended to make the EV into an attractive alternative, understanding the assumptions that shape policy, and the effect of interventions. Additionally, it seeks to identify dimensions of the transitions that are being neglected by traditional SNM framework, as made visibly by bringing a marketing sensitivity to the analysis.

The main research questions that must be answered to gain insight on early-market SNM are as follows:

- *What dimensions, if any, of the niche building process as observed during the early-market introduction of EVs in Milton Keynes are different to those described in the literature of pre-market niches in SNM?*

- *How should the SNM framework be developed to account for any previously unexplored aspects of early-market niche processes?*

- *What are the implications of early-market SNM for innovation and transport policy?*

The main questions will be answered by investigating the following subsidiary questions

1. *What social, technical and market factors are considered relevant by pioneering and prospective organizational adopters of EVs?*

2. *What social, technical and market factors are considered relevant by policy makers (and other intervention designers) supporting EVs?*

3. *To what extent are the factors considered relevant by intervention designers reflected in their policy actions?*

4. *What are the similarities and differences between the factors addressed by policy and those considered relevant by organizational adopters (who constitute 75% of the early market for EVs)?*

Questions 1 to 4 are meant to identify the assumptions that are shaping EV policy, as well as those that shape the choices of potential adopters. All policies involve assumptions about what governments can do and what the consequences of their actions will be. These assumptions are rarely spelt out, but policies nevertheless do imply a theory (or model) of cause and effect (Hogwood and Gunn, 1984). The development and use of those models involves making precise assumptions about a limited set of variables and parameters to derive precise predictions (Ostrom, 2011). This exploration should shed light on the reasons behind the limited success of EV policy. Questions 1 to 4, centred on identifying relevant "factors", "parameters" or "variables" implicit in the theories used by prospective adopters and by

interventions designers in preparation for question 5 , which will seek to identify patterns related to those factors.

The analytical component of this research seeks to identify patterns associated with successful adoption of EVs. From the perspective of SNM success is defined as the degree to which a project set off new activities (van der Laak et al., 2007). If a niche experiment supports a rich learning processes and contributes to institutional embedding, disruptive innovations can be harnessed into configurations that are valuable to the adopter, making it likely that the use of the innovation will be continued, reproduced, or otherwise increased in scale and scope (van der Laak et al., 2007; Hommels et al.,2007).

The analysis draws on concepts from SNM and social marketing with the expectation that previously neglected forces affecting the early market for EVs will be made visible, with particular focus on the increasing importance of market selection and the competition presented by an entrenched but socially undesirable incumbent. Thematic analysis, a form of qualitative content analysis, is applied to evidence from interviews with key organizational actors in the community of pioneering and prospective EV users, participant observation and documentary sources. After the thematic analysis has been produced, the results are discussed in the context of a case study based on evidence from the PiP programme in MK. The use of the established SNM case study format facilitates the construction of links between the evidence base of this thesis and the core concepts of SNM theory. Because this updated theory is informed by the sensitivities of social marketing, it can provide a suitable framework for the design and evaluation of social marketing interventions related to sustainable innovation.

4.2 Rationale for the Selection of a Qualitative Approach

Depending on the nature of the investigation, a researcher needs to choose whether it is necessary to use quantitative or qualitative techniques, or both. The quantitative/qualitative distinction can be summarized as follows: quantitative researchers employ measurement and qualitative researchers do not. In practice, however, quantitative and qualitative research differ with respect to their epistemological foundations. This section describes some of the implications of quantitative and qualitative research designs, providing a justification for the selection of a qualitative approach.

Quantitative research can be construed as a research strategy that emphasizes quantification in the collection and analysis of data. As the name suggests, the departure point of quantitative research is numerical measurement of specific aspects of phenomena (Miller and Brewer, 2003; Bell and Bryman, 2003). Some of the methods commonly associated with quantitative approaches are structured observation, self administered questionnaires or surveys, structured interviews, and content analysis of documents (Blaikie 2003, p 233). Quantitative research frequently incorporates the practices and norms of the natural scientific model and of positivism in particular; thus embodying a view of social reality as an external, objective reality.

Quantitative methods rely on the assumption the phenomenon under study can be measured and understood in numerical terms. As such, these methods cannot be applied in the absence of suitable indicators and measurements for the concepts of interest (Bell and Bryman, 2003, p 71). This would suggest that a quantitative approach is unsuitable for the study of sociotechnical transitions, as quantitative indicators for core processes like learning, networking and societal embedding have not been established.

Qualitative research can be construed as a research strategy that often emphasized words rather than quantification in the collection and analysis of data. The qualitative approach is based on intensive study of as many features as possible of one or a small number of phenomena. Instead of condensing information, it seeks to build understanding through depth (Miller and Brewer, 2003; Bell and Bryman, 2003).

Qualitative research traditionally emphasizes the generation of theories rather than testing. The practices and norms of the natural scientific model, and of positivism in particular, are often rejected, with a preference for understanding the ways in which individuals interpret their social world (Miller and Brewer, 2003). Qualitative research is often constructivist, embodying a view of social reality as a constantly shifting emergent property of individuals' creation (ibid). Those characteristics make the case study approach relevant for the study of an ongoing transition.

This research follows a qualitative approach because it is appropriate for understanding processes and contexts through the eyes of the actors involved (Bryman and Bell, 2003), and this kind of empathetic, process-oriented understanding is crucial for understanding the social component of sociotechnical transitions. Qualitative indicators relevant to the SNM framework include: new coalitions formed, emerging net-works, new types of discourse and a new language, changes in perspective, behaviour, and actions of actors involved, long-term and short-term objectives, vision and related pathways, outcomes of experiments and project results, measures, and instruments, different forms of learning (technical, conceptual, and social) (Rotmans and Kemp, 2008; Raven et al., 2010).

A qualitative approach is also appropriate for the social marketing aspect of this research. Qualitative approaches are widely used in social marketing studies (e.g., Donovan and Henley, 2003; Hastings et al., 2004; Gordon et al., 2010). Relevant phenomena amenable

to qualitative exchange include the value-creating processes of the target population, which should not be based solely on hard data such as customer satisfaction measures, but should incorporate a deep understanding of customer experiences and processes (Payne et al 2008). This is in line with a broader conception of the exchange process as used in social marketing: not a simple exchange, but "*a conversation, a sharing of information, which may later lead to changes in beliefs, actions and behaviours*" (Peattie and Peattie 2003, p 370). Qualitative research is also relevant more broadly to research in marketing, as many of the relevant phenomena cannot be studied usefully outside of their natural setting and are not amenable to quantification (Bonoma, 1985). Industrial marketing research, for example, is characterized by the use of qualitative case studies to build theory (Beverland and Lindgreen, 2010). The inherent flexibility of the method suits the study of the complex, evolving relationships and interactions involved (Dubois and Araujo, 2004)

4.3 Rationale for the Selection of a Constructivist Epistemology

The moderate constructivist approach selected for this research occupies a middle ground between naive realism and naive relativism. Naive realism, an extreme form of positivism, is based on the belief that there exists a reality that is apprehendable through objective, empirical observations. In contrast, naive relativism suggests that there are multiple local and specific constructed realities; reality exists only in texts and interpretations (Javernisu and Tornroos, 2010). Moderate constructionism is oriented towards a community-based, multifaceted conception of truth (Dubois and Gibbert, 2010). Truth is defined as community-based, but derived from empirical data. Under this perspective, a truth claim is epistemically acceptable in a community if it is based on evidence that is acceptable to the community and if the community is open to investigating the claim and its evidence in an openly critical manner.

Moderate constructionism is related to critical realism, with which it shares ontological and epistemological grounds. However, critical realists believe that there is a reality independent of our knowledge of it, even if it is only imperfectly and probabilistically apprehendable (Lincoln and Guba, 2000; Easton, 2002). The moderate constructivist position used in this thesis acknowledges the possibility of multiple community-formed knowledge bases. Table 4.1 outlines some key aspects of this position and shows how they contrast with other approaches.

Table 4.1: Key features of realist and constructionist perspectives (Javernisu and Tornroos 2010)

	Naive realism	**Critical realism**	**Moderate constructionism**	**Naive relativism**
Ontology	Only one, true reality exists	There is a reality; specific local, contingent truth claims apply	There may be a reality; specific local, contingent truth claims apply	There is no reality beyond subjects
Epistemology	It is possible to know exactly what this reality is through objective, empirical observations	It is possible to move closer to local truths through empirical observation, bounded by community-based critique/consensus	It is possible to understand local truths through community-based knowledge creation and empirical observations bounded by subjectivity	It is possible to understand subjective reality through analysis of the subject's account of knowledge
Methodology	Direct empirical observation	Empirical observations bounded by subjectivity and community-based critique/consensus	Community-based knowledge creation through empirical observations bounded by subjectivity	Analysis of knowledge structures and processes by observing texts
Research process	Deductive; theory testing	Abductive; theory generating and testing	Abductive; theory generating and testing	Inductive; theory generating

A moderate constructivist perspective has been selected for this research because socially constructed behavioural patterns, sociotechnical configurations, and conceptions of

value are at the core of the phenomenon under study. Transition theory has a predominantly constructivist ontology (Geels, 2010) with the struggle between the incumbent and innovators being enacted by interpretive actors that negotiate, learn and build coalitions. The co-construction of new socio-technical configurations can be supported through network-building, participatory visioning exercises, multi-stakeholder and societal debates (Rotmans et al., 2001).

A constructivist approach is also relevant to social marketing research. Social construction theories allow marketers to explore how shared understandings constitute a "social consensus" that shapes the perceptions and interactions of individuals (Deighton and Grayson, 1995). The constructivist approach is particularly relevant for the creation of valuable exchanges, with the social construction of value taking place prior to, during and after the actual exchange and uses take place (Peñaloza and Venkatesh, 2006; Edvarsson et al., 2008).

4.4 Rationale for the Selection of an Abductive approach

Logics of enquiry can be defined as the positions and the sets of procedures followed for linking new data to theory, and producing sound answers (Blaikie, 2000; Stainton-Rogers, 2006). Different strategies have connections with particular philosophical and theoretical traditions. Two approaches in widespread use are the inductive approach and the deductive approach. Inductive logic draws inferences from observations in order to make generalizations. Knowledge is gained by gathering objective data in order to establish regularities, producing general laws of cause and effect. The plausibility of a general law increases as more and more instances are observed (Stainton-Rogers, p 83).The deductive logic of enquiry develops hypothesis on the basis of existing theory, and then data is gathered and analysed (generally through statistical analysis) in order to prove or disprove the theory and to produce an explanation of cause and effect (ibid, p 84).

Both approaches were found unsuitable for this research, because it was not possible to know in advance how the concepts from social marketing and other themes that emerged from the thematic analysis would fit the existing SNM framework. The objective of this research cannot be described as theory testing (deductive), or theory building (inductive), but rather theory development. Additionally, induction and deduction are usually associated with positivism (see Section 4.3), and reductionism, as they smooth out complexity. Consequently, pure inductive and deductive logics of enquiry are unsuitable to the study of complex, socially constructed sociotechnical transitions. A less familiar logic of enquiry, abduction, has been selected for this research. Abduction consists of assembling or discovering, on the basis of an interpretation of collected data, such combination of features for which there is no appropriate explanation or rule in the store of knowledge that already exists. Since no suitable explanation can be found, a new one must be discovered or invented (Reichertz, 2004).

An abductive approach was used to develop the SNM framework and integrate social marketing elements as a result of unanticipated empirical findings. Unlike induction, abduction accepts existing theory, which might improve the theoretical strength of case analysis. Abduction also allows for a less theory-driven research process than deduction, thereby enabling data-driven theory generation (Javernisu and Tornroos, 2010).

The following Subsection explains the philosophical foundations and procedures associated with abduction.

Abduction is most associated with the writings of the philosopher Charles Sander Peirce, who defined it as "*the process of forming an explanatory hypothesis*" (Peirce, 1955, p. 67). Abduction deals with complexity by using anomalies and inconsistencies to home in on just those elements of a complex situation that cannot be neatly accommodated within pre-existing theoretical frameworks (Stainton-Rogers 2006, p 85).

It must be noted that the main concern of the abductive approach is related to the generation of new concepts and development of theoretical models, rather than to the confirmation of existing theory. One major difference, as compared with both deductive and inductive studies, is the role of the framework. In studies relying on abduction, the original framework is successively modified, partly as a result of unanticipated empirical findings, but also of theoretical insights gained during the process. Stress in placed on theory development, rather than theory generation (Dubois and Gadde, 2002).

Abductive inferences seek to go beyond the data themselves, to locate them in explanatory or interpretative frameworks. The researcher is not content to try to slot them into existing ideas, for the search includes new, surprising or anomalous observations. On the other hand, such strange phenomena are not used only to disconfirm existing theories: They are used to come up with new configurations of ideas (Coffey and Atkinson 1996, p 155).

Abduction efforts seek some (new) order, but they do not aim at the construction of any order, but at the discovery of an order that fits the surprising facts; or, more precisely, one that solves the practical problems that arise from these. "*The refuge for this selective attention (which targets a new order) is not the greatest possible closeness to reality or the highest possible rationality. The refuge is, above all, the usefulness which the type that is developed brings to the question of interest*" (Reichertz, 2004, p 163).

An abductive discovered order, therefore, is not a (pure) reflection of reality, nor does it reduce reality to its most important components. Instead, the orders obtained are mental constructs with which one can live comfortably or less comfortably (ibid). This is reflected in the quality criteria selected for this research, as certainty about the validity of abductive inferences cannot be achieved for abductively developed hypotheses. *"All that one can*

achieve, using this procedure, is an intersubjectively constructed and shared 'truth' " (Reichertz 2004, p 164). This approach is compatible with the aims of SNM, as the study of transitions does not aspire to provide ontological descriptions of reality, but "*analytical and heuristic concepts to understand the complex dynamics of sociotechnical change*" (Geels 2002, p 1259).

4.5 The Abductive, Qualitative Case Study

The research choices explained in Sections 4.2 to 4.4, contributed to the selection of a research design based on a qualitative, abductive case study. Case studies can provide fertile ground for abductive theory development because they allow for continuous movement between an empirical world and a model world (Dubois and Gadde, 2002). New combinations can be developed "*through a mixture of established theoretical models and new concepts derived from the confrontation with reality*" (Dubois and Gadde, 2002, p 559).

Case research can be defined as a research method that involves investigating one or a small number of social entities or situations about which data are collected using multiple sources of data and developing a holistic description through an iterative research process (Easton 2010). The case study is preferred in examining contemporary events when relevant behaviours cannot be manipulated (Yin, 1989), as is the case for the PiP programme. The case study approach is also appropriate given the organizational focus of this thesis. Case studies are typically negotiated and carried out in close interaction with practitioners and as they deal with real management situations they have the potential to create knowledge that practitioners will consider useful (Amabile et al., 2001; Leonard-Barton, 1990).

Research in SNM is predominantly based on qualitative case studies, and the format developed by Weber et al., (1999) and refined by Hoogma et al., (2002) is the main analytical tool used in the description of structures and dynamics within niches. The design of this PhD

research was intended to develop the SNM case study format (Hoogma et al., 2002; see Table 3.2 in Chapter 3). A research design based on the established SNM approach facilitated the development of links to some of the major theoretical concerns in transition theory. The SNM case study format was developed around systemic functions initially described by Rip and Kemp (1998) and widely cited as key elements of innovation and transition processes (see, for instance, Hoogma et al. (2002), Van Lente et al. (2003); Geels (2002) or Grin et al. (2010)). By working with this established format, this research can benefit from and contribute to a growing body of knowledge (Weber et al., 1999; Hoogma et al., 2002; Geels, 2002; Grin, Rotmans and Schot 2010; among others). A discussion of the contribution of the case study based on the Plugged-in Places Programme in Milton Keynes to the understanding of related SNM-based cases centred on sustainable transport is provided in Chapter 6.

Case studies in SNM are often centred on a single case (e.g., the cases collected in Hoogma et al., 2002, or Ieromonachou et al., 2004). This can be justified because SNM cases explore industrial networks within their context. Their study presents researchers with particular challenges since they do not constitute closed, bounded or clearly defined systems. The main units of analysis are organizations and relationships which are difficult to access and complex in structure in comparison with, for example, consumer markets (Dubois and Gibbert, 2010). As a result, a single case study of a single entity or a small number of such entities can provide a great deal of largely qualitative data offering insight into the nature of the phenomena (Easton, 2010).

The SNM case study format (Hoogma et al., 2002) is designed for analysing and reporting the processes that take place when a new technology is introduced in a protected environment, and for assessing the contribution of this limited introduction towards the creation of conditions that encourage widespread adoption. This is clearly relevant to the PiP programme and to the research questions. However, the SNM approach has concentrated on

the construction and reinforcing supply chains, under the assumption that new technologies become competitive because of economies of scale, technological development and network benefits. Because of this, behavioural, market and social factors have been neglected or highly stylized[3] in the theoretical framework and in the case study format. An additional limitation of the SNM case study is the lack of guidelines for its operationalization (Raven et al., 2010).

4.6 Scope and Unit of Analysis for the Case Study

Most researchers wish to compare their findings with previous research; for this reason the key definitions should not be idiosyncratic. Rather, each case study and unit of analysis either should be similar to those previously studied by others or should deviate in clear, operationally defined ways. In this manner, the previous literature therefore can become a guide for defining the case and unit of analysis.

The unit of analysis in SNM is the "experiment", defined as an open-ended search and learning process taking place within a niche, working towards societal embedding and adoption of the new technology (Hoogma et al., 2002, p 4). Each experiment is studied within its context, including regional and national developments, competing technologies, and related experiments

This research project is based on a single case study centred on the "experiment" that took place in the town of Milton Keynes between the years 2011 and 2013. The case study concentrates on the organizational and policy actors that contributed to or engaged with the search and learning processes fostered by the PiP programme. Organizational and policy actors have a disproportionately large impact on niche-building processes involving

---

[3] One important difficulty in research is to find an appropriate level of abstraction. The model should be parsimonious enough to avoid distraction by minor details and at the same time rich enough to capture the relevant aspects of the phenomenon. In this context, "stylization" refers to the simplified presentation of an empirical findings concentrating on broad tendencies and ignoring individual detail.

sustainable transport. The market for electric vehicles in the UK provides a clear example of the observation that "*business marketers serve the largest market of all; the dollar volume of transactions in the industrial or business market significantly exceeds that of the ultimate consumer market. In the business market, a single customer can account for an enormous level of purchasing activity*" (Hutt and Speh, 2012, p 4).

Industry figures for the automotive sector in general (SMMT, 2011) show that organizational buyers accounted for 55% of the purchases of new vehicles in the UK for the year 2010 (the year in which this research design was taking shape). In the case of the emerging EV industry, the organizational market is even more important. According to government figures (DFT, 2012), corporate sales accounted for nearly 75% of the registrations for ultra-low emission vehicles in 2012.

As this research project is concerned with decision-making there is also a definite methodological benefit to be gained by concentrating on organizational actors. Decision making processes in organizational life are more readily accessible than those related to the private sphere because organizational life calls for continual, deliberate negotiation (Czarniawska-Joerges, 1992; Weick, 1995). Decision makers have to justify their choices to actors that occupy a higher position in the organization. In consequence, they have to build a solid case for adoption and are very aware of the needs, barriers and motivations of technology users within their firm.

A preliminary analysis of the documents associated with this project (Constantinides, 2009; OLEV, 2011) identified 28 categories of organizational actors associated with the project. 11 of those are particularly relevant for this research because they are situated at the interface between patterns of production, consumption and utilization, and actors in those groups had a decision making role or were in direct contact with decision makers. The

empirical aspect of this research concentrated on actors belonging to the 11 groups highlighted in Fig. 4.1.
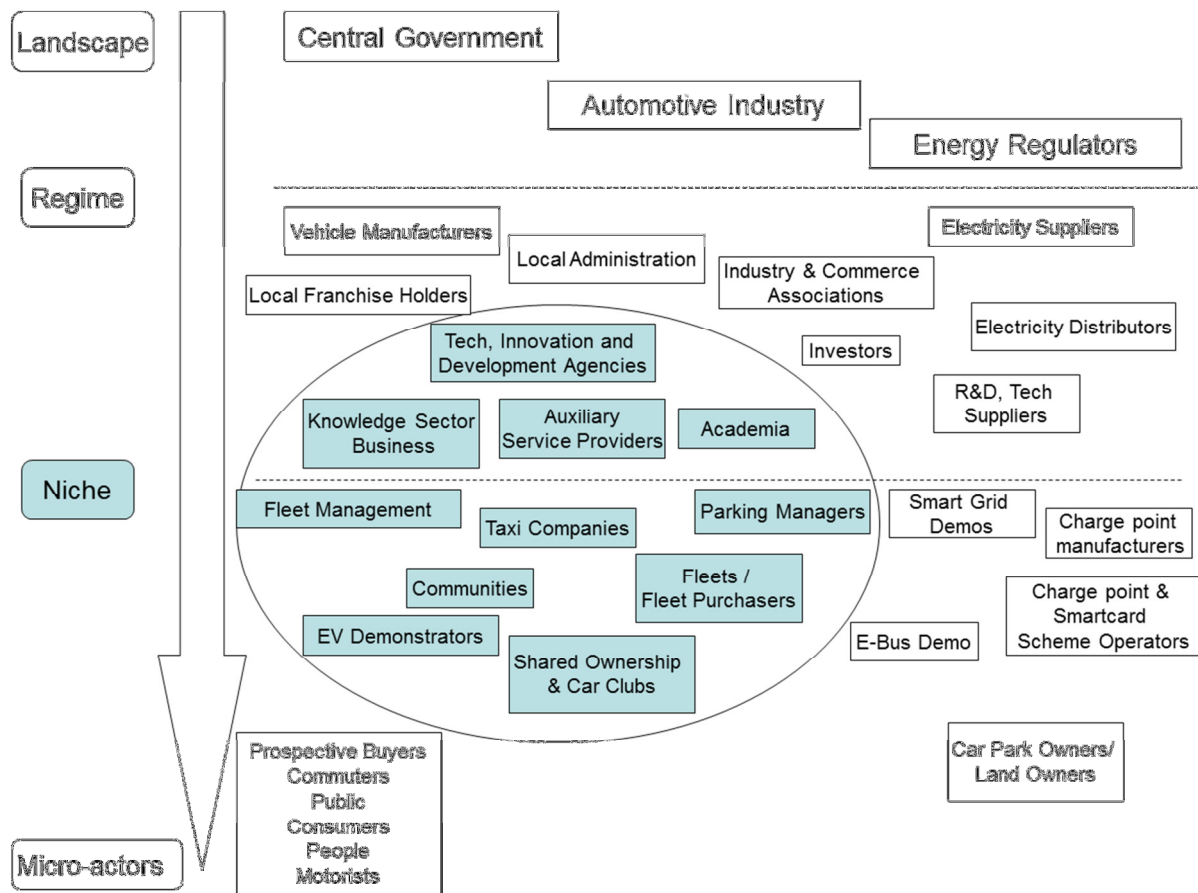
Figure 4.1: Categories of actors involved in the PiP programme
As identified in funding bid and relevant policy documents (Constantinides, 2009; OLEV, 2011).

Access to actors relevant to the case was greatly facilitated because of the role of the Open University as partner to the consortium coordinating the implementation of the PiP programme in Milton Keynes. This high level of access supported a research design based on the in-depth analysis of a single case study, an approach that can be justified for revelatory cases (Yin, 1989).

A major strength of such a case study is the opportunity it provides to use many sources of evidence (Yin, 1989). This research benefits from the use of multiple sources of

evidence (semi-structured interviews, participant observation, and practitioner literature), drawing from the inherent strong points of each source in order to increase the reliability of the results. The evidence provided by those multiple sources was expected to converge towards a coherent picture of the processes taking place within the protected learning space supported by the PiP programme. By replicating the findings across methods within this single research project, high levels of data validity and generalizability can be achieved, and a fuller picture of the business unit under study can be provided (Bonoma, 1985; Bryman and Bell, 2003).

Case studies entail the detailed exploration of a specific case, which could be a community, organization or person. They can provide fertile ground for abductive theory development because they allow for continuous movement between an empirical world and a model world (Dubois and Gadde, 2002). However, the case study approach must be complemented with the use of appropriate methods. The case study approach is often referred to as a method, but it is more aptly described as a research design. . Simply selecting an organization and deciding to study it intensively will not provide data (Bryman and Bell 2003, p 32). Once a case has been selected, a research method or research methods are needed to collect data. For this research, it was decided to base the case on a thematic analysis drawing on semi-structured interviews, participant observation, and documentary evidence. Thematic analysis is well suited for this approach because it is not associated with a particular theory, so it can be used within different theoretical frameworks (although not all). A theory-led engagement with the data is made possible, thereby going beyond mere description and providing scope for theory development (Clarke and Braun, 2006). Section 4.7 justifies the selection of thematic analysis as a method for systematic analysis of qualitative data. Section 4.8 describes the data sources and the data selection strategies that provided the evidence to be analysed.

4.7 Thematic Analysis as an Analytical Method for Case Studies

The overarching design of this research is based on an existing case study design, but one key contribution of this research comes from adding an intermediate stage to the analysis, in which the outputs of a thematic analysis are used as inputs for the case study.

Thematic analysis belongs to the "content analysis" class of analysis methods. Shapiro and Markoff (1997, p 14) propose a minimal and encompassing definition of content analysis: "*any methodological measurement applied to text (or other symbolic materials) for social science purposes.*"

The goal of content analysis is the systematic examination of communicative material (originally from the mass media in particular). Ideally, the analytic process involves a progression from description, where the data have simply been summarized and organised to show patterns in semantic content, to interpretation, which seeks to theorise the significance of the patterns and their broader meanings and implications (Patton, 1990). This form of analysis is applied generally but not exclusively to texts (Mayring, 2004). Initially, analysis relied on quantitative procedures like frequency analyses, in which particular textual components were counted. This approach was criticised because it neglected latent meaning structures (Kracauer, 1952). Subsequently there were repeated attempts to develop a qualitative form of content analysis (e.g., Ritsert, 1972; Mostyn, 1985). The broad label "qualitative content analysis" has been used to describe significantly different methods (Kohlbacher, 2006; Mayring, 2000), but they share a common approach to the analysis of texts and documents emphasizing the role of the investigator in the construction of their meaning. "*There is an emphasis on allowing categories to emerge out of data and on recognizing the significance for understanding the meaning of the context in which an item being analysed (and the categories derived from it) appeared*" (Bryman, 2004, p 542). Thematic analysis follows this qualitative, context-sensitive approach to content analysis.

Thematic analysis can be defined as a qualitative method for identifying, analysing and reporting patterns (themes) within symbolic materials. It can be used to identify surface meanings (semantic analysis) as well as underlying ideas, assumptions and conceptualizations (latent analysis) (Clarke and Braun, 2006). Thematic analysis is not associated with a particular theoretical framework, but it can be used for a theory-led engagement with the data, thereby going beyond mere description and providing scope for theory development (ibid).

The thematic analysis in this research builds on concepts from Strategic Niche Management (SNM) and social marketing. This dual perspective is used for understanding a body of evidence based on interviews, participant observation and documentary sources related to the organizational adoption of EVs in Milton Keynes. In turn, empirical evidence is used to explore underdeveloped aspects of the theoretical frameworks. The literature review identified some areas of SNM and social marketing that have not been subject to systematic empirical testing. Particularly, early-market SNM and upstream social marketing were explored following an abductive logic of enquiry (as outlined in Section 4.4). Abductive logic is based on an iterative exploration of the original theoretical frameworks, unanticipated empirical findings, and theoretical insights gained during the process. New combinations were developed "*through a mixture of established theoretical models and new concepts derived from the confrontation with reality*" (Dubois and Gadde, 2002, p 559).

There is no single, universally agreed-upon procedure for performing a thematic analysis. The approach outlined in Clarke and Braun (2006) was found to provide a useful degree of guidance and structure. A complete account of the implementation of this method is provided in Chapter 5.

4.8 Rationale for Selection of Data Sources

4.8.1 Data Source Considerations for the Case Study Approach

One of the defining characteristics of the case study is its reliance on multiple data sources, which facilitated the development of holistic descriptions of the entity under study, and contributes to the validity of the findings by avoiding excessive reliance on a single approach and creating opportunities for triangulation (Yin, 1989; Knights and McCabe, 1997; Easton, 2010). In qualitative case studies, where verification of data is not the main issue, multiple sources are selected because they contribute to revealing different dimensions of the research problem (Dubois and Gadde, 2002).

Exponents of the case study design favour qualitative methods such as participant observation and unstructured interviewing because these methods are viewed as particularly helpful in the generation of an intensive, detailed examination of a case (Bryman and Bell 2003). For this research, semi-structured interviews, documentary evidence (policy and trade literature) and participant observation were used as sources of evidence. The benefits of drawing on those sources is discussed in Sections 4.8.2 to 4.8.4

4.8.2 Rationale for the Selection of Semi-Structured Interviews as Data Sources

The body of evidence feeding into this research benefited from the inclusion of 16 semi-structured interviews with organizational decision makers. The interview is considered one of the most important sources of case study, because most case studies are about human affairs that should be reported through the eyes of specific interviewees. Additionally, interviews provide shortcuts to the prior history of the situation, so that the investigator can readily identify other relevant sources of evidence (Yin, 1989, pp 90, 91).

In the continuum between fully structured and completely open-ended interviews, case study interviews tend to be of an open-ended nature, as more unstructured formats allow

for the respondent to provide their own insight into the phenomenon under study (Robson, 2002). However, one of the downsides for unstructured approaches is the significant time commitment it requires from the researcher and the respondent. This can make a fully open-ended approach unsuitable for studies that involve high-level organizational actors (Bell and Bryman, 2003), as was the case for this research project.

While a completely open-ended interview approach was not considered practical, the theory-building aspect of the research means that a fully structured approach would also be unsuitable. While the structured approach is often the least demanding in terms of time commitments, it is only suitable for research project with clearly defined theories and conceptual frameworks (Bell and Bryman, 2003).

The semi-structured approach that was followed relied on a relatively small number of flexible, open-ended questions. This approach is considered useful in situations when the researcher is interested in a particular phenomenon without having identified a conceptual framework to account for this (Robson, 2002). While this research was based on the conceptual frameworks outlined in Chapter 3, some crucial concepts within the frameworks were underdeveloped and the semi-structured approach contributed to their exploration.

The interview guidelines needed to adopt a conversational tone. Respondents were encouraged to propose their own insights, which were used as the basis for further inquiry. Interviews with experts and high-level decision makers were sought, and in consequence they were considered "key informants" rather than interviewees. Key informants as a result of their personal skills, or positions within a society, are able to provide more information and a deeper insight into what is going on around them than what could be provided by the average member of their society (Marshall, 1996).

The constructivist approach selected for this research was also compatible with this conception of the interviewee as a key informant. Under positivist approaches, interviews should be designed to maximize the flow of valid and reliable information that resides inside the respondent's mind, minimizing any distortions and controlling the interview process to eliminate possible sources of bias, error, and misunderstanding (Javernisu and Tornroos 2010). In constructivist approaches, the interview is conceptualised as a social encounter in which knowledge is jointly constructed by the interviewer and a key informant (ibid).

Interviews should always be considered as verbal reports only. As such, they are subject to the problems of bias, poor recall and poor or inaccurate articulation (Yin, 1989; Bryman and Bell, 2003). A further limitation of the interview as a research method comes from its reliance on verbal behaviour, as matters that interviewees take for granted are less likely to surface than in observational methods (Robson, 2002). Given these potential shortcomings, a reasonable approach is to corroborate interview data with information from other sources. For the purposes of this research, the problems of poor recall and inaccurate articulation were therefore addressed by triangulation with documentary sources, and the limitations of verbal methods were addressed by drawing upon participant observation.

4.8.3 Rationale for the Selection of Participant Observation as a Data Source

This research benefited from the opportunity to observe experts and industry decision makers, with the researcher acting as a participant observer in the context of six Business User Workshops associated with the Plugged-in Places programme in Milton Keynes and organized by the Open University. Observational methods involve some form of direct observation of what is going on in the situation the study is set out to explore (Robson, 2002). Participant observation is an observational method that calls for the researcher to become engaged in the social setting where the phenomenon under study takes place. The participant

observer is in contact with people for a long period of time, participating in many of the same kinds of activity as members of the social setting being studied.

Because of the ability to observe behaviour rather than just rely on what is said, and because of the unstructured nature of participant observation, participant observation provides opportunities for encountering unexpected topics or issues. Participant observation is therefore useful to gain insight to a situation that is new to the researcher and to acquire a rich and detailed picture of the situation throughout the study (Geertz, 1973). For this PhD project, participant observation was particularly useful for achieving familiarity with the concerns and practices of various policy and industrial sectors related to the automotive industry.

Becker and Geer (1957) argued that the participant observer is in the same position as a social anthropologist learning the language of the land. In the case of business research, "learning the language" requires familiarization with the specialized use of words and slang. In the context of this research, participant observation required fluency with a rather large number of acronyms for various programmes and technologies, whose definitions are provided in appendix A2.

There are various distinct approaches towards participant observation, which are defined by their level of engagement with the population of interest. They can be placed in a continuum toughly defined by three positions: complete participation, marginal participation, and participant as observer (Robson, 2002). Two of those approaches were considered unsuitable for this research. An approach based on complete participation with full engagement in the situation would have depended on the concealment of the purpose of the study, creating ethical concerns. An approach based on marginal participation, with the researcher undertaking a passive role on the social setting, was also unsuitable because the

events under observation were hosted by the supervisors of this PhD research, and the researcher was expected to take active speaking and moderation roles. In consequence, a participant-observer role was pursued, in which the role of the researcher as observer was made clear to the social setting at the start of the study.

Given the commercially sensitive nature of the information discussed during the events under study, the researchers committed to avoid publication of the discussions that took place during the workshops, except for the minutes of the events, which were sent to all the attendants. The downside of this approach is that a full chain of evidence cannot be provided for data acquired in the course of the exercises. This was also the case with interview data, as a commitment was made to avoiding disclosure of commercially sensitive information. This had the potential to negatively impact upon the reliability of the research. In order to address this potential issue, an additional method of data gathering was used, drawing on publicly available documents. In this way, insights gained in the course of interviews and participant observation exercises are corroborated through publically available and readily verifiable documentary evidence. The provision of such a chain of evidence supports the reliability of the research, allowing external observers to follow the derivation from questions to evidence to conclusions (Yin, 1989).

4.8.4 Rationale for the Selection of Documents as Data Sources

Documentary evidence is considered relevant to all case studies except in preliterate societies. Organizational and institutional documents have been a staple in qualitative research for many years (Yin, 1989). The key assumption is that the analysis of texts lets the researcher understand other people's cognitive schemas (Huff, 1990; Gephart, 1993; Woodrum, 1984). Content analysis is considered a suitable approach for rigorous exploration of many important but difficult to study issues of interest to management researchers (Carley, 1993). Qualitative analysis of documents is particularly useful for the study of topics like

corporate social responsibility and managerial cognition, which are difficult to study using traditional quantitative methods and archival, financially oriented databases (Duriau et al., 2007).

Documents can also be used to gain insights about the context within which research participants operate (Bowen, 2009). This context revealing function becomes particularly relevant in the case of documents intended for widespread circulation within the organizations and industries being studied, as mass media "*not only defines what we 'know' and 'feel' about certain issues, but also what 'knowing' and 'feeling and 'being involved' look like*" (Altheide, 2000, p 288). For the research described in this thesis, specialized publications aimed at transport professionals and governmental actors involved in transport policy were analysed to gain insights about the context in which the conversation about EVs was taking place.

There are many benefits to using documentary sources as a complement to other methods. Documentary analysis has low obtrusiveness and reactivity: the subject of research is unaffected by the research process, and therefore does not suffer from researcher demand bias (Woodrum, 1984, Bryman and Bell 2003, p 361). Additionally, documentary analysis is a very time-efficient method, and many documents are available in the public domain, simplifying data collection and allowing for direct verification of the evidence by external observers.

4.9 Data Selection and Gathering Strategies

4.9.1 Purposive Sampling and Snowball Methods

This section provides a discussion of the strategic approach that shaped the data gathering and selection stage of this research. It outlines the rationale for the choices made in planning the data gathering and selection, with Sections 4.9.2 to 4.9.3 discussing specifics for

the three main sources of evidence that were used in this research: Interviews, participant observation and documentary sources.

Each of the sources of evidence sought called for the use of distinct data collection procedures, but in all cases the strategy for identifying viable sources of evidence was based on a purposive sampling approach complemented with the use of snowballing methods.

Much social science is concerned with classifying different "types" of behaviour and distinguishing the "typical" from the "atypical." In quantitative research this concern with similarity and difference leads to the use of statistical sampling so as to maximise external validity or generalizability. However, since qualitative data collection is generally more time consuming and expensive than, for example, a quantitative survey, it is not usually practicable to use a probability sample. Furthermore, statistical representativeness is not a prime requirement when the objective is to understand social processes (Mays and Pope 1995).

An alternative approach, often found in qualitative research, is to use systematic, non-probabilistic sampling. The purpose is not to establish a random or representative sample drawn from a population but rather to identify specific groups of people who either possess characteristics or live in circumstances relevant to the social phenomenon being studied (Mays and Pope, 1995). This approach to sampling allows the researcher deliberately to include a wide range of types of informants and also to select key informants with access to important sources of knowledge (ibid).

Because this approach is not conducive to the collection of statistically generalizable evidence, the case study does not represent a "sample" Non-probabilistic methods make impossible to calculate sampling errors or to provide estimates for precision. Non-probability approaches are considered viable when the investigators goal is the expansion and

generalization theories (analytical generalization) rather than the enumeration of frequencies (statistical generalization) (Yin, 1989). Non-probabilistic approaches are recommended when very few cases can be included in the study because of cost, availability, or (as was the case with pioneering EV adopters in Milton Keynes) because the population contains very few cases relevant to the research questions. In non-probabilistic studies "sampling" will consist of studying all identifiable and cooperative units. A non-probabilistic approach is considered unsuitable for quantitative studies, but advantageous when the aim of a study is primarily explorative, qualitative and descriptive (Hendricks et al., 1992).

The snowballing approach is a non-probabilistic technique normally reserved for the identification of research subjects in hidden or hard to reach populations. Traditionally, it has been used to identify hidden or stigmatized populations (e.g., criminals, drug users, the unemployed), but is also considered useful when the subjects of interest are few in number and not readily identifiable, so that sampling methods like household surveys are likely to produce few or no leads (Atkinson and Flint, 2001). This is the case for industrial networks, which present researchers with particular challenges since they do not constitute closed, bounded or clearly defined systems. The main units of analysis are organisations and relationships which are difficult to access and complex in structure in comparison with, for example, consumer markets (Easton, 2010).

The snowballing approach can be described as follows: One subject gives the researcher the name of another subject, who in turn provides the name of a third, and so on (Vogt, 1999). This method allows for the researcher to take advantage of the social networks of identified respondents to reach an ever-expanding set of potential contacts (Thomson, 1997). The process is based on the assumption that a bond or link exists between the initial sample and others in the same target population, allowing a series of referrals to be made within a circle of acquaintance (Berg, 1988). Those links facilitated the identification of the

population of interest in Milton Keynes, as the snowballing approach revealed the loose industrial network coalescing around EVs.

Snowballing approaches require some previous knowledge of insiders in order to identify initial respondents. When such prior knowledge is not readily available to researchers, it may be very time consuming and labour intensive to acquire. Under these circumstances, people in positions of relative authority or proximity may provide a route into the required population (Groger et al., 1999, Atkinson and Flint, 2001). In the case of this PhD research, this knowledge of insiders was provided by Professor Stephen Potter, one of the supervisors of this research. His familiarity with policy and industry actors relevant to the study of transport issues in Milton Keynes proved invaluable for establishing contact with the initial set of key informants required to set the snowballing procedure in motion.

Though statistically representativeness is not a concern for most qualitative approaches, a purposeful sample must be theoretically informed and relevant to the research questions. In the case of this research, the "sample" was considered as satisfactory once two conditions were met: First, actors belonging to all of the main categories identified in section 4.6 had been identified, and second, using a snowball approach to ask for further referrals did not contribute to further understanding of the group under study. By following a theoretically informed approach, the possible bias arising from convenience selection was minimized.

The specific procedures used for identifying potential sources of evidence and for gathering data for each of the three main types of evidence informing this research is described in the following sections.

4.9.2 Data Selection Strategy for Interview Data

Trade literature, business user workshops and references from the initial set of key informants were used to identify actors with potential for acting as key informants. Trade

events related to the EV industry, including the workshops organized by the Open University, were particularly useful for this. Informants were asked to suggest other potential informants in their network. Participant information and informant referrals were used until locally active organizations in all the relevant categories discussed in Section 4.6 were identified. Participant observation made it possible to identify the organizations that were taking a more active approach towards understanding the needs of organizational EV users, and decision makers within those organizations were contacted. In the instances where the initial interview revealed that the position of the organization was likely to evolve or was undergoing change, follow-up interviews were sought.

Actors in some of the categories identified in Section 4.6 were found to have a low level of involvement with the patterns of use and consumption for EVs, and in-depth interviews were not pursued. This was the case for R&D organizations, technology suppliers and parking managers. Evidence related to actors in categories not covered by the interviews was gathered by alternative methods such as participant observation.

4.9.3 Data selection Strategy for Participant Observation

The bulk of the participant observation data collected for this research was gathered in the course of 6 biannual EV business user workshops organized by The Open University in its role as a PiP partner. The workshops were open to users and potential users, technology and service providers including automotive manufacturers and retrofitters, as well as policy actors. Invitations were circulated in advance via electronic mail and interested parties were invited to forward the invitation to their contacts.

To allow the discussion of commercially sensitive matters, the events were not recorded and no transcripts are available. However, notes were taken during group exercises

as members of different groups worked towards a consensus on different aspects of the electric car issue (see Table 4.2 for an example).

Table 4.2: Discussion guide for EV business users workshop, Summer 2012
1. Initial session (in groups).Where organisations get information and support from.   2. Then what sort of information and support would they like? Explore what type of appraisal takes place and what are the criteria set?   3. Go into what support is available (locally, nationally, 1-to-1 and networking)   4. Final session- identify what kind of information/knowledge is missing – particularly about practice?

Anonymized minutes were circulated with authorization of the participants. Providing the minutes and encouraging feedback from participants confirmed that the notes reflected the position of the participants accurately.

Additional evidence was gathered by means of marginal participation in various trade events related to EVs and low carbon policy (Table 5.2). In order to avoid the ethical concerns associated with undisclosed participant observation, evidence gathered was restricted to publicly available information (e.g., exhibitor lists, publicly available abstracts and press releases).

4.9.4 Data Selection Strategy for Documentary Sources

The documentary component of this research draws on two distinct pools of data. One body is based on periodical practitioner literature with mass-circulated print editions, while the other draws on policy documents.

The practitioner literature data set draws evidence from three UK-based publications with nationwide distribution: "*Local Transport Today*", "*FleetNews*" and "*GreenFleet*".

There are three criteria that can be used to assess the suitability of the selected publications. First, their stated target audiences can be roughly mapped into the landscape, regime and niche levels described in transition theory (See Section 3.3.2). Second, the publications can also be mapped to upstream and downstream audiences relevant to the social marketing perspective (Section 3.4.2.2). Additionally, the collective reach of the three selected publications covers all of the relevant actors identified in Section 4.6.

"*Local Transport Today*" targets decision-makers in central government and local authorities, whose sphere of influence corresponds to the "landscape" level (Rip and Kemp, 1998). It is published fortnightly, and has a reach of 20,000 readers per issue.

"*FleetNews*" is aimed at senior decision makers in the fleet industry, and in consequence it can provide insight into the perspective of entrenched incumbents as they evaluate a potential competitor which also has the potential to enter into a symbiotic relationship (Geels, 2002). Each weekly issue reaches a readership of 16,000.

"*GreenFleet*" is aimed at fleet, transport and environmental managers, with a focus on the emerging low-carbon fleet industry. In consequence it can provide insight into the perspective of the actors conforming the coalescing niche. It is published ten times a year, with each issue reaching 7000 readers.

At the time of this research, the full archives for all three publications were available online for the period between 2009 and 2013. All the web sites had a built-in search function that could be used for rapid retrieval of articles with relevant keywords. Articles containing at least one of the following search terms were located by means of the built-in search engines and added to the data set: "*Milton Keynes*", "*Plugged-in Places*", "*Electric Vehicles*" and "*Electric Cars*".

A second component of the documentary analysis drew evidence from policy and industry documents that informed the context for the PiP programme. Selection was guided by the review of policy literature in Section 2.2.1, with additions made when particular documents were identified as relevant on the basis of the participant observation described in Sections 4.9.3 and 5.2.2.

4.10 Criteria for Quality

The status of all forms of research depends on the quality of the methods used. Users and funders of research require some means of assessing their quality and of distinguishing "good" and "poor" quality research. However, the issue of "quality" in qualitative research is part of a much larger and contested debate about the nature of the knowledge produced by qualitative research, whether its quality can legitimately be judged, and, if so, how (Mays and Pope, 2000). It is important to note other substantial differences between qualitative case research and more high-data-integrity methods. First, the goal of data collection in qualitative case research is not quantification or even enumeration, but rather

(1) description

(2) classification (typology development)

(3) theory development and

(4) limited theory testing.

Rather than seeking generalization, the goal of case research is rich learning and understanding of a particular case in a specific context (Bonoma, 1985; Dubois and Gadde, 2002). Because of the constructivist approach followed in this research, the usual (positivistic) criteria for validity and reliability are not applied. This rejection of positivism does not need to result in vague or relativistic statements, but rather in a modest position towards knowledge; "*we can make strong claims, but since these claims are limited, we have to be modest about them*" (Ciliers, 2005, p 263, quoted in Avelino, 2011, p 17).

In discussions of quality criteria for qualitative studies, three positions may be distinguished (Steinke, 2004): the first position seeks to transfer quantitative criteria to qualitative research. The second position involves a postmodern rejection of criteria, and the third position holds that evaluation of qualitative research requires the formulation of appropriate criteria. The third position asserts that a conclusive discussion of quality criteria can be conducted with reference to the respective research questions, methods, specific features of the research field, and the object of the investigation (Steinke, 2004).

The first position, involving the reformulation and operationalization of criteria from quantitative research, was found unsuitable to this research. It is important, however, to acknowledge its influence in academia. Several authors have recently conducted surveys of published case study research (e.g. Piekkari et al., 2010; Gibbert et al., 2008), finding that the most influential model used in published case study research at large adheres to what is commonly called the "natural science model" (e.g. Behling, 1980). While scholars typically agree that quantitative and qualitative methods of inquiry are complementary rather than incommensurable, they have often criticized the other method on the basis of rigor, validity, and reliability (Dubois and Gibbert, 2010). According to this model, natural science with its positivist world view is the ideal which social science should try to emulate. From the perspective of the natural science model, four criteria are commonly used to codify the rigor of field research: construct validity, internal validity, external validity and reliability (Campbell and Stanley, 1963, Cook and Campbell, 1976 and Cook and Campbell, 1979).The intention is to ensure that that correct operational measures have been established for the concepts that are being studied, that a causal relationship has been established, and that the findings can be replicated and generalized.

At the other extreme of the continuum, the postmodern perspective postulates that it is not possible to formulate criteria for qualitative research. Researchers write their texts in the

first person singular, overcoming the division between observer and observed reality. Questions about reliability and validity are seen as incompatible with a socially constructed world (Denzin, 1990; Shotter, 1990).

The rejection of quality criteria implied by the postmodern position was unsuitable for this research because it conceals the risk of randomness and arbitrariness in qualitative research. This can result in problems for further recognition of qualitative research beyond its narrow scientific community. Postmodern constructivist social researchers are confronted with the problem of convincing others of the value and quality of their investigations (Lincoln and Guba, 1985; Steinke, 2004).

For this research, the third position was taken, and quality criteria were selected with reference to the research questions and the object of the investigation (Steinke, 2004). For this research, the alternative criteria of creditability, trustworthiness and transferability (Padgett, 1988) will be used. A fourth criterion, relevance, is concerned with the judging of theories with regard to their pragmatic usefulness (Steinke, 2004), and is addressed in Chapter 6 of this thesis.

Creditability refers to the idea that research can produce more or less convincing accounts, and it is achieved in research design if the arguments it presents are convincing. This is closely related to the trustworthiness criteria, as others may choose not to believe in the story provided by the researcher. Trust can be established by demonstrating the research process in an open and transparent way. There are several strategies that can be followed to address creditability and trustworthiness issues. Creditability, according to Padgett (1988) comes from prolonged involvement, and from providing an audit trail. For this research, the prolonged involvement criterion is met because research spanned the complete, three year duration of the Plugged-in Places programme. Chapters 4 and 5 constitute an audit trail, providing step-by-step documentation of the research process so the external public is given

the opportunity to follow the investigation and to evaluate the research process and the results which derive from it. This audit trail consists of the following components:

- Documentation of the decisions, problems and considerations that shaped sampling and choice of method.

- Documenting the researcher's prior understanding, that is, explicit and implicit expectations.

- Documentation of the collection method and collection –context, including specification of the procedures used.

- Documentation of information sources,

- Documentation of methods of analysis,

Transferability comes from the findings being creditable in a different context. Greenwood and Levin (2007) make a distinction between internal and external creditability, meaning that people who have/have not participated in the study believe in the outcome. For this research, creditability can be defended because the findings were constantly discussed with and found creditable by internal and external experts, for example during the business user workshops, UTSG conference, and sustainable transport futures workshop at Greenwich (see Section 5.2.2).

An important question for case study research is whether the findings are generalizable beyond the immediate case studies. Does the conceptual perspective only hold for the particular cases or does it have external validity? The generalizability in case study research does not stem from statistical generalization but from analytical generalization (Yin, 1984). If the theoretical propositions or the conceptual perspective is confirmed in one case study (or better, in several case-studies), then it can be expected to hold in other cases with similar characteristics (ibid). This research benefits from the availability of many other case

studies following the format outlined by Hoogma et al. (2002), particularly because many of them are also related to the societal domain of transportation. Chapter 7 provides a discussion of the contribution of this research to understanding of previous SNM case studies, particularly Hoogma et al. (2002) and Weber et al. (1999).

4.11 Ethical Considerations in Research Design

Most social research involves intervention in some aspects of social life. There is always a risk that even asking someone quite innocent questions could be disturbing to that person. It has therefore become normal practice for the ethical implications of a social research project to be made explicit, together with the procedures to be used to deal with them. Assessing the ethical merit of the research approach involves a judgement weighing up the relative balance of potential benefits and potential harms (Oates, 2006). Because benefits, including contributions to knowledge, are discussed elsewhere in the thesis, this section is focused on the potential harms, and on the approach used to address them.

The ethical implications of the research design were discussed with the Research Director of the department providing the main supervision for this research (the Department of Design, Development, Environment and Materials; now Engineering and Innovation). The Risk Checklist Human Research Ethics Committee (HREC) of The Open University (Appendix A2) was used to assess the research design. It was concluded that the research was low risk, as it involves consenting adults on positions of power, on topics that are not personally sensitive. The research design did not require any planned deception or withholding of information, as informing the participants about the purpose of the research would not compromise the accuracy or usefulness of the data. Participants were not offered any payments or other recompenses, and no conflicts of interest were identified.

The major ethical issue in most social research is related to the treatment of human respondents or participants. Procedures need to be in place to provide them with adequate information about the nature of the project, what is expected of them, how the research procedures might affect them, and how their anonymity will be assured, as well as assuring them that the personal details they provide will be treated in confidence (Blaikie, 2000). Data should only be gathered from people who have consented, have been given a clear statement about why the information is going to be collected, and have been told how it is going to be used. Typically, consent is gained and documented by using a combination of an information sheet and a consent form. The information sheet should give sufficient detail about the research study and the data collection from the potential participants so that they can make an informed choice as to whether or not take part (ibid).

The protocol used for addressing concerns related to human participants in this research followed the guidelines established by Human Ethics Research Committee of The OU. A protocol was prepared informing potential of any potential benefits, risks, inconvenience or obligations associated with the research. Consent was gained in a consistent manner. Participants were informed of their right to withdraw from the process at any stage, and they were given information as to whom they should contact in the event of any issues arising in the course of the research.

There are some additional concerns to be addressed in research centred on organizations. A concern for participating organizations is the impact that any negative data might have on external stakeholders' opinions of them. Any such sensitive data must be handled carefully and not revealed in a way which could damage organizations (Beattie et al., 2002). In the case of this research, data acquired in semi-structured interviews and participant observation were stripped of details that could identify individuals or organizations, and the researcher secured authorization to use unattributed quotes for illustrative purposes.

The information sheet and consent form provided to the interviewees that participated in this research is provided in Appendix A2. When interviews took place over telephone, and written consent form was not practical, participant was informed about use of data, right to withdraw. The relevant component of the interview protocol can be found in Appendix A1.

The data set used in this research also had a large component of documentary data, selected from mass media and publicly available policy documents. Unlike research based on interview data or participant observation, the conduct of mass communications research often presents little or minimal risk to participants (Chew, 2000). It is considered that few ethical problems arise from research on documentary and mass media sources intended to reach the general public. In such instances it is considered that the material may be freely analysed and quoted to the degree necessary in the research without consent (Wimmer and Dominick, 2013).

4.12 Summary

This chapter described the research design that guided this thesis, providing the justification for the choices made regarding the best means to collect the evidence needed to answer the research questions under investigation. The research questions first identified in Section 1.2 were re-examined in light of the literatures from Chapter 3, as a pre-requisite for the selection of a suitable research design. Thematic analysis was selected to identify the factors that were considered relevant by the different actors involved in the PiP programme. The research design described in this chapter sought to identify neglected dimensions in the processes taking place in a protected space supporting early market adoption of EVs. Several subsidiary questions related to the main question were proposed and, in order to answer these, a series of methodological choices were made leading into the research design selected for this thesis.

The design described in this chapter can be summarized as a qualitative, abductive case study. Case studies can provide fertile ground for abductive theory development because they allow for continuous movement between an empirical world and a model world (Dubois and Gadde, 2002). The case study is centred on organizational actors in the loosely defined network defined by the PiP programme and related policy measures in support of the EV that took place in Milton Keynes between 2010 and 2013.

It is argued that case study is not properly a method, but rather an approach. Thematic analysis was selected as a method for analysing the evidence. Thematic analysis is a qualitative method for identifying, analysing and reporting patterns (themes) within symbolic materials. For this research, the thematic analysis is applied to evidence from semi-structured interviews, participant observation and documentary sources.

While this chapter provided a detailed description and justification of the research design, and of the strategy for data collection feeding into it, no details of the actual implementation have been provided. Chapter 5, "Data Gathering and Analysis" describes the data sets produced by the selection strategies described in this chapter, and provides an account of the analysis performed on the evidence from the Plugged-in Places programme and the early market niche formation taking place in Milton Keynes.

Chapter 5 – Data Gathering and Analysis

5.1 Introduction

The overarching design of this research is based on a case study design, and the SNM case study format (Hoogma et al., 2002, p 66) is used to present the findings, but one contribution of this research comes from adding an intermediate stage to the analysis, in which thematic analysis is used to build a link between the evidence in the data set and the theoretical frameworks informing this research. This confrontation of empirical evidence against the theoretical concerns of SNM and social marketing provided a systematic approach for addressing the research questions, and facilitated an expansion of the SNM framework to account for the previously neglected marketing dimension.

This chapter explains the procedures that were used for implementing the research design outlined in Chapter 4. Section 5.1 introduces the objectives of the chapter and describes its structure. Section 5.2 describes the contents of the dataset produced following the data collection strategies in Sections 4.9.2 to 4.9.4, with Section 5.2.1 discussing the documentary component of the evidence. Section 5.2.2 discusses participant observation and Section 5.2.3 discusses the interview data. Section 5.4 describes the implementation of the analytic procedure outlined in Section 4.7, with Sections 5.4.1 to 5.4.6 describing the implementation and preliminary findings achieved through the successive stages of thematic analysis.

5.2 Composition of the Data Set

One of the defining characteristics of case studies is the reliance on multiple data sources, with the different sources contributing to the exploration of different dimensions of the research problem (Dubois and Gadde, 2002). For this research, semi-structured

interviews, documentary evidence (policy and practitioner literature) and participant observation were used as sources of evidence, as described in Chapter 4. This section describes the composition of the different sub-sets that constitute the data set providing the evidence base for this research. Section 5.2.1 describes the contents of the documentary component of the dataset that was used for this research, Section 5.2.2 discusses the semi-structured interviews with organizational actors, and Section 5.2.3 describes the evidence acquired by participant observation and its contribution to the thematic analysis.

5.2.1 Composition of Interview Data Set

Because of the low market penetration and relative lack of maturity of the EV technology in the period under study, a limited number of organizations using EVs in their operations could be identified in the Milton Keynes region covered by this study. After inclusion of organizations supporting the EV market and organizations exploring the possibility of adopting their business models for EV use, 17 organizations operating in Milton Keynes and the surrounding region were identified as relevant to this research. Confidential semi-structured interviews could be arranged with decision makers in 13 of those organizations. This provided coverage of all the relevant categories identified when setting the scope of the research (Section 4.6). Follow-up interviews were arranged for three of the interviewees after the initial contact indicated that the organization was undergoing processes of particular interest. For example, when the Director of a fleet management organization revealed that his organization was adding EVs to his line-up, a follow-up interview that took place nine months later revealed that his organization gained access to large corporate clients as a result of this decision. The addition of three follow-up interviews contributed to a total of 16 interviews. The interviews provided evidence related to the decision-making process of actual and prospective EV adopters from the following broad organizational categories:

- Fleet Management (2 interviews + 1 follow-up),

- Demonstrator Managers (2 interviews+ 1 follow-up),

- Knowledge Sector Business (2 interviews),

- Taxicab Companies (1 interview + follow-up),

- Fleet Users (1 interview),

- Innovation and Development Agencies (1 interview),

- Auxiliary Service Providers (1 interview),

- Community Organizations (1 interview),

- Academia (1 interview),

- Shared Ownership & Car Clubs (1)

The interviewed actors provided insights relevant to the different organizational categories that were identified as relevant in the preliminary analysis of policy documents summarized in Fig. 4.1 of Section 4.6, which categorised organizational actors according to their role on the Landscape-Regime-Niche-Micro-actor spectrum. The actors in the area encircled in Figs. 4.1 and 5.1 were identified as potentially relevant for this research. The selected actors were situated in the interface between the niche and the regime. This made them candidates for developing innovative patterns of production, consumption and utilization and introducing them into mainstream markets. This selection of potentially relevant actors provided guidance for the snowballing sampling approach used for this component of the data-set. The pool of potential interviewees was considered satisfactory when actors belonging to all the relevant categories were contacted and interviewed informally, or observed in a participant observation setting. Actors whose experience was related to the development of early-market activities were selected for formal semi-structured interviews. The match between the categories of interest and the number of interviews that contributed to the interview data-set can be seen in a development of this diagram in Fig. 5.1.
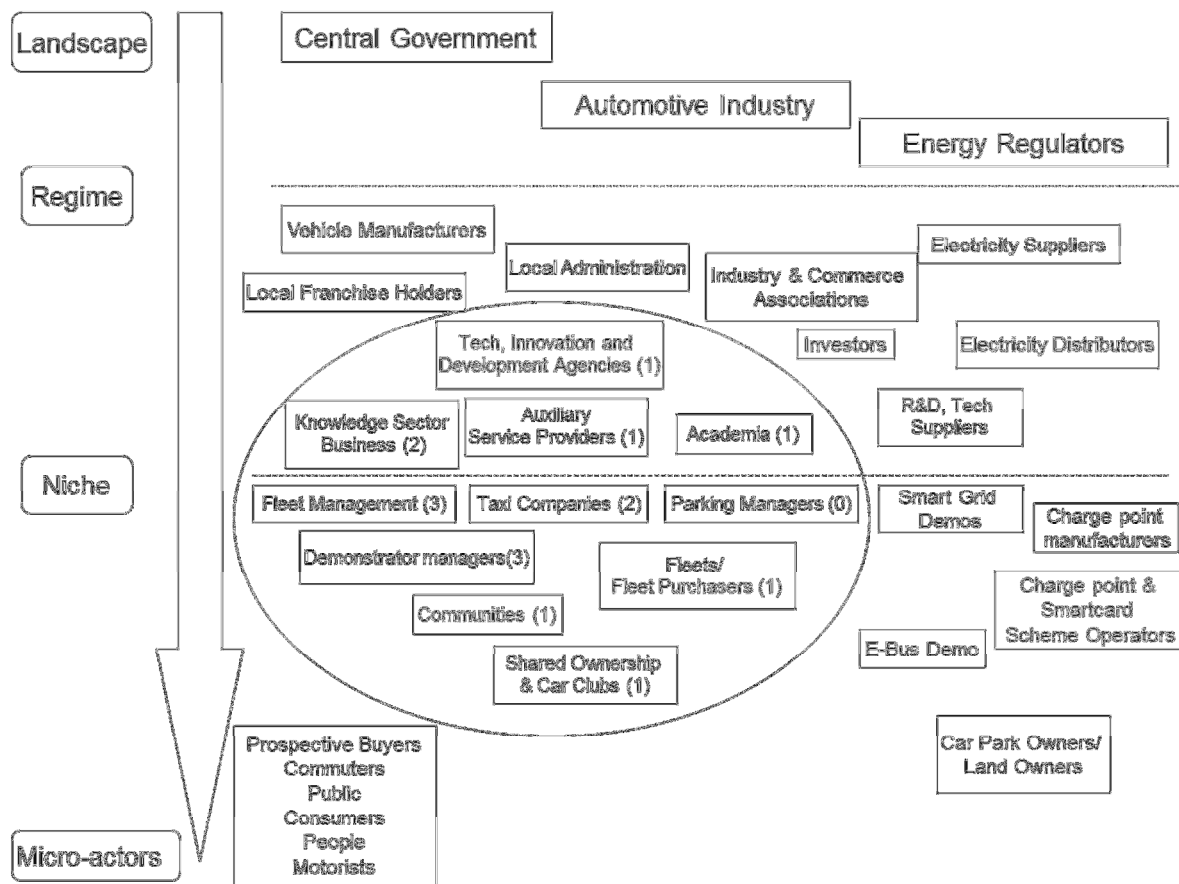
Figure 5.1: Actor categories represented in interview data

Actors in categories identified in Section 4.6 but not included in the formal interview list (parking managers, infrastructure manufacturers) were interviewed off the record during the Business User Workshops described in Section 5.2.2, and were found to have a low level of involvement with the patterns of use and consumption for EVs. In-depth interviews with low-involvement actors were therefore not pursued, and evidence on them was gathered by alternative methods such as participant observation. Interviewees were asked to describe their organization and their role within it, the fit of EVs to the needs of their organization (barriers and benefits), the networking and learning process experienced, and the up-stream and down-stream actors collaborating in EV-related issues. An interview protocol (Appendix A1) was used as a guide, but the tone of the interviews was conversational and informants were

encouraged to provide their own insights and suggest other issues of relevance to their organization.

The interviews had duration of 30 to 60 minutes in consideration of the busy schedules of the interviewees. The interviews were digitally recorded, and audio-processing software "Audacity" was used to improve the sound quality of the original recording when needed. Transcription software "F4", which provides semi-automated time-stamping and low-distortion half-speed reproduction, was used to facilitate the creation of a transcript.

5.2.2 Composition of Participant Observation Data Set

The bulk of the participant observation data collected for this research was gathered in the course of 6 biannual EV business user workshops organized by The Open University in its role as a partner of the Plugged-in Places programme in Milton Keynes. Data from the workshops were complemented by means of marginal participation in various trade events related to EVs and low carbon policy.

The business user workshops featured presentations by industry experts, technology demonstrations for vehicles and infrastructure, and semi-structured discussions. The workshops were intended to appeal to users and potential users of electric vehicles, but were open to all interested parties and were attended by a wide range of actors, including

- Electric vehicle manufacturers
- Infrastructure providers
- Transport sector (fleet management, taxicab companies, transport consultants, etc.)
- Organizations in the supply chain of the above
- Energy industry
- Technology integrators,
- Public sector and local government
- Community organizations

Attendance at the workshops was variable and grew over time as interested actors were identified or referred to us by previous attendees. The first workshop took place in December 2010 and had an attendance of 4 participants not related to the coordination of the event. The last workshop covered in this research took place in November 2012, and had 24 attendees.

Evidence gathered during the Business User Workshops included records such as workshop programmes, invitee and attendee lists (that were useful for identifying organizations that were active in the region in the period covered by the research), and reports summarizing the presentations and discussions. The reports were circulated among the attendees and feedback was invited in order to validate the conclusions. 39 pages of documentary evidence (single spaced, 12-point characters) were gathered as a result of the workshops.

Because of the commercially sensitive nature of the discussions that took place during the Business User Workshops, the organizers and the researchers associated to the event agreed not to publish the proceedings except for circulation among the attendees. However, this aspect of the research provided valuable leads regarding the goals and concerns of the participants. The workshops were also useful for identifying key informants to be interviewed.

Additional evidence was gathered by means of marginal participation in various trade events related to EVs and low carbon policy, as listed in Table 5.1. In order to avoid the ethical complications associated with undisclosed participant observation, evidence gathered was restricted to publicly available information, which also provided valuable leads regarding the goals and concerns of the participants. It is difficult to provide a sense of scale for this component of the data-set because of the eclectic nature of the evidence gathered

(programmes, exhibitor lists, transcripts of webcasts, publicly available abstracts and press releases, etc.), but the events listed in Table 5.1 accounted for approximately 50+ hours of observation.

Table 5.1: Industry events contributing to the participant observation dataset
• LowCVP Passenger Car WG meeting – May 2013 • RAC Foundation Cars and Climate event – Apr 2013 • EV Conference: Overcoming Barriers, Driving Adoption - Apr 2013 • 45th Annual UTSG Conference - Jan 2013 • Cenex LCV event – Sep 2012 • GreenFleet Arrive 'n' Drive - May 2012 • Silverstone EV & Low CO2 Fleet Show – Apr 2012 • RAC Foundation Green Charge event – Mar 2012 • Low Carbon Vehicle Show – Sep 2011 • 43th Annual UTSG Conference - Jan 2011

5.2.3 Composition of Documentary Data Set

The documentary component of this research draws on two distinct pools of data. One of the sub sets is based on periodical practitioner literature with mass-circulated print editions, and the other draws on policy documents.

As described in Section 4.8.3, the sub set informed by practitioner literature draws evidence from three UK-based publications with nationwide distribution: "*Local Transport Today*", a publication targeting decision-makers in central government and local authorities; "*FleetNews*", a publication aimed at senior decision makers in the fleet industry; and "*GreenFleet*", a publication focused on the emerging low-carbon fleet industry aimed at fleet, transport and environmental managers.

Articles published in the period between 2009 and 2013 and containing at least one of the following search terms were located by means of the built-in search engines: "Milton Keynes", "Plugged-in Places", "Electric Vehicles" and "Electric Cars". The data set was

considered complete once further searches using other keywords from the literature (e.g., "OLEV", "EV", "LEV") failed to produce additional results. The search returned the following number of articles:

- **Local Transport Today:** 25 articles

- **Fleet News:** 39 articles

- **Green Fleet:** 21 articles

Those articles varied greatly in length, from single paragraph releases to full multi-page analyses. The total page count was equivalent to 122 single-spaced pages printed on 12 point font, or 46,000 words. This initial dataset was read in full for familiarization purposes, but yielded many articles that were not relevant or had only tangential relevance to the research questions (for example, articles that mentioned Milton Keynes but were mostly centred on PiP deployments in other regions). Articles discussing organizational use of electric vehicles were identified and selected for further analysis. This selection had to be performed by hand, as there was not a particular set of keywords that would have allowed confident identification of the relevant articles by mechanistic means. Table 5.2 provides some examples of articles selected or rejected for inclusion in the revised dataset.

Table 5.2: Examples of candidate articles accepted or rejected for full thematic analysis.	
Articles selected for analysis	**Articles not included in the data set**
Green Fleet: *The right vehicle for the job* **Local Transport Today:** *EV charging implications at workplaces 'ignored'* **Fleet News:** *Firms cautious about electric vehicle subsidy*	**Green Fleet:** *Manchester launches EV charging scheme* **Local Transport Today:** *Johnson cuts back size of e-car network* **Fleet News:** *Free Nissan Leaf plug-in offers announced*

In the examples provided, two of the articles were rejected because they were centred on other PiP regions and mentioned Milton Keynes only tangentially. The other article was centred on home users. Because there is an element of subjectivity implied by the manual selection of articles, it was decided to err on the side of caution when in doubt, including borderline cases in the corpus (for example, articles with a national or European perspective but with potential implications for Milton Keynes).

After articles with low relevance to the research questions were eliminated, the count of articles selected for full thematic analysis, arranged by source, was as follows:

- **Local Transport Today:** 6 articles

- **Fleet News:** 28 articles

- **Green Fleet:** 10 articles

A second component of the documentary analysis drew evidence from policy and industry documents that informed the context for the PiP programme. Priority was given to documents discussing or enacting policy actions with a direct impact on actors in Milton Keynes and the surrounding region. This selection was guided by the literature review discussed in Section 2.2.1, with further additions when participant observation revealed documents considered relevant by the policy and organizational actors being observed. This sub set was composed of 10 documents, with 8 of them relating to the Plugged-in Places programme on a national level, and 2 discussing its implementation in Milton Keynes. Table 5.3 provides the full list of policy documents selected for analysis.

Table 5.3: Policy and industry documents selected for analysis	
The King Review of low-carbon cars **Source** : HM Treasury, Dame Julia King **Date** : Oct 2007	
Milton Keynes: Open to action on climate change? - A response to the UK Government's Electric Car Initiative **Source**: John Miles, Ove Arup & Partners **Date**: July 2009	
Plugged-In Places: The Electric Vehicle Charging Infrastructure Framework, Application Guidance **Source**: OLEV **Date**: Nov 2009	
Plugged-In Places: The Electric Vehicle Charging Infrastructure Framework, Application Form Source: Alex Constantinides on behalf of the ELVIS Consortium, MK Council, Date: Jan 2010	
Making the connection: the plug-in vehicle infrastructure strategy **Source:** OLEV **Date:** June 2011	
4th Report - Plug-in vehicles, plugged in policy? **Source** : Transport Committee, House of Commons **Date** : Sept 2012	
Plug–in vehicles, plugged in policy?: Government Response to the Committee's Fourth Report of Session 2012–13 **Source** : House of Commons **Date** : January 2013	
New measures announced to support the uptake of plug-in vehicles (Press Release) **Source** : DFT, OLEV **Date** : Feb 2013	
Plugged-in Fleets Initiative: charging-forward **Source** : Energy Saving Trust **Date** : Apr 2013	
Powering Ahead- The future of low-carbon cars and fuels **Source** : Ricardo AEA & RAC Foundation **Date** : Apr 2013	

5.3 Procedure for Thematic Analysis

The dataset described in the previous section was analysed systematically using thematic analysis, a qualitative method for identifying, analysing and reporting patterns (themes) within symbolic materials. This chapter describes the implementation of this analysis, which proceeded along six stages (Table 5.4, from Clarke and Braun, 2006). The endpoint is the reporting of the content, but thematic analysis goes beyond mere description seeks to provide interpretation, theorising the significance of the patterns (themes) and their broader meanings and implications (Patton, 1990).

Table 5.4: The six stages of thematic analysis (Clarke and Braun, 2006)
1- Familiarizing yourself with your data: Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
2- Generating initial codes: Coding interesting features of the data in a systematic fashion across the entire dataset, collating data relevant to each code. For a deductive, theory-led analysis, initial coding will reflect the underlying theories.
3- Searching for themes: Collating codes into potential themes, gathering all data relevant to each potential theme.
4- Reviewing the themes: Checking if the themes work in relation to the coded extracts (level 1) and the entire dataset (level 2), generating a thematic map of the analysis
5- Defining and naming themes: Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definitions and names for each theme.
6- Producing the report: the final opportunity for analysis. Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research questions and literature, producing a scholarly report of the analysis.

The procedure as implemented for this thesis is described in Sections 5.3.1 to 5.3.5. When relevant, this description of the procedure is accompanied by selections from the dataset that relate to the codes and themes under discussion. This section demonstrates how the successive stages of thematic analysis contributed to increased familiarity with the data and with the patterns within it, and provides a chain linking the evidence described in Section 5.2 to the results discussed in Chapter 6.

5.3.1 Familiarization with the Data

The first step of thematic analysis requires immersion in the data. Immersion requires repeated, active reading of the data, searching for meanings and patterns. Because the reading and re-reading of data can be rather time consuming, thematic analysis tends to use far smaller samples than, for example, quantitative analyses of questionnaire data (Clarke and Braun 2006). In the case of verbal data such as interviews, the process of transcription can contribute to creating familiarity with the content (Riessman, 1993). In the case of the documentary component of the data set used in this thesis, the familiarization stage involved a full reading of the selected texts. Documents from trade literature had been read in full during the selection process described in Sections 4.9.2 and 5.2.1. The policy documents in the data set were read in full during the policy literature review described in Section 2.2. All the documents were read for a second time at this stage of analysis to achieve increased familiarity.

5.3.2 Generating Initial Codes

The second stage of thematic analysis involves the production of initial codes from the data. Coding involves organizing data into meaningful groups, and identifying features of interest (Tuckett, 2005).This stage of thematic analysis can begin once familiarity with the data has been achieved, and an initial list of ideas about what is in the data and what is interesting about them has been produced. This process involves two distinct operations.

First, interesting features are selected. Codes identify features of the data relevant to the inquiry, and refer to "*the most basic segment, or element, of the raw data or information that can be assessed in a meaningful way regarding the phenomenon*" (Boyatzis, 1998, p 63). Once the basic segments of interest have been selected, the coding stage calls for the systematic labelling of interesting features of the data across the entire dataset.

This use of the seemingly subjective term "interesting" was potentially problematic, as it could be seen as implying biased, unsystematic choices. This choice of this phrase by Clarke and Braun was likely intentional and intended to force reflection. Claims of "unbiased" analysis and of spontaneous "emergence" and "discovery" are seen as suspicious in thematic analysis, as they lead to passive accounts that deny the active role of researcher (Taylor and Ussher, 2001). Thematic analysis requires that the biases brought into the analysis by the researcher must be brought out in the open and accounted for. In this case, the SNM framework provided the criteria for selection of "interesting" features, with social marketing concepts addressing underdeveloped areas and so identifying additional "interesting" features. All the statements that could be identified as having a relationship to the main concepts and processes of SNM and social marketing were selected for analysis, and the whole of the literature discussed in Chapter 3 can be seen as formative of what Blumer called "sensitizing concepts", or knowledges held by the analyst that give the user a general sense of reference and guidance in approaching empirical instances. Sensitizing concepts are not meant to provide prescriptions on what to see, but they rather suggest directions along which to look (Blumer ,1954).

During this process of selection of interesting features in the data it was found necessary to keep track of the actors mentioned by name or by general category. Coding for actor categories facilitated the exploration of network-building processes, and provided insight into the intended targets for different interventions. Consequently, an inclusive

conception of the term "actor" was adopted. This conception views an actor as an entity that creates and negotiates meaning (Callon and Latour, 1981), and makes no analytical distinction between macro actors (government agencies, transnational corporations, SMEs) and micro actors (e.g., individual politicians, fleet managers, EV users), which must be examined using the same tools and the same arguments (ibid).

Coding was performed by hand. Qualitative software is used sometimes for this task, but several issues made qualitative analysis software (e.g., Nvivo, Atlas, QDA Miner) unsuitable for this research. Qualitative analysis software is suitable when a predetermined, mature and straightforward coding structure us available. However, it is not considered appropriate when the themes are expected to evolve (Auld et al., 2002). One of the benefits of software-assisted analysis comes from the increased speed of analysis of large data sets through features like automated coding, but in the case of thematic analysis patient engagement is considered desirable to facilitate in-depth familiarity with a relatively reduced data set (Auld et al., 2002; Clarke and Braun, 2006).

This research was performed on print-outs of the entire documentary data-set, plus transcripts from the semi-structured interviews. Evidence gathered through participant observation was not used for this stage of the analysis because exact transcripts were not available. Passages related to major themes in the literatures were highlighted (as illustrated in Fig 5.2) in preparation for a coding stage involving the systematic classification of "*interesting features of the data*" (Clarke and Braun, 2002, p 35).

At this stage, it is recommended to code for as many potential themes/patterns as possible (time permitting), as it is not possible to identify potentially relevant patterns in advance. Individual extracts of data can be coded in as many different themes as they fit into - so an extract may be uncoded, coded once, or coded many times, as relevant (Clarke and

Braun, 2006, p 19). Following the recommendations of Braun and Clarke (ibid) inclusiveness was a guiding concern during the process of selection. First, selection erred on the side of caution by including segments that made marginal or indirect references to the phenomena of interest. Second, selection sought to keep a little of the surrounding data in order to address the common criticism about the loss of context during the coding stage (Bryman, 2001).
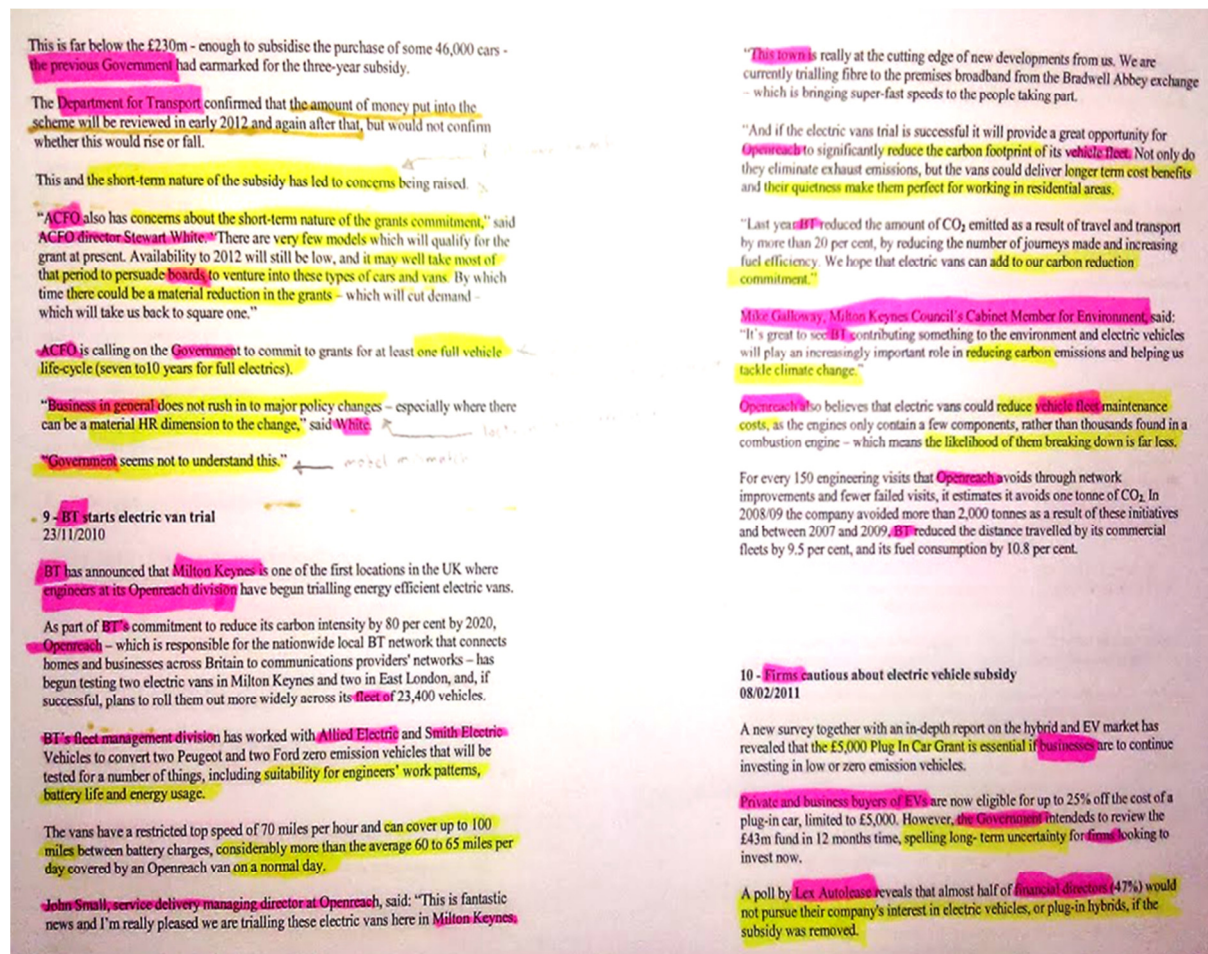
Figure 5.2: Example of first coding stage for documentary sources
The procedure took place in two stages. In the first one, interesting sections (that is, sections related to research question) were highlighted in yellow and coded using SNM and social marketing sensitivity. Actors were highlighted in purple and coded by actor category.

After relevant passages had been highlighted and familiarity with the complete data set had been achieved, candidate codes were written in pencil on the margins of the selected segments. The end result for this stage is a list of candidate codes, but quantification or

systematic identification of patterns is not performed at this point. A list of the candidate codes produced during this stage, acknowledging the theoretical influences for the selection of each, is shown in Table 5.5. Where a code has been listed as "underdeveloped", the literature was not found useful for understanding in full the relevant passages in the dataset.

Table 5.5: Candidate codes in the data set

CODE	Relevant Literature
Economic pressures on ICEs	SNM
Economic pressures on EVs	SNM
Regulatory pressures on ICEs	SNM
Regulatory pressures on EVs	SNM
Cultural pressures on ICEs	SNM
Cultural pressures on EVs	SNM
Physical pressures on ICEs	SNM
Physical pressures on EVs	SNM
Lock-in – poor technical expectations for EVs	SNM
Lock-in - poor organizational expectations for EVs	SNM
Lock-in caused by poor technical knowledge of EVs	SNM
Lock-in caused by poor organizational knowledge of EVs	SNM
Lock-in - poor technical network of EVs relative to ICEs	SNM
Lock-in - poor organizational networks of EVs relative to ICEs	SNM
Measurable targeting criteria (accessible, substantial, compatible)	Social marketing
Blanket (untargeted) interventions	Social marketing
Top-down and bottom-up interventions	Social marketing
Bidirectional engagement	Social marketing
Deficit model / tell-and-sell	Social marketing
Technical performance as a barrier to adoption	SNM
Regulatory barriers to adoption	SNM
Cultural barriers to adoption	Social marketing
Financial barriers to adoption	Traditional models
Infrastructure barriers to adoption	SNM
Lack of support networks as a barrier to adoption	SNM
Uncertainty as a barrier to adoption	SNM
Lack of hard data as a barrier to adoption	SNM, but underdeveloped
Other cognitive barriers to adoption	SNM, but underdeveloped
Technical barriers addressed by interventions	Traditional models
Regulatory barriers addressed by interventions	Traditional models
Cultural barriers addressed by interventions	SNM & social marketing
Financial barriers addressed by interventions	Traditional models

Table 5.5: Candidate codes in the data set

Infrastructure barriers addressed by interventions	SNM &traditional models
Support network barriers addressed by interventions	SNM, but underdeveloped
Uncertainty barriers addressed by interventions	SNM, but underdeveloped
Informational barriers addressed by interventions	Social marketing
Cognitive barriers addressed by interventions	SNM, but underdeveloped
Regulatory benefits valued by adopters	Traditional models
Market benefits valued by adopters	Social marketing
Reputational benefits valued by adopters	Social marketing
Financial benefits valued by adopters	Traditional models
Operational benefits valued by adopters	SNM, but underdeveloped
Societal benefits (externalities) valued by adopters	Social marketing
Networking benefits valued by adopters	SNM, but underdeveloped
Future benefits expected by adopters	SNM, Social marketing
Learning as a benefit valued by adopters	SNM, but underdeveloped
Regulatory benefits caused or reinforced by interventions	Traditional models
Market benefits caused or reinforced by interventions	Social marketing
Reputational benefits caused or reinforced by interventions	Social marketing
Financial benefits caused or reinforced by interventions	Traditional models
Operational benefits caused or reinforced by interventions	SNM, but underdeveloped
Societal benefits (externalities) caused or reinforced by interventions	Social marketing
Networking benefits caused or reinforced by interventions	SNM
Expectation of future benefits caused or reinforced by interventions	SNM
Learning benefits caused or reinforced by interventions	SNM
Expectations held by users	SNM & social marketing
Expectations held by innovators	SNM & social marketing
Expectations disseminated by innovators	SNM & social marketing
Expectations disseminated by incumbents	SNM & social marketing
Expectations disseminated by interventions	SNM & social marketing
Scepticism about expectations disseminated by innovators	SNM & social marketing
Scepticism about expectations disseminated by interventions	SNM & social marketing
Support for learning about technical aspects	Traditional models
Support for learning about user needs (articulation)	SNM & social marketing
Support for learning about societal impact	SNM & social marketing
Support for un-learning (identifying obsolete assumptions)	SNM, underdeveloped
Support for second-order learning	SNM, underdeveloped
Interventions subsidizing purchases	Traditional models
Interventions subsidizing R&D	Traditional models
Interventions deploying infrastructure	SNM & traditional models
Interventions supporting development of new services and	SNM (underdeveloped) &

Table 5.5: Candidate codes in the data set	
articulation of demand	Social marketing
Interventions supporting operational adjustments to characteristics of new technology	SNM
Interventions supporting the development of new financial structures	SNM, underdeveloped
Interventions fostering alignment in positive expectations	SNM and social marketing
Interventions fostering technical alignment (e.g., setting standards)	SNM and traditional models
Interventions supporting development of supply networks	SNM and traditional models
Interventions supporting development of support networks	SNM

Actor categories in the full data set closely matched those identified during the preliminary documentary analysis required for setting the scope of the research and delimiting the unit of analysis (See Fig. 4.1 in Section 4.6). However, some new categories were identified (community organizations, supporting organizations) and some of the original categories were further refined. Particularly in the case of organizational users it was found necessary to differentiate between incumbent organizations that gave a relatively minor role to EVs and innovative organizations willing to give EVs a central role in novel propositions. Similarly, the full data set made distinctions between lead users and users in mainstream markets that had not been identified in the preliminary analysis. Actor categories that were not identified before the full analysis are indicated in bold in table 5.6.

Table 5.6: Actor categories identified in documents and interviews

- Users
- **Lead users**
- Mainstream markets
- Organizational Users (Incumbents)
- **Organizational Users (Innovators with novel propositions built around EVs)**
- Consumers
- Purchasing organizations
- **Organizational decision makers**
- Fleet managers
- Manufacturers
- Supply-chain

- Innovation integrators
- Mobility service providers
- **Supporting organizations**
- National government
- Local administration
- Lease and fleet management organizations
- Industry bodies
- Infrastructure and energy providers
- Academia
- Pilot and niche management
- **Community organizations**

In this stage of the analysis, no attempt was made to identify the role of those additional actor categories, or to go beyond mere identification and labelling of potentially interesting features. While some of the codes can go on to form main themes or sub-themes, others may be redefined or discarded in later stages of the analysis. Examples of the data associated with selected codes are provided in Table 5.7 to illustrate how very diverse data can be grouped under a given code.

Table 5.7 (i): Examples of selected codes- Informational barriers
This label was used to identify objections to the use of EVs associated with a lack of information.

__Questions remain__ over the reliability, life expectancy and cost of battery technology and, until these are resolved, fleets will resist wide-scale adoption of such vehicles (Fleet News, 2009).

Until the average consumer __understands__ their own transport pattern, EVs will continue to be a hard sell. Accepting the fact that not many consumers understand their transport patterns should focus our efforts on the few who do (Green Fleet,2010).

It can be hard for a company to __know__ if a PIV makes good business sense. High acquisition costs can be unappealing, and a __lack of familiarity__ with the products and their capabilities can mean sticking with diesel or petrol is the default option (EST, 2013).

Table 5.7 (ii): Examples of selected codes – Expectation management
This label was used to identify data related to actions influencing (or failing to influence) the expectations of potential adopters and their plans regarding adoption of EVs.

*The Department for Transport confirmed that the amount of money put into the scheme will be reviewed in early 2012 and again after that, but **would not confirm** whether this would rise or fall. This and the short-term nature of the subsidy **has led to concerns being raised**.* (Fleet News, 2009b)

*For their benefits to be truly realised more people must make the decision to use EVs as a mode of transport. But first, investment in an EV infrastructure is needed to provide an initial network of charging points to **build customer confidence** and allow the market to grow*. (Green Fleet,2009)

*What the LowCVP is then calling for, however, is a longer-term funding **commitment** from 2012. "**We need to give the market confidence**," Archer explains. "**We need to encourage vehicle manufacturers** to invest in the UK – we have got the start of a really promising industry here* (Local Transport Today,2010)

Table 5.7 (iii): Examples of selected codes – Alignment intervention

This label was used to identify actions intended to facilitate coordination and integrate niche actions with the regime, expanding the influence of regional initiatives.

---

*The Joined-Cities Plan announced by the ETI in September aims to help cities across the UK to deploy a cost effective and **compatible network** of recharging points. The plan has been created to help support the roll-out of **a single national network** that will ultimately enable plug-in vehicles to be easily used and recharged anywhere, including at home.*(Green Fleet, 2009b)

*"We don't want charging points in 33 boroughs having 33 different logos." In a similar vein, TfL is also trying to do what it can to **harmonise the incentives** (such as cheaper or free parking) that London's boroughs are offering to incentivise the uptake of electric vehicles.* (Local Transport Today,2010b)

*As a specific example of how Plugged-in Places stands to secure additional value for money from being part **of this bigger project**, partners within the city are engaged in planning for the building of a fifty homes low carbon living demonstration development. This will **pull together all the various strands of low carbon living,** with homes built to the most advanced eco-standards, onsite and district power generation, smart grid technology, and external charge points for electric vehicles.* (Constantinides, 2009)

The examples above are by no means exhaustive, as there were too many individual codes for providing a complete description and the majority of the individual codes were later absorbed into overarching themes. The procedure for linking codes together so they can coalesce into themes is described in the following section, along with an explanation of each of the candidate themes identified.

5.3.3 Searching for Themes

The next stage in thematic analysis involves sorting the different codes and considering how different codes may combine to form an overarching theme (Clarke and Braun, 2006). A theme captures something about the data in relation to the research question, and represents a level of patterned response or meaning within the data set. It can begin when all data have been initially coded and collated, and a long list of the different codes identified across the data set is available.

Codes are collated into potential themes, gathering all data relevant to each potential theme. Some initial codes form main themes, whereas others may form sub-themes or are discarded. The end result of this phase is a collection of candidate themes and subthemes, which are to be reviewed and reworked in subsequent stages of the thematic analysis. There is no fixed procedure for identifying patterns in the codes. The search for themes can involve tables, mind-maps, or writing each code in a separate piece of paper and playing round and organizing them into theme-piles. In the case of this thesis, adhesive notes were used for this stage of research. The arrangements of adhesive notes were later translated into the mind maps that will be shown in Section 6.2 (Findings of the Thematic Analysis).

The initial selection of candidate themes was guided by the frameworks of SNM and social marketing discussed in Chapter 3. Social marketing contributed to the concepts of barriers, benefits, and value creation, while SNM yielded a sensitivity towards visions and expectations, learning processes, and network-building. One central concept from SNM, that of "protection", proved to be too limiting during the initial stages of theme-development and was replaced by the concept of "intervention", more commonly used in social marketing. An intervention is defined as a deliberately initiated attempt to introduce new, or modify existing, patterns of collective action (May et al., 2007). While some of the interventions that

took place in Milton Keynes can be described as "protective interventions", others should be more accurately labelled as "empowering interventions" (themes E and F in Table 5.8)

As discussed in Section 5.3.2, the coding stage also identified several broad categories that could be used to classify the actors involved in the niche processes being studied. A search for themes related to actor categories revealed that the model implied by policy, with a clear division separating supply and demand sides, and with the government as the main force behind pro-EV interventions, was of limited usefulness for analysing the niche under study (see Fig. 3.1 in Chapter 3.2 for the model of policy actors in King 2008). At this stage of the analysis, the actors that could not be accommodated in the policy model (and that were identified as likely to be neglected by policy actions) were provisionally labelled as "unusual suspects. A list of candidate themes is provided in Table 5.8.

Table 5.8: Candidate themes and sub-themes	
A	**Candidate theme**: Barriers to EV Adoption **Sub-themes:** technical barriers, financial barriers, operational barriers, risk and uncertainty, cognitive barriers, systemic barriers
B	**Candidate theme:** Benefits of EV adoption **Sub-themes**: Financial Benefits, Operational Benefits, Reputational Benefits, Competitive Benefits And Differentiation, Knowledge, Networking, Future-Proofing
C	**Candidate theme**: Value and Evaluation Criteria **Sub-themes**: positivist value ,value in use, value co-construction
D	**Candidate theme**: Engagement and Intervention Approaches **Sub-themes**: unidirectional, consultation, dialogue, top-down, bottom-up, high-engagement, low-engagement, targeted, blanket approach
E	**Candidate theme**: Protective intervention **Sub-themes**: financial, technical, informational, infrastructural, regulation
F	**Candidate theme**: Empowering intervention **Sub-themes**: Undefined at this stage. Smith and Raven (2012) use "adapt and conform" and "fit and stretch", but were not useful in this analysis. This required further analysis, so concept and its sub-themes will be developed in Section 5.3.5

G	**Candidate theme**: Visioning and Expectation Management **Sub-themes**: Technical Coordination, Social and Cultural, Industry and Markets
H	**Candidate theme**: Learning **Sub-themes**: technical, organizational (first order), organizational (second order)
I	**Candidate theme**: Network Building **Sub-themes**: supply chains, support networks, ecosystems
J	**Candidate theme**: Unusual Suspects **Sub-themes**: Undefined at this stage. There is some overlap between the observed "unusual suspects" and the role of innovation intermediaries (Van Lente et al., 2003), but the categories in the literature (knowledge intensive business services, research and technology organizations, and industry associations) did not match the observations.

At this stage, no attempt was made to quantify the prevalence of each candidate theme (and quantification is not the goal of qualitative analysis). Themes at this stage are not final (hence the label "candidate themes"), but patterns are clearly beginning to take shape. Discussion of candidate themes is useful for understanding tensions in the formation of an early market for EVs, as well as making visible the thought processes in this research.

Candidate themes and their associated sub-themes are discussed in some depth in this section, providing illustrative examples from the dataset described in Section 5.2. The selected examples start to make visible some tensions that will be explored in later stages of this thematic analysis.

A: Barriers to EV Adoption

There are many different factors preventing adoption of EVs. Some of the sub-categories are well known to all actors (e.g., technological limitations, high cost) and do not require explanation. Others are less common, are only familiar to actors closer to the ground, and sometimes are not made explicit. It may be that EVs are not seen as a good fit for specific

tasks, or that they are seen as a risky choice because of a lack of information and experience. There are also cognitive barriers, where adoption is seen as unfeasible because of a lack of knowledge about the technology and the appropriate processes and models for using it. Sometimes, even if the technology itself is seen as promising, the support system around it is seen as insufficient (e.g., lacking sufficient infrastructure or institutional support).

Sub-Themes: technical barriers, financial barriers, operational barriers, risk and uncertainty, cognitive barriers, systemic barriers

Codes associated with this theme:

- economic pressures on EVs,
- regulatory pressures on EVs,
- cultural pressures on EVs,
- physical pressures on EVs,
- lock-in caused by poor technical expectations of EVs relative to ICEs,
- lock-in caused by poor organizational expectations of EVs relative to ICEs,
- lock-in caused by poor technical knowledge of EVs relative to ICEs,
- lock-in caused by poor organizational learning of EVs relative to ICEs,
- lock-in caused by poor technical network of EVs relative to ICEs,
- lock-in caused by poor organizational networks of EVs relative to ICEs,
- technical performance as a barrier to adoption,
- regulatory barriers to adoption, cultural barriers to adoption,
- financial barriers to adoption,
- infrastructure barriers to adoption,
- lack of support networks as a barrier to adoption,
- uncertainty as a barrier to adoption,
- lack of hard data as a barrier to adoption, other cognitive barriers to adoption

The first example below is representative of the perspectives held by national government and automotive industry, who tend to see cost and range as the main barriers, and as inherent to the state of technology. The second example, from an interview with an organizational decision maker, also sees range as a barrier, but is not seen as a strictly

technological issue but is rather the result of practices, perceptions and availability of information.

Example 1- Technical and financial barriers:

BEVs face major challenges in gaining market share because of their high prices and limited range. Breakthroughs in technology, particularly in the cost and performance of batteries, are required before PHEVs and BEVs can achieve significant market share (Kay et al., 2013).

Example 2- Risk, uncertainty and cognitive barriers:

The actual range is a barrier, whether that barrier is real whether people will find 90% of their journeys they could manage, the car is seen as personal mobility, flexibility, etcetera. So a vehicle that has some restriction on that is a barrier to uptake... Different people do this in ICE cars. I would generally not mind until the range guide in my vehicle tells me I have about 25 miles to go, some people would fill up before that, but if we took that as a lower level you really have restricted your range in an electric vehicle by 25 % before you started. I would probably take more risk around that than other people, so you may find that other people fill up when they get down to 50 miles left of their gauge. Some of it is probably about how it is presented within the vehicle so when you get the last block of fuel the last bit of the gauge is when people may feel it is time for filling up so lets say if you get to 35, 40% of the range of the vehicle people want to recharge at that point because there is that period of anxiety. Then if you take in the account that maybe the figures in range are slightly

168

overestimated because in real life you will be using functionality within the car that will drain battery power that might bring you from a hundred to 90 and then if you take 40% of range anxiety if you like you are down to a 50 mile range and you know that gets harder. (Interview with the head of strategic development of a fleet management organization)

B: Benefits of EV adoption

Despite high barriers to adoption, some actors saw sufficient positive aspects in EVs that made adoption viable, or at least worthy of consideration. For some, the benefits were mainly financial, with the low cost of operation compensating for the high upfront cost. For others, the benefits were operational, as the performance characteristics of EVs made them better suited for specifics tasks (e.g., recharging at the depot could be more convenient that refuelling at a petrol station). For other pioneering adopters, the benefits were reputational and translated into access to new markets. While green marketing for consumer products seems to have limited impact, CSR seems to make green reputation valuable in Business to Business contracts, giving competitive advantages to pioneering EV adopters. For other pioneers, the knowledge generated through participation in early EV experiences was seen as a valuable investment for the future, in anticipation of larger deployments and more widespread acceptation of EVs by mainstream markets.

Sub-Themes: financial benefits, operational benefits, reputational benefits, competitive benefits and differentiation, networking, knowledge, future-proofing.

Codes associated with this theme:

- regulatory pressures on ICEs,
- economic pressures on ICEs,
- cultural pressures on ICEs,
- physical pressures on ICEs,
- regulatory benefits valued by adopters,

- market benefits valued by adopters,
- reputational benefits valued by adopters,
- financial benefits valued by adopters,
- operational benefits valued by adopters,
- societal benefits (externalities) valued by adopters,
- networking benefits valued by adopters,
- future benefits expected by adopters,
- learning as a benefit valued by adopters,
- regulatory benefits caused or reinforced by interventions,
- market benefits caused or reinforced by interventions,
- reputational benefits caused or reinforced by interventions,
- financial benefits caused or reinforced by interventions,
- operational benefits caused or reinforced by interventions,
- societal benefits (externalities) caused or reinforced by interventions,
- networking benefits caused or reinforced by interventions,
- expectation of future benefits caused or reinforced by interventions,
- learning benefits caused or reinforced by interventions.

In the first example below, financial benefits are discussed. Those benefits are reinforced by government protection in the form of subsidies and a favourable tax regime, but the temporary nature of this protection is mentioned as a concern. This seems to be a problem inherent to the protective approach. The second example provides an illustration of the competitive and reputational benefits of pioneering EV adoption.

Example 1- Financial benefits:

A lot of drivers may be interested in doing it for pure sustainability reasons, but quite frankly a lot of drivers will be interested in doing it because it makes financial sense to spend less on travelling and spend less in benefit car tax. Of course, that is going to change in a few years time, so... (Interview with a fleet manager responsible for the company cars of a national retail chain.)

Example 2- Competitive benefits:

What I was surprised by is we don't normally deal with big corporates. We deal with SMEs generally. But I've been talking to big corporates because there are not many people trying this. I've just taken our first order from [fortune 500 company] for instance and I think before we did this there was no way that we would even get to talk to them. I don't think that would even happen. But because of this we have got an inquiry in from [major national chain]...They want Kangoos [electric vans]. (Interview with the managing director of a fleet management firm entering the green market).

C: Value and Evaluation

Value is not necessarily a balance of costs and benefits, or a straightforward calculation of costs relative to the competition. Different actors had different conceptions about the point where value was created. While the predominant view saw value as an objective feature of the vehicle itself, for other the value was discussed in terms of fitness for purpose, and for others it depended on many other actors (support networks, finance providers, potential customers) that contributed to making adoption feasible and valuable.

Sub-Themes: positivist value, value in use, value co-construction

Codes associated to this theme:

- economic pressures,
- technical barriers,
- operational barriers/benefits,
- networking benefits,
- learning benefits/ cognitive barriers,
- market benefits

In the first example below, value is not seen as inherent to the vehicle, but it depends on its fitness for its intended role. While electric cars are seen as unsuitable, because they are expected to be flexible means for personal transportation, electric vans with the same characteristics are seen as effective tools when used for scheduled deliveries on fixed routes. In the second example, value depends on information provided by other actors, and in the effect that this information would have on the market.

Example 1- Value in use:

I think that there is a bigger opportunity with vans whether as pure electric or hybrid than there is with cars because a van tends to, as a work tool, there is a big part of the van market where they are doing local deliveries ,scheduled, that they know what they are doing in the course of the day, they are often localized...I think those people would be the adopters of the technology when it is introduced in a cost effective way in vans, more so than cars, because people have got a perception with cars that cars can be used for long journeys. And you and I know that the average journey is 20, 17 miles in a car, but too frequently my average journey might be 30 miles at a time but too frequently people then use their cars for really long journeys (Interview with the brand manager for a car leasing company).

Example 2- Value co-construction:

What's quite good is that CAP[4] is now happily quoting future residual values on electric cars which I don't think they were doing a year ago and that has taken away a lot of fleet anxiety about it. And the residuals that they are

---

[4] CAP is a used-car valuation website that is widely used by fleet managers (http://www.cap.co.uk/)

sharing are actually quite respectable as well. It will show that if I get a Fluence now and I run it for four years and then I want to sell it then it is not going to be a dead weight in our hands. We can get someone to buy it (Interview with the managing director of a green fleet management firm).

D: Engagement and Intervention Approaches

This candidate theme explores the nature of the relationship between designers or managers of an intervention, and the targets of the same. Different intervention approaches implied different conceptions of the characteristics of the flow of information, and assumptions on the actors with the relevant knowledge. Many interventions appeared to be based on a deficit model, where authorities are assumed to have all the relevant knowledge and other parties take sub-optimal actions due to misinformation. At the other end of the spectrum, some interventions assumed that the targets of the intervention were in closer contact with the knowledges relevant to intervention designers.

Sub-Themes: unidirectional, dialogue, top-down, bottom-up, high-engagement, low-engagement, targeted, blanket approach

Codes associated with this theme:

- blanket (untargeted) interventions,
- accessibility as targeting criterion,
- compatibility as targeting criterion,
- substantiality as targeting criterion,
- engagement,
- deficit model.

The first example below is very consistent with national policy, with interventions functioning as a soft substitute for coercing the public into taking the course of action designed by authorities. In the second example, knowledge provided by the target community is used for designing a mutually beneficial intervention.

Example 1- Top-down, low engagement intervention:

But isn't the key difference that people wanted the petrol engine cars at the time, whereas now I think Dr Berkeley said that consumer demand was lagging, which I automatically just translated to mean that people do not want these?...What we are saying is that we are trying to get everybody in society to make a transition that they do not want to make that is extremely expensive and they are just not doing it. Is that what we are saying?...

...earlier on when the term "market failure" was used and bearing in mind some of these factors we have talked about, rather than market failure, is it not a public failure just to obey the Government and do the things that Government want?...

I want to make one more point. I have tried to make this case with a degree of humour to try and soften it a bit. When I am listening to this, what I hear is that any of this only matters if the carbon dioxide issue is an existential threat to society and to humanity. Perhaps it is not a question for you, but why can't we just be honest then and say we should just use naked power to make people get off petrol and carbon? Is it going to work trying to do it gently, to incentivise and pretend that there is freedom, or should we just abolish freedom and force people?(Stephen Baker, Minister of Transport, in Transport Committee 2013, p 4 of oral evidence appendix)

Example 2- Bottom-up, high engagement intervention:

If you started by saying "this is the hardware, this is the vehicle, here they are", then you would have a very different scheme developing. But if you start

with the community and you start by looking ant what the needs of that community are, businesses, schools, then you start identifying needs that can be met through the e-car, it is a different way of doing it, a very different way of doing it.

You start with the community, you start with people's aspirations, their needs, their financial needs, their practical needs, and what that does is to open up lots of ways in which the vehicles can be used rather than saying "this is the hardware". In a top down process we would not have gotten that...

...there is got to be a community process that begins there rather than that being an add-on that people think about after they got the hardware in place (Interview with the convener of a community group supporting a private EV initiative).

E: Protective intervention

This theme explores interventions that assume that the product is socially beneficial, but it is also assumed to have inferior price and performance characteristics. Therefore, it needs protection to develop an early constituency. Protection can be financial, can take the shape of support for technological developments (that are expected to lower costs and improve performance), can be based on information and advertising campaigns, or can be based on regulation.

Sub-Themes: financial, technical, informational, infrastructural, regulation

Codes associated to this theme:

- financial barriers addressed by interventions,

- technical barriers addressed by interventions,
- regulatory benefits as interventions,
- interventions subsidizing purchases,
- infrastructure subsidies,
- chicken and egg conundrum,
- regulatory barriers addressed by interventions,
- infrastructure barriers addressed by interventions,
- informational barriers addressed by interventions,
- support for learning about technical aspects,
- interventions subsidizing R&D,
- interventions deploying infrastructure.

Interventions defined in terms of protection appeared to introduce ambivalence. In the first example below, protection creates negative perceptions about the protected technology. In the second example, since protection is defined as a temporary feature, uncertainty results. This uncertainty is reinforced by previous attempts to introduce cleaner fuels (such as LPG, or liquefied petroleum gas), as early adopters of LPG were "burned" when protection measures were withdrawn.

Example 1- Protection reinforcing perceived uncompetitiveness:

It would be fair to describe plug-in vehicles as expensive in terms of purchase price. With cars, in particular, if they were seen as accessible, there would be no reason for the Government to subsidise their purchase by up to £5,000 with the plug-in car grant (Fleet News).

Example 2- Protection and risk perception:

There is a whole number of other reasons why adoption is low. Performance issues, there is consistency about taxation policies. We have some consistency but the £5,000 grant for new vehicles only gets reconfirmed annually so there is no long term view about that, creating a fleet policy around or

changing the way you operate around when we don't know if there is long-term access to that. There is the personal taxation, how that works and whether the government looks to recover any other duties on EVs. I was with [other leasing company] when LPG went from being a very low tax fuel to effectively becoming much more in line with petroleum and diesel for car. (Interview with the head of strategic development of a fleet management organization)

F: Empowering intervention

This theme explores interventions that create conditions that make adoption beneficial to the adopter. Niche innovation is made competitive with mainstream socio-technical practices by stimulating the dynamic accumulation of innovative capabilities and undermining the incumbent regimes. (Smith and Raven, 2012)

Sub-Themes: Undefined at this stage of analysis. Smith and Raven (2012) use the term "fit-and-conform" to describe processes that make niche innovations competitive within unchanged selection environments, and "stretch-and-transform" to describe processes that contribute to changes in mainstream selection environments in ways favourable to a path-breaking niche innovation. However, those labels were of limited use for understanding the empowering interventions observed in the case study. This theme required several revisions, so this concept will be developed further in Section 5.3.5

Codes associated to this theme:

- unusual suspects,
- support network barriers addressed by interventions,
- uncertainty barriers addressed by interventions,
- cognitive barriers addressed by interventions,
- support for learning about user needs (articulation),
- support for un-learning (identifying obsolete assumptions),

- support for second-order learning,
- interventions supporting development of new services and articulation of demand,
- interventions supporting operational adjustments to characteristics of new technology,
- interventions supporting the development of new financial structures,
- interventions fostering alignment in positive expectations,
- interventions fostering technical alignment (e.g., setting standards),
- interventions supporting development of supply networks,
- interventions supporting development of support networks.

The examples below describe interventions by unrelated organizations that saw EVs as viable challengers. After identifying viable applications, support was provided to actors that had the experience and resources to implement profitable solutions about EVs. In both cases, the risk of pioneering adoption is acknowledged, and measures to protect early adopters are considered.

Example 1 – Support for electric fleets:

Although the benefits to society and the environment are clear, we wanted to bring to light the benefits to business, highlighting opportunities where PIVs[5] make good financial sense to business now. We see this as key to the successful uptake of new ultra low carbon technology vehicles. Fleets purchase over 60% of new vehicles so they are instrumental in bringing new technologies to market.... We are also aware that purchase and lease costs of PIVs can be off-putting. However, when the costs are considered over the ownership of the vehicle, PIVs used in the right place can offer financial benefits. (EST, 2013)

Example 2 – Support for electric taxicabs:

We have looked recently into a project with [a private enabling organization]. Its early days but they are talking about the possibility of an enabling company which essentially purchases a number of electric vehicles and this company has come up with a plan whereby they make it affordable to your average taxi driver... taking all those costs into consideration, fuel costs, insurance, tax and the outlay of the vehicle initially and basically are coming up with a plan whereby they can make an electric vehicle as a brand new car available to taxi drivers at a rate they can see a saving if not the same cost they would spend out for your average conventional VW conventional car (Interview with the marketing and development manager of a taxicab company).

---

[5] Plug-in Vehicles

G: Visioning and Expectation Management

This theme represents one of the 3 core processes in SNM, as observed in the case study. In the early years of development, the advantages of a new technology are not evident. In order to position the new technology, the interested actors therefore make promises and raise expectations. Promises are especially powerful if they are shared, credible, specific, and coupled to societal problems (Weber et al., 1990). In a national level, visioning concentrated on technical visions, roadmaps, and contested expectations regarding future directions for the automotive industry. On a regional level, the focus was on societal impact, the role of EVs in everyday life and organizational life, and market potentials.

Sub-Themes: technical coordination, social, industry and markets

Codes associated to this theme:

- expectations held by users,
- expectations held by innovators,
- expectations disseminated by innovators,
- expectations disseminated by incumbents,
- expectations disseminated by interventions,
- scepticism about expectations disseminated by innovators,
- scepticism about expectations disseminated by interventions.

In example 1 below, a long term vision for technology development is discussed, and is expected to provide direction to coordinate the efforts of industry and research. In example 2, expectations are more immediate, with trials contributing to the development of realistic expectations. This illustrates how expectation management is not about creating positive expectations for the sake of "selling" the product, but about creating credible, realistic expectations that direct action in a productive direction.

Example 1 –Technical expectations:

Foresight Vehicle is a partner of the Low Carbon Vehicle knowledge transfer network. Foresight Vehicle is run by the Society of Motor Manufacturers and Traders Ltd (SMMT) which aims to drive forward R&D in this sector. It is a collaborative network between government, academia and industry to identify and demonstrate sustainable technologies for road transport. The R&D programme aims to promote technology and stimulate suppliers to develop market driven enabling technologies for motor vehicles. The parties that set up Foresight Vehicle created a Technology Roadmap, which identified five themes reflecting the technology development needs for the next 20 years (King, 2008)

Example 2 – User expectations:

Yes I know of a few people who have bought Kangoo vans and they've not been very happy because I think the way that they were told about it. They were not given the opportunity to trial them. When they went into operation they were really disappointed with what they got. So I don't want to see that happen for us. When people get in that position and they've made a bad decision, it's hard to admit that it's your fault that you made a bad decision. So you tend to rubbish the person you bought the product from (Interview with the managing director of a fleet management firm entering the green market).

H: Learning

This theme represents one of the three core processes in SNM, as observed in the case study. It is important to learn more about the barriers to the development and introduction of the new technology, and how they may be overcome. Niches provide valuable opportunities for learning about needs, problems and potentialities. The learning process takes place along multiple dimensions, including design, policy, culture, market demands, characteristic of

production and maintenance networks, and nature of societal and environmental effects (Weber et al., 1999). In first learning, optimization is sought but no change in criteria of effective performance takes place. Second order learning involves a change in the criteria of evaluation. Past practices are called into question, new assumptions about the organization are raised, and significant changes in strategy are believed to be possible (Van de Ven 1986).

Sub-Themes: technical, managerial, practice-oriented, first order, second order

Codes associated to this theme:

- learning as a benefit valued by adopters,
- uncertainty barriers addressed by interventions,
- cognitive barriers addressed by interventions,
- support for learning about user needs (articulation),
- support for un-learning (identifying obsolete assumptions),
- support for second-order learning.

In the first example below, interventions result in the creation of technical knowledge. In the second example, organizational knowledge is created and shared, and there is potential for the re-evaluation of assumptions inherited from the incumbent regime.

Example 1 – Technical knowledge:

Government grants for R&D administered by Regional Development Agencies (RDAs) provide finance to individuals and small and medium size enterprises (SMEs) in England to research and develop technologically innovative products and processes. Various different types of projects can be supported through this scheme; from micro projects, through research and development projects to large development that is strategically important for the sector, with funding of up to £500,000 (King, 2008).

Example 2 – Organizational knowledge:

It can be hard for a company to know if a PIV makes good business sense. High acquisition costs can be unappealing, and a lack of familiarity with the products and their capabilities can mean sticking with diesel or petrol is the default option...when you add in the questions around recharging logistics, it's not necessarily straightforward to weigh up the financial implications and practical impacts of adopting EVs. The level of interest in PIFI [6] from organisations across the country demonstrates the appetite from fleets to lead the way in adopting plugin vehicles, but also the desire for support to take that step.

The true value of PIFI is not just the support for the twenty individual fleets but the knowledge this project brings to a developing market. We have therefore compiled the findings of the PIFI projects in this report in order to share the lessons learnt and evidence gathered with the wider fleet market (EST, 2013)

I: Network building

This theme represents one of the three core processes in SNM, as observed in the case study. The development of a niche may require the formation of a new actor network. Incumbent actors will generally not be interested in stimulating a new, competing technology, but are often needed for expanding the niche. New actors may bring fresh perspectives and may have a better understanding of how to develop a new technology (Weber et al., 1999). In the case study, different networks had very different objectives (sharing knowledge, coordinating actions, providing complementary services), but they contributed to embedding

---

[6] Plugged-in Fleets Initiative. See glossary in appendix A3

the new technology into society, and to providing links that went beyond the initial protective space.

Sub-Themes: supply-chains, support networks, ecosystems

Codes associated to this theme:

- interventions supporting development of supply networks,
- interventions supporting development of support networks,
- networking benefits caused or reinforced by interventions,
- networking benefits valued by adopters.

In the first example below, network building is focused on the supply side, and incumbent actors play a prominent role. In the second example, networks of users and adopters are formed to share knowledge and co-create solutions. .

Example 1 – Supply chains:

The vehicle manufacturers, either acting singly or through NAIGT [New Automotive Innovation and Growth Team], are keen to explore all reasonable avenues through which they can test their new electric products in the market-place. Direct discussions with these players should be encouraged.

The desirability of co-ordinating all these efforts is being emphasized by government. A demonstrable willingness to co-operate and share data/information by any organization which seeks government funding is likely to be essential (Miles, 2009).

Example 2 – Knowledge networks:

It has to be that knowledge sharing has to be a mutual benefit, and obviously not giving away intellectual property or something that gives much advantage, but bringing people together to discuss, to share common problems and common barriers is often quite a successful way to bring it in. if you bring potential users together from different sectors who are not necessarily competitors. Companies that have fleets and delivery vehicles maybe with, you know, large taxi companies or companies that may be not necessarily direct competitors to each other but would have similar issues and similar problems, and bringing those together to discuss (Interview with an adviser for a knowledge-based network).

J: Unusual suspects

This category emerged through this research because of the difficulty in classifying all the actors found in the data according to the taxonomies implied by the models in policy and literature. In particular, national policy (e.g., King, 2008) saw innovation as concern for a limited number of actors: supply chain, consumers, government as agent of interventions, and investors. National policy had a narrow focus on consumer subsidies, infrastructure deployment and supply side networking. Other activities were expected to be done by private actors, but sometimes traditional private actors were not in a position or did not have the resources to address issues neglected by policy makers.

As discussed in Section 2.2, the Office for Low Emission Vehicles had a £400m initial budget: £300m were earmarked for Consumer Incentives, £82m for research and £30m for infrastructure deployment. Those funding categories were strictly enforced, limiting the range of interventions available to the actors they funded. Spending the money on actors outside of these defined categories was not permitted.

As I am running a Plugged-In Places programme, I feel very scrutinised. I am reporting to Government Ministers on a monthly and three monthly cycle. They know exactly how many charging points I have put in the public domain and how many are with companies. They know precisely how much money I am spending and the rate at which I am spending it....Perhaps we have spent more money on infrastructure than we needed to, but in fact the Government grant is structured in such a way that the money we have to spend is on infrastructure. We are not paid to do the other nice things such as engaging with the public. We are paid to build the infrastructure. Providing freedom in that spend to do these other things would help (Dr. Keith Bevis, advisor to PiP programme, in Transport Committee 2013, pp 8,9 of oral evidence appendix).

National policy assumed that other functions would be taken by industry actors, as it was in their interests to do so, but business organizations could be unprepared to take the role.

Educating people about electric vehicles is the absolute key, and I think we can only do so much as a commercial business. We are educating people because we want to sell them something, buy I think it will only really start when there is independent information that's made available (Interview with brand manager for a car leasing company).

This apparent deadlock was addressed by actors that have been provisionally labelled as "unusual suspects". Some evidence of their action has already been presented in the subthemes discussed in Section 5.3.3, with example 1 in of candidate theme F (Empowering Intervention) illustrating their support for knowledge co-creation in operational level at a scale that cannot be addressed by national government, and example 2 illustrating their role in networking and risk management. Example 2 in candidate theme D (Engagement and

Intervention Approaches) illustrates networking and visioning supported by an unusual suspect at a community level. In all cases, actors were acting on private funding (or, in the case of EST, on independently managed national funds), and performing roles that could not be performed by traditional governmental or commercial roles.

The role of unusual suspects identified in this research has some overlap with that of "innovation intermediaries" (Van Lente et al., 2003; Hekkert et al., 2007), defined as organizations that connect, translate and facilitate flows of knowledge on a systemic level. However, the intermediary categories found in the literature (Knowledge Intensive Business Services, Research and Technology Organizations and a (semi-) public organizations or industry associations) still had a focus on supply side.

Attempts to explore unusual suspects or reconcile observations to literature of intermediation brought some promising observations. Policy measures with a supply side orientation have led to a focus on supply-side intermediary actors. But a wider perspective, looking down the supply chain and exploring the emergence of "empowered" business models seems to bring on board different approaches, as observed in the integration of the Milton Keynes EV project with wider low carbon living developments. This perspective calls for a new set of intermediary actors, which vary depending on the level at which the niche processes are studied (e.g., supply side, demand side, community level).

For the purposes of this thesis the role of unusual suspects could not explored further, as the number of organizations that could be studied is not large enough to fully develop this theme. Additionally, the study of unusual suspects is not directly related to the original research questions. However, this exploration has contributed to drawing attention towards actors that fell outside of the established conception of innovation in terms of supply, demand, and government intervention. While this theme remains underdeveloped and in need

of further research, it proved useful for this thesis because it drew attention towards neglected aspects of the niche processes taking place in Milton Keynes, as will be discussed in Section 5.3.5

Discussion of candidate themes

The output of this stage is predominantly descriptive, and the first iterations of this process appeared to describe and re-state the literature of SNM and social marketing (particularly, in interrogating the concepts of barriers, drivers, protection, learning, networking, and management of visions and expectations). However, the end product of this stage went beyond mere description, as it greatly increased familiarity with the patterns in data, and facilitated a systematic re-reading and thinking about the relation between empirical evidence and the theoretical frameworks.

The search for themes in the data brought attention to areas where theory could not provide a full description of evidence related to the case of Milton Keynes, particularly in the area of empowering interventions that were addressing aspects neglected by conventional interventions.

Another observation produced at this stage, facilitated by the use of sensitizing concepts from SNM and social marketing, was that existing categories tended to bring together phenomena of a very different nature. Patton (1990) proposes dual criteria for judging categories – internal homogeneity and external heterogeneity, meaning that data within themes should cohere together meaningfully and that there should be clear and identifiable distinctions between themes. Application of this criteria brought into relief tensions in some of the candidate themes, particularly in those related to the three core processes.

The original candidate themes underwent several revisions, as required by the thematic analysis procedures. Revision of the themes contributed towards resolution of the underdeveloped aspects of the "empowering intervention" as a theme, and towards resolution of the tensions in the core processes. Section 5.4 describes the next stage in thematic analysis, where repeated confrontations between theory, analysis and evidence are used to further the interrogation of patterns identified in this section.

5.3.4 Reviewing the Themes

This phase involves the refinement of the potential themes. The process can begin once a set of candidate themes has been devised. Upon further review, it can be the case that some of the candidate themes identified in the previous phase are poorly defined, and lack sufficient data to support them. Two apparently separate themes may collapse into each other, or themes may need to be broken down into separate themes. This phase involves two levels. First, all the coded extracts for each theme must be reviewed, and confirmed to form a coherent pattern. Level two involves a similar process in relation to the whole dataset. If the thematic map does not fit the dataset, it is necessary to review the coding until a satisfactory fit can be achieved (Clarke and Braun 2006). As explained in Section 5.3.1, data gathered through participant observation was not directly used in the thematic analysis. However, participant observation contributed to further insights, gained through discussion of preliminary results with experts from academia and industry. Discussions of intermediate results of the analysis took place in the context of a series of events that included six Business User Workshops (Milton Keynes, Dec 2010 to Nov 2013), one UTSG conference (Oxford, Jan 2013) and one workshop on Smart Urban Transport Policy Futures (Greenwich, Jun 2013). This iterative process results in abductive theory development through a mixture of established theoretical models and new concepts derived from the confrontation with reality (Dubois and Gadde, 2002, p 559).

The review of themes and confrontation with the literature suggested that some of the candidate themes did not require further exploration, as they did not contribute to any novel or surprising findings. Later stages of the research concentrated on themes that were identified as underdeveloped. Interrogation of the concept of empowerment converged with the inquiry about the role of "unusual suspects". A study of those interventions that had an empowering effect (that is, interventions that identified approaches for out-competing the incumbent through adoption of innovative technologies) found that they were often supported by unusual suspects. This revision of the candidate themes associated with empowering interventions identified some recurrent subthemes that were seldom present in purely protective measures. The subthemes linked to empowering interventions are as follows:

A. Competitive benefits
B. Highly targeted interventions
C. High informational needs
D. Knowledge co-construction and second order learning
E. High engagement
F. Risk management

The methodology of thematic analysis anticipates the possibility of candidate themes "collapsing together" during the revision stage. In this case, the possibility of collapsing several sub-themes into the revised perspective for empowering interventions was explored. The following section will discuss each component of the empowering intervention, providing examples from the evidence related to PiP in Milton Keynes.

A: Competitive benefits

This is the defining feature of empowering interventions. Adopters are expected to benefit from adoption of the innovation, ideally identifying niches where they can outcompete users of the incumbent technology. Empowerment supports the diffusion of the innovation because the precedent set by successful adoption contributes to reproduction of

the model. In the example below, the Energy Saving Trust has the explicit goals of making a clear business case for adoption, and creating a precedent that can be followed by future adopters.

> *We really wanted us to explore what are the opportunities for fleets when you adopt electric vehicles and help the 20 fleets directly to understand the business benefits to them. Each of those fleets received a tailored report from their own real life vehicle data. A fleet consultant was signed to each of the vehicle fleets...The fleet consultant would do a whole life cost comparison of their existing vehicles with plugged-in vehicle alternatives. And each of these 20 fleets would then receive a clear recommendation of where plugged in vehicles would work, and where would they be cost-effective... The majority of those 20 fleets had a clear business case for adopting electric vehicles.*

> *So, what we really want to do is show where plugged-in vehicles can work. And to demonstrate that if they can work for these 20 fleets they can work for other fleets across the country* (Caroline Watson, EST, as recorded Feb 2013 in Plugged-in Fleets initiative (PIFI) Webinar)

B: Highly targeted interventions

On a national level, interventions are frequently targeted using somewhat abstract (and colourful) segmentation schemes, classifying potential adopters as "waste watchers", "positive greens", "sideline supporters" and "honestly disengaged" (see Fig. 5.3, which appeared originally as Chart 4.1 in King (2008), reproduced below). Those segmentation schemes are specifically designed for consumer segmentation, however, and are of limited usefulness for understanding the predominantly organizational early market for EVs.

Chart 4.1: Segmentation of consumers by attitudes and behaviours

Ability to act

High potential and willingness to act

Waste watchers – 12%

"'Waste not, want not' that's important, you should live life thinking about what you're doing and using"

Positive greens – 18%

"I think we need to do some things differently to tackle climate change. I do what I can and I feel bad about the rest"

Concerned consumers – 14%

"I think I do more than a lot of people. Still, going away is important, I'd find that hard to give up… well I wouldn't, so carbon offsetting would make me feel better"

Honestly disengaged – 18%

"Maybe there'll be an environmental disaster, maybe not. Makes no difference to me, I'm just living my life the way I want to"

Willingness to act

Cautious participants – 14%

"I do a couple of things to help the environment. I'd really like to do more… well as long as I saw others were"

Sideline supporters – 14%

"I think climate change is a big problem for us. I suppose I don't think much about how much water or electricity I use, and I forget to turn things off…I'd like to do a bit more"

Stalled starters – 10%

"I don't know much about climate change. I can't afford a car so I use public transport… I'd like a car though"

Low potential and willingness to act

Source: Department for Environment, Food and Rural Affairs

For the purpose of designing policy these clusters can be grouped into three broad types:

- people who are keen to act and have relatively high potential to do more, where enabling different choices, through overcoming barriers such as a lack of information, and direct engagement are important to promote change;

- people who are willing to act and have the potential to do so, for whom it is important not only to enable new choices, but also for Government to encourage change, for example through fiscal incentives, and to exemplify through its own actions; and

- people who are less likely to make different choices, where regulation can be important.

Figure 5.3: DEFRA Segmentation of Consumers (King, 2008)

The design of empowering interventions targeting organizations need to use much more precise and specific criteria for identifying potential target adopters. Because innovations are competitive only within specific parameters, it is important to concentrate on

operational needs rather than on attitudinal issues. As illustrated in the example below, specific guidelines are needed so that unsuitable users are not targeted, preventing reputational damage to the innovation.

> *The key thing for us as a customer and service level organization is, we don't want to sell these vehicles in to a customer when it is not appropriate for them to have them because that's not what we are about. We are about making sure that we are giving the right service, providing the right vehicles to fit the customers' needs, so the worst thing is if we sold a Nissan Leaf that has got a 80 mile range to a customer when the driver needs to do 150 miles a day and has not got the chance to charge because he is out here, there and everywhere. So it has been an education piece for the sales people and we got various documents around the business detailing the questions that need to be asked of the customer to make sure that the vehicles that we are selling them are the appropriate vehicles to them* (Interview with brand manager for a car leasing company).

C: High informational needs

Because potential adopters are unfamiliar with the new technology, they are not always in a position where they can readily identify suitable applications. Many parameters of the incumbent technology that are taken for granted, such as expected performance, cost structures, resale values or maintenance schedules, are widely known in the industry as result of decades of cumulative experience. As a result, proponents of the innovative technology must provide support for the creation of a suitable body of knowledge that will allow planning and design of competitive applications. In the example below, a taxicab company supported by a third party describe the process of identifying the relevant information to make it available to potential adopters that do not have the resources or inclination to so do individually.

At the moment we are in the process of playing with figures. We want to have a set rate of figures that we can say to a driver; this is the realistic savings or earnings you can make from leasing this vehicle. Obviously with things that have been taken into consideration like the time taken to charge the vehicle, the cost to license the vehicle. All of these costs have been considered and we're just coming up with that one figure we can say to a driver this is what it will cost you. This is your fuel cost, your tax, your insurance and see if they think on that basis its going to be something they can proceed with. So we are in the process of sorting out those figures. We haven't anything in writing confirmed because it's difficult to calculate all these things because there are so many things to take into consideration (Interview with the marketing and development manager of a taxicab company supported by non-governmental enabler).

D: Knowledge co-construction and second order learning

Competitive applications are not exclusively based on optimisation of existing practice, and they can involve the re-assessment of incumbent business and operational models (second order learning). Because this reassessment requires in-depth knowledge of the existing operation of the business, it cannot be performed by experts external to the adopting organization. The experts, however, can be in a position to guide the co-creation of competitive applications. The example below illustrates this point, as improvements to the regular fleet operation are co-created by consultants from the Energy Savings Trust with support from specialized software from RouteMonkey and knowledge of the specific operations of the potential adopter.

Our partnership on PIFI brought together companies that offered unique benefits to the plugged-in world. Route Monkey has developed software that optimises the use of fleet vehicles through complex algorithms and inputs set by

194

the company's fleet manager. The Route Monkey software was developed originally around the unique requirements of PIVs which are range, charging rates and duty cycles. The software focuses on getting the best from the vehicle in terms of energy consumption and then planning in charging opportunities whether they are the main 'overnight' charge or a short top up charge during the working day to ensure the duty cycle can be met or even extended. Route Monkey does this through looking at the routes and optimising load against route. In a simple example, when a vehicle is fully laden it makes more sense for it to be scheduled to tackle a hill towards the end of the shift once it's load has reduced. Obviously operational requirements are the key driver, but when these have been met, optimising the route to minimise energy consumption is the right approach.

The second and equally important benefit is the scheduling of the charging route within the route plan. An opportunity of a half hour stop within a schedule could change the whole pattern of usage and make pure EVs viable.

The key is for a fleet to consider how much they are willing to make changes to their operation in order to move to plug-in solutions. Change of operation does not have to mean a loss of efficiency, quite the contrary; it could be a long term improvement in working practice and vehicle utilisation while reducing energy use and costs. (EST, 2013, p 19)

E: High engagement

The co-construction of knowledge cannot take place without a high level of engagement with the potential adopter, and buy-in from the organization. On a national level, interventions were often designed assuming (and providing) a very low level of

engagement, as illustrated by the following example in which a general lack of knowledge about the specific effects (or lack thereof) for the OLEV incentives is explained:

> *We have not done any monitoring of individual purchases, but we would expect the motor manufacturers to do that. It is in their interest to sell more vehicles and it is in their interest therefore to understand who is buying them, who is likely to buy them and where they should aim their market. That is a job for the motor manufacturers rather than the Government* (Stephen Baker, Minister of Transport, in Transport Committee 2013, p 17 of oral evidence appendix)

This can be contrasted with a description of the high-engagement procedures involved in interventions by the PIFI, with the example below providing more insight about the process of knowledge co-construction discussed under category D (*Knowledge co-construction, Second order learning*), above:

> *During the initial meeting explorative discussions were held to identify opportunities where PIVs could work. This discussion helped us to segment the fleet by usage to target where PIVs would potentially fit. We explored and developed an understanding of what the fleet manager was doing with his or her vehicles and the likely areas where we could find plug-in benefits taking into account business needs...*

> *..We can't overstate the value of face to face meetings to explore the requirements of the review process. In the early stages of the PIV market there are many questions and also assumptions that some fleet operators have about the new technologies. We wanted to get to the bottom of organisations'*

expectations of the review process, find out what data they had, and what

opportunity there was within the fleet for PIVs. (EST 2013, p 14)

F: Risk management

This aspect of the empowering intervention is related with the high informational needs of pioneering adopters discussed under category C: *High Information Needs*. Planning the deployment of a competitive proposition around an innovative technology involves the use of an unusually large number of assumptions, and therefore a very high level of risk is involved even for best-case scenarios. This uncertainty can have a dampening effect, as illustrated by the following example:

So there are some benefits, but then you know you got what its worth at the end of the contract term or fixed mileage and we got to guess what it is going to be worth at the end of the period. If we get it right that's fine, if we get it wrong we could lose money ... You know, electric vehicles when you are three four years down the line, typical length of the company car cycle, it is not yet clear if the batteries are going to last, it is not clear what the replacement batteries are going to cost, it is not clear what the infrastructure will be to manage that. So predicting the value of a purely electric vehicle in four years time is really difficult. I don't know what the tax environment is going to be, I don't know what the road tax environment is going to be or if there are any other duties getting in place (Interview with the managing director of a fleet management firm entering the green market).

Every designer of empowering interventions identified in this research was aware of the importance of assessing and managing risk. It was often the case that the intervention

designer had the resources to protect the pioneering adopters from the risk of a worst case scenario, as exemplified below:

You get all these players, they all got something that they think it is interesting but not one of them will do it because each one of those sees his own risk and that risk is too big to bear in their own eyes. It only works if the whole story works... Everybody can see that they have a win there somewhere, but only if some other part of the jigsaw works. The only way you can set this to work, therefore, is if you set up some special operation which takes the risk...

...what's most important for us right now is that we can make an economic case today. [our organization] has been set up as an enabling company and it takes the risk, so if there is going to be a loss of money, or lawsuits, or anything horrible [our organization] is where the buck stop, but [the organization] does not like to lose money, so we have done everything we can to do the economic analysis, convince ourselves that money probably wont be lost (Participant observation of consultant for non-governmental enabling organization).

Reviewing the core SNM processes

The reviewing of the theme "empowering intervention" had a cascading effect on the review of other themes. In particular, as discussed in Section 5.3.5, there were some noticeable tensions in the evidence related to core SNM processes. Examples selected for illustration of candidate themes A-J in Section 5.3.4 illustrate those tensions. Broadly speaking, some of the interventions applied in support of the core processes had a protectionist mindset, and some had an empowering mindset. Each of the core processes had to be sub-divided in two themes, giving rise to categories that were provisionally labelled as

"empowering visioning and expectation management", "empowering network building" and "empowering learning". However, further iterations of the review process suggested that "empowerment" and "protection" were related with several assumptions about the nature of the processes taking place. In particular, the "protective" mindset was associated with the framework provided by neo-classical economics. The results of exploring the tension between the neoclassical perspective and the "empowering" holistic perspective are reflected in the final definition of the themes that resulted from this analysis, as described in the following section.

5.3.5 Defining and Naming the Themes

In thematic analysis, phase 5 begins when satisfactory thematic map of the evidence has been produced. At this point, themes are defined and refined. That is, the essence of each theme is identified. An overarching narrative should begin to emerge at this stage, with the data telling a story in relation to the research questions. It is important to identify not only the story that each theme tells, but also the fit to the overall story being told about the data in relation to the research questions (Clarke and Braun 2006). The themes and sub-themes should reflect a hierarchy of meaning within the data.

The analysis described in Sections 5.3.1 to 5.3.4 identified two subsets of the data that presented very distinct patterns. One of the groups had what was provisionally labelled as the "neoclassical perspective", and was most predominant in material produced by actors associated with national policy, major manufacturers, and actors in their supply chain. The other sub-set of the data exhibited what was provisionally labelled a "holistic perspective", predominant in documentary and interview data produced by local government actors, pioneering and prospective users, and by "unusual suspects". While the neoclassical perspective actors tend to follow a top-down approach, with interventions focused on the "downstream", actors following the holistic perspective are located "mid-stream". They play

(or attempt to play) enabling roles, but need the support of a network of enablers themselves. Their downstream includes organizational users as well as individuals. In contrast to "neoclassical" actors, who "black box" the demand side, intervention designers and decision makers with a "holistic" perspective show a rich understanding of the needs, goals and practices of their downstream actors.

Insights from the social marketing perspective made visible some elements that were previously underdeveloped in SNM, and that are central to the holistic approach. Sections 5.3.10 and 5.3.11 will discuss and contrast the characteristics of the data associated with the neoclassical and the holistic perspectives. This comparison of narrow and broad perspectives of niche-building will be followed by a discussion of other themes of interest that emerged from the application of the holistic perspective to the analysis of interventions (Section 5.3.12) and core niche processes (Sections 5.3.13 to 5.3.16). This reflects the key themes produced by this thematic analysis, which are as follows:

> 1-Neoclassical perspective
> 2-Holistic Perspective
> 3-Empowering Intervention
> > 3.1-Holistic visioning and expectation management
> > 3.2-Holistic network building
> > 3.3-Holistic learning

5.4 Neoclassical Perspective

Neoclassical actors (and early versions of SNM theory, like Rip and Kemp, 1998) discuss interventions in terms of protection: The product is assumed to be socially beneficial, but it is also assumed it will have inferior price and performance characteristics. Therefore, it needs protection. This protection is designed by experts and applied from the top to influence the choices of potential adopters downstream. In consequence, there is a low level of engagement with users and the protection is untargeted, providing blanket coverage. The

implicit assumption is that if a product is made a bit more affordable, somebody out there will be persuaded to buy it.

In terms of the evidence provided by the thematic analysis, the following candidate themes and codes were present in a majority of the items labelled "neoclassical":

- Technical barriers,
- financial barriers,
- infrastructural barriers,
- financial interventions,
- infrastructural interventions,
- interventions supporting R&D,
- economic benefits,
- supply-side actors (e.g., SMEs, R&D actors, and major manufacturers).

The example below, from a publication predominantly addressed to policy actors in local government, illustrates how the key barriers are assumed to be the high cost and low performance of EVs relative to their ICE-based counterparts. Because the barriers have been narrowly defined, the interventions are framed in similarly narrow terms, with subsidies addressing the high cost and infrastructure deployments addressing low performance. When the issue is framed with this perspective, however, the interventions are insufficient to address the high up-front cost and range anxiety issues associated with EVs :

So, what are the current barriers to EV take-up? One is that, even with government subsidies, they still cost significantly more than equivalent petrol and diesel vehicles. A Nissan Leaf costs around £26,000 even with a government Plug-In grant - the battery packs alone cost around £6,000, for which it is possible to buy a small petrol engined car.

The other major barrier is drivers' concern that they will run out of power while driving, a problem dubbed "range anxiety". This will only be addressed when EV batteries are more reliable and there are plenty of places to recharge, or at least top-up, while out and about. There is clearly a need for readily accessible rapid charging points in car parks and workplaces across the UK (Local Transport Today).

The following example, from a document outlining the approach followed for the design of pro-EV interventions in Milton Keynes, fulfils many of the characteristics of the neoclassical perspective. Regulatory benefits like parking and provision of electricity are framed in monetary terms that, upon further analysis, are insufficient to compensate for the cost premium of EVs. In addition, the measures are framed as temporary protection subject to review and withdrawal.

First among these incentives is the provision of free parking for electric vehicles for all those parking bays in which a charge point is installed, which for those drivers who park daily in the city centre will offer the potential for a saving of approximately £1,800 per annum. Electric car users can already park for free at Central Milton Keynes railway station, saving users an annual £990 in parking charges.

The second local incentive will be the provision of free electricity from the charge points in public parking bays. On the assumption that a full eight hour charge will cost approximately one pound this will offer those drivers who park daily in the city centre the potential for a saving of up to £300 per annum... We plan at some point from 2013 onwards to re-introduce parking charges and to

introduce a charge for electricity provided from charge points (Constantinides 2009, p XXII).

5.5 Holistic Perspective

Under the neoclassical perspective, it is very difficult to build a sensible business case for adoption of electric vehicles. None of the pioneering adopters of EVs identified in this research had a neoclassical perspective. All the actual adopters and those prospective adopters that were giving serious consideration to EVs seemed to have a perspective compatible with the holistic framework, and the organizations that provided support to those pioneering adopters shared a similar perspective. The characteristics of the holistic perspective match those of more recent literature in SNM (e.g, Smith and Raven, 2012) and social marketing. The focus is on creating conditions that make adoption beneficial to the adopter. The following example from a consultant from an enabling organization provides a clear summary of this approach

> *So in my view, a much harder question is "what can you do today that moves you in the right direction"? Does it make sense in today's economic environment? That is a difficult question to answer in my view, and that is what my position is about, looking for those things when you can begin to make a movement in what you think is the right direction and you are going down there in a path that in business terms I may call a "no regrets path". You can't really be sure about the future, no one can, so if you move off in this direction and your picture of the future is wrong and the economics doesn't work you lost a lot of money for absolutely no results and you get a lot of regrets about that. But if you think this is the right way to go and you can construct a path to get there in today's economic terms and that path is a profitable one, then if the picture changes you have no regrets because you had a profitable path all along*

(Participant observation of consultant for non-governmental enabling organization).

In contrast to the sales orientation of the neoclassical approach, that seeks to increase the attractiveness of a predefined product, the holistic approach is associated to a marketing orientation: Needs are identified and addressed to create a valuable offering (Kotler 1997). Because of this, interventions are highly targeted. As discussed in Section 5.37, empowering interventions identify particular adopters (niches within the niche), and craft a proposal that is valuable for them. Empowering measures are not designed by authorities, but co-created in collaboration with the "targets". The "targets" investigated in this research changed the structural conditions in their environment, making adoption possible for actors "downstream". Thus, empowering interventions frequently resulted in changes to the "environment" (upstream interventions).

In terms of the evidence provided by the thematic analysis, the following candidate themes and codes present in a majority of the items labelled "holistic":

- Barriers related to organizational issues, support networks, cognitive barriers and risk or uncertainty.

- Benefits related to accessing new markets, providing new services, using (green) reputation to build new networks. Knowledge as a benefit

- Codes for interventions related to financial, technical and infrastructural barriers were as prevalent as they were for the "neoclassical" subset, but in the "holistic" there were also informational and knowledge-based interventions, learning (and unlearning) support, and interventions providing support networks.

- Codes related to actors had more variety, including lease and fleet management orgs, support organizations, fleet users, organizational users, consumers, mobility services.

Saying that a given prospective adopter had a holistic perspective does not imply that EVs are immediately perceived as viable options. Holistic actors could identify very definite barriers that could dampen their enthusiasm. However, those barriers were not determined by the technology, but they were related to organizational issues, support networks, cognitive barriers and risk or uncertainty.

Internal combustion engines , the stuff we see outside the office, we have a fairly good understanding of how much they cost to run, when they are going to need oil, when they are going to need tyres, when they're going to need servicing and the like... but we don't have any experience of that, really, with EVs.

For an individual vehicle, understanding what you total financial cost of operating that vehicle for three or four years is pretty much impossible to estimate until we get some experience about what that number is. So it is hard, it is hard for us to make ... If a customer ordered one hundred today we would take their order but we would not take residual value risk on it, so we would leave that risk with the customer, it would be their risk. Again, with the maintenance we would manage the maintenance, so we use our network of repair agents everything else to manage the vehicle, we would give them all the rest of the experience but we would expect them to carry the financial risks of the residual value and maintenance (Interview with the head of strategic development for a fleet management organization).

Because the barriers were not determined by the state of technology, the concerns of holistic adopters were more readily solvable, and they benefited from the knowledge generated in the niche experiment. The barriers discussed in the previous example were

addressed by the interviewee himself, who ran an EV pilot within his organization. As is the case with most holistic actors, the interviewee saw the potential to produce valuable knowledge, and to use that knowledge for the provision of valuable services:

Really, the reason that we are doing this is twofold, I think. One is because customers will expect us to be able to give them advice and guidance about the suitability of these vehicles, the practical usage, how they work in real life, so we think we should have some experience on that, and we think we can, we can use that experience. But also to allow customers to use these vehicles as demonstrator vehicles for a period to understand how they may work in real life and their practical uses.

The second is for us to start to evaluate operating costs, from two angles really. One is what are the operating costs in the real world and how do we model those in any analysis that we do for a customer about the cost impact of their fleet choices. And the other is our ability to forecast future values, future maintenance and repair costs, servicing costs, etc, etc... So we want to be able to just get an idea of how these vehicles actually operate and understand them (Interview with the head of strategic development for a fleet management organization).

Knowledge developed through those organizational pilots was used in support of the business model:

Our business model really is centred on two themes: One is, we take risk on behalf of our customers. We take residual value and operating risks. And the other is that we provide aggregation of data and insight and expertise across in terms of how to create and structure a fleet and policies, about how they manage their employees and

their vehicles (Interview with the head of strategic development for a fleet management organization).

While the interview above illustrates the case of an actor that pursued a holistic approach without external support, that was not the most common scenario. There were many cases where organizations interested in encouraging adoption of EVs sought and supported prospective adopters. Interventions designed by "holistic" actors provided support for sharing information and knowledge, and usually involved the co-generation of knowledge, the creation of new business and operational models, or the "unlearning" of old assumptions. Holistic interventions engaged a very varied set of actors in comparison to the supply-side focus of the neoclassical approach, involving lease and fleet management organizations, support organizations, fleet users, organizational users, consumers, mobility services. This approach is illustrated by the following example:

> *We get groups of people together so we have workshops and we do something called technology road mapping, it is a technique enables us to map out what technologies of the future can be and what is encouraging them, what the barriers are, what the drivers are could be meet carbon targets, climate change, resource scarcity, changes in public perception of the environment. Barriers might be things like legislation, planning infrastructure, lack of political will, lack of funding. We need to identify all of the barriers or drivers around a particular technology area.* (Interview with an adviser for a knowledge-based network).

The defining features of the holistic (or empowering) intervention have been discussed in Section 5.3.7. Application of the holistic perspective to the exploration of the core niche processes suggests a possible approach for empowering interventions, developing

the approach suggested by Smith and Raven (2012). Sections 5.5.1 to 5.5.3 describe some central components of empowering interventions as identified in this research.

5.5.1 Holistic visioning and expectation management

Analysis of the visioning and expectation management actions undertaken by holistic actors in the case study identified a number of features: When possible, areas seen as uncertain or risky by potential adopters were identified and addressed. This involved identifying and addressing damage caused by negative or mixed signals by regulators, incumbents (e.g, about future regulations, expected resale values and market demand, etc). Exploration of scenarios, tailored to the specific circumstances of adopters and backed by demonstrable data, contributed to positive expectations regarding adoption benefits. This is illustrated by the following example:

The community in [the town] did this thing called "a market town self-help process" which is basically a community visioning process which is rooted on a 20 year vision for [the town], and within that document were lots of aspirations that local people had for the way they wanted to see [town] improved and get better over time and regenerate really, and parking and the influence of cars on the town which is a Victorian railway town, it was never built for a huge number of cars... So that is the sort of background of everything that subsequently happened...so what we did was drafting a new action plan in 2012, and within that new action plan, which is also on the website, there was a very strong push towards addressing peoples energy consumption in [town] and trying to make [town] a more sustainable place, so basically there is two things. The original aspiration about dealing with parking issues and traffic dominance in [town], and the second aspiration that came out of the review of the vision came together, and basically, through the national energy foundation the whole project, the car

project came into my radar really (Interview with the convener of a community group supporting a private EV initiative).

5.5.2 Holistic network-building

Analysis of the network-building actions undertaken by holistic actors indicated an emphasis on the creation of demand-side support networks (as opposed to supply-chains).Networks were expected to engage in co-creation of value, and they facilitate the flow of (organizational) knowledge and services. Intervention designers were not supporting the intervention from the top, but they acted as peers in the network. The following example illustrates the holistic perspective for network-building:

Actually, language is really important, because in terms of the terminology you've got people like government departments and regulatory framework who have one kind of common language if you like, you've got industry who talks differently, and you've got academia again, so actually bringing those three groups together in the same room at the same time and getting a shared understanding of the problem, that's also quite an interesting work. It is actually problem how you actually frame the problem, so how does everybody understand the problem on the same way? because you might think you do, but actually it could be quite a different perception, so it's actually how you get everybody to have a shared view of that particular issue or problem or barrier, and talk of how they see it, we have that common ground, very often you'll talk to people and when you actually start to dig underneath the issue they see into it differently, their issues are quite different, so that's quite an interesting thing to do (Interview with an adviser for a knowledge-based network).

5.5.3 Holistic learning

Analysis of the learning activities undertaken by holistic actors showed that this involved collaborative sense-making in multiple dimensions. That is, instead of a deficit model pushing "expert knowledge" (often technical), knowledge in the holistic perspective is created through engagement with potential adopters, learning about their business and operational models. For purposed of this discussion, the term "model" is used in a somewhat abstract sense, as a set of "*precise assumptions about a limited set of variables and parameters to derive precise predictions about the results of combining these variables using a particular theory*" (Ostrom, 2011).Using this definition, the holistic learning process can lead to the design of interventions focusing on individual "variables" identified as relevant to the actors (first order learning), or it can lead to the co-creation of improved models (second order learning).

The following example provides a succinct illustration from documentary evidence.

TfL and DfT's investment into PIFI is a visionary move. The PIV market in the UK is still in its early stages and there are large bodies of data as a result of both vehicle trials and PIV user experiences. However, until now, there has been very little information available with regards to the process fleets need to follow to successfully acquire and integrate plug-in vehicles. Some of the main barriers are a lack of understanding of the costs and utility, and preconceptions about the vehicles (EST, 2013, p9).

The following example from interview data provides a complex but interesting illustration of the holistic learning process. The interviewee used a model for cost that involved a set of assumptions about the value of certain variables (e.g., cost of fuel, cost of maintenance), and also made assumptions about the operations of the organization (e.g., that the vehicles would be leased for three years, and that the total mileage per vehicle would be

close to *80,000*). The model was enforced by the software used by the organization (the Deloitte modelling tool[7]), and using the model for evaluating the suitability of EVs would have concluded that there was no business case for their use. However, the assumptions in the model were based on values and operations that made sense for ICE-powered vehicles. Because the interviewee was aware of the assumptions embedded in the model, a custom-made version was commissioned, and a successful case for the adoption of EVs could be made.

From an employee point of view, our whole life cost model, we use the Deloitte modelling tool but then we basically built our own version customized to us and its fundamentally based on so purchase price of the car after any discount, a pence per mile maintenance figure that we get and again because of the simplicity of servicing an electric vehicle they score quite well on that. Operating cost in terms of fuel, we calculate the employees will play on the actual employees tax bill on top of the car.

[The Deloitte model] is a brilliant tool, in 99% of the circumstances, but because we buy rather than lease, which is unusual for a fleet this size, because we keep our cars for 4 years rather than 3 years, 3 years and 80,000 is pretty much industry standard, and the Deloitte model gets a little bit shaky once we get past three year idea (Interview with a fleet manager responsible for the company cars of a national retail chain.)

In the example above, the interviewee did not require support for identifying the assumptions in the model, but the example below, from the EST, illustrates a similar case

---

[7] A whole life costing model available to customers of the Deloitte and widely used by businesses to evaluate the purchase or lease of fleet vehicles. See:
http://www.deloitte.com/view/en_GB/uk/services/tax/employers/compensation-benefits/car-consulting/index.htm

when operational models inherited from diesel vehicles can be questioned and improved to make a case for EV adoption that would be unfeasible otherwise:

> *PIVs could work if they kept the vehicle for a year or so longer than they normally would (i.e. four rather than three years). However, we also found during the PIFI analysis that some fleets made decisions based on a formula that did not reflect how they actually used their vehicles in practice. A regular formula for decision making is based on the cost of running a vehicle over X years based on Y miles per annum. For example, this may be three years at 15,000 miles per annum. However, some of the fleets we worked with were asking for vehicle quotes based on a formula that did not match the actual mileage and vehicle cycle of their fleet. This may not matter so much when comparing two diesel vehicles for example, but it can make the difference to the business case of a PIV. Because a PIV will be more cost effective at higher mileages and a longer life cycle on fleet, it is crucial to ensure the calculations reflect how the fleet actually use their vehicles to gauge if they will be the best option for the fleet (EST, 2013, p25)*

5.6 Summary

This chapter described the implementation of the research design first outlined in Chapter 4. First, the composition of the different datasets that provided an evidence base for this analysis was described in Section 5.2. The body of evidence sought to provide insights into the framing of the early EV market by policy makers and organizational adopters, and was based on interview data, participant observation, and documentary sources. This provided complementary perspectives about the processes that took place for the duration of

the Plugged-in Places programme in Milton Keynes. A central concern of the research questions introduced in Section 1.2 was the identification of the factors that were considered relevant by policy designers and pioneering adopters who contributed to the creation of the early-market niche for EVs. The thematic analysis performed in this chapter provided a systematic approach for identifying salient factors and recurrent patterns in the evidence produced by actors within the experimental space created by the PiP programme. Section 5.3 outlined the procedure of thematic analysis, where the evidence is systematically labelled to facilitate identification of reporting of recurrent patterns in the data.

Accounts about spontaneous, unbiased emergence of themes are seen as suspect in thematic analysis. Accordingly, this chapter acknowledged that the analysis was influenced by sensitizing concepts from the literatures of SNM and social marketing. The influence of those literatures was clear in the selection of candidate themes reported in Section 5.4.3. During intermediate stages of the analysis the candidate themes identified appeared to be merely descriptions, grounded in the evidence from the PiP programme, of patterns already described in the literatures reviewed in Chapter 4. Data from Milton Keynes showed patterns consistent with the existing literature regarding barriers, benefits and creation of value, and provided opportunities to observe the core SNM processes of learning, networking and visioning. Further analysis of the evidence, documented in Sections 5.3.6 to 5.3.14, provided a richer understanding of the developments in Milton Keynes that went beyond the established literature. In particular, it was observed that the PiP programme acted as a protective space for some actors, but was transformed into an empowering space by others. Those different approaches were associated with distinct perspectives regarding the nature of innovation and societal change. Those two perspectives, labelled "neo-classical" and "holistic", became major themes in this analysis, and the exploration of the tension between those approaches is one of the major contributions of this research. The following chapter,

"Results and Discussion", will summarize the results of this analysis and will look at the relevance of the findings in the context of the case of PiP in Milton Keynes.

Chapter 6 - Results

6.1 Introduction

This chapter reports the findings of the thematic analysis performed in Chapter 5, providing a description of the overarching themes identified and discussing their prevalence in the various actor categories that contributed to the experiment. The findings are then recontextualized, linking them back to the context of Plugged-in Places in Milton Keynes through the application of the SNM case study format.

The first section of this chapter reports the results of the thematic analysis documented in Chapter 5. The themes in the original analysis suggested that developments within the experimental space created in Milton Keynes were shaped by the perspectives of the actors that created the space or operated within it. The second half of this chapter uses the SNM case study format to reconnect the findings of the thematic analysis to their context in Milton Keynes. By using this case study format, attention is drawn to the niche processes that took place within the experimental space created by the PiP programme. The chapter is organized as follows:

Section 6.1 provides an introduction to the objectives of the chapter and describes its structure. Section 6.2 reports on the findings of the thematic analysis documented in Chapter 5, re-contextualizing them to discuss their significance to the case of Milton Keynes. Section 6.3 summarizes the findings of this research in the form of a SNM case study, following the format outlined by Hoogma et al. (2002). The SNM case study links the evidence discussed in previous sections to the key structures and processes of the SNM framework, with

particular attention towards core niche processes. Observation of core niche processes taking place in Milton Keynes is central to the research questions guiding this thesis, as discussed in Section 1.2.

6.2 Findings of the Thematic Analysis

A common criticisms of thematic analysis, shared with all methods based on content analysis, is that they can have a decontextualizing effect on the evidence being studied (Bryman, 2001).The objective of this section is to reflect back on the case of the PiP programme in Milton Keynes through the lens of the holistic framework developed in Chapter 5, recontextualizing the findings, and discussing the concrete impact of the abstract patterns and themes identified in the previous chapter.

Thematic maps (Figs 6.2 and 6.3) are used to convey the patterns and themes present in both sub-sets of the evidence. The maps build on the evidence presented in Chapter 5. Cross-references to the relevant sections will be provided to avoid excessive repetition. The maps will support a description of the key features in the neoclassical and the holistic perspectives in subsections 6.2.1 and 6.2.2 and a discussion of their implications for the interventions observed in Milton Keynes in subsection 6.2.3. Basic quantitative information regarding the prevalence of holistic and neoclassical themes as observed in Milton Keynes will be provided in sub-section 6.4.

6.2.1 The Neoclassical perspective in Milton Keynes

The neoclassical perspective for organizational EV adoption, as identified through thematic analysis, has many features in common with the linear model of innovation discussed in Chapter 3 (see, particularly, Fig. 3.1). On the left of Fig. 6.2 are technology developers and SMEs, who are assumed to be the sources of innovation, driven (or rather, pulled) by the

demand for components by major manufacturers. The economic competitiveness of a country or region is assumed to depend in a significant measure on the presence of technology developers and suppliers. This justifies the provision of government funding supporting the research, development and production of improved technological inputs. Innovation integrators facilitate the inclusion of those improved technologies into the products of major manufacturers, who in turn make products available to consumers.
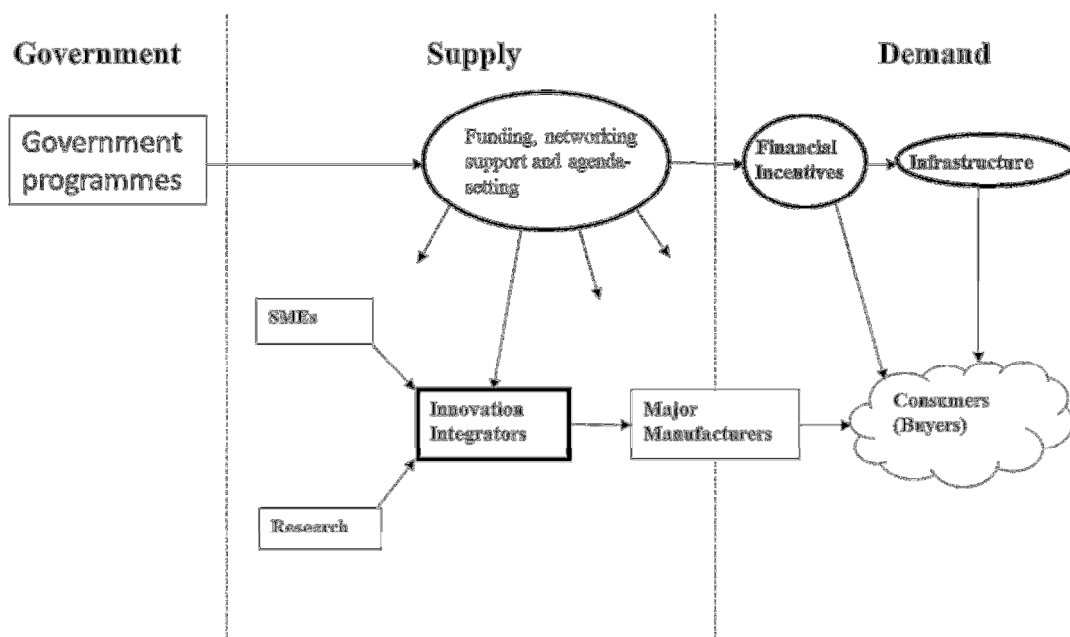
Figure 6.1: The neo-classical perspective for organizational EV adoption

Government programmes set the agenda and fund the research and networking initiatives on the supply side, and incentivize the demand side through financial incentives and infrastructure deployment.

The neoclassical model assumes that the interaction between supply and demand happens at the moment of the sale. The neoclassical conception of the supply side sees major manufacturers as the interface between supply and demand, and seems to consider that the

success of EVs depends on major manufacturers supported by a well-developed supply chain involving universities, technology developers, SMEs and innovation integrators.

The demand side is "black boxed" (as defined in Rosenberg, 1994, p 202), meaning that no attempt is made to understand the needs of demand-side actors, which are assumed to be purely rational. The decision to adopt appears to be conceptualized as a simple calculation based on cost and performance (See the counterexample provided for theme E, "high engagement", in Section 5.3.4).

This perspective seems to take for granted that the EV in its current state is an inferior technology in need of protection (Theme E in Section 5.3.3). The barriers most emphasized in this sub-set are cost, performance, and range anxiety (Section 2.2.2). EV adoption is supported through financial, networking and learning interventions. The expectation is that this support will bring costs down and improve performance, allowing suppliers to provide a more compelling product.

Consumer incentives are intended to offset perceived shortcomings of the EV, with infrastructure addressing the range anxiety produced by inferior technical performance, and subsidies addressing the cost disadvantage. There are regulatory incentives on the consumer side (e.g., provision of free parking spaces, congestion zone waivers) but they are framed in financial terms (e.g., money saved in parking fees), suggesting that regulation is seen as a mechanism for offsetting a perceived cost disadvantage, rather than as a tool for the creation of a distinctive advantage (See example 2 in Section 5.4).

Expectation management is limited to the management of technical expectations (e.g., technology roadmaps, technical standards) oriented to providing a technical direction to the supply chain (e.g., NAIGT, 2007; RAC, 2013). Other aspects of expectation management (e.g., signals about the stability of regulatory and fiscal frameworks) are neglected, and result

in the perception of mixed signals by potential adopters (See the examples for Theme E in Section 5.3.3).

Networking activities are focused on building the supply chain. The expected benefit from networking interventions is the formation of a supply chain that will lead to major manufacturers offering products with better technical performance at a lower price.

Support for learning processes includes funding for technical learning. Pilot programmes like Plugged-in Places are designed to facilitate and capture learning on limited dimensions (technical performance, infrastructure management).

6.2.2 The Holistic perspective in Milton Keynes

In contrast to the neoclassical perspective, the holistic perspective conceptualizes the creation (or rather, co-creation) of the market for EVs as a multidimensional phenomenon involving a very diverse set of actors (Fig 6.3). The supply chain behind the technical artefact, a central element in the neoclassical perspective, is not relevant for holistic actors. Instead, their conception of the supply side looks at the providers of supporting services like financing, leasing and fleet management that make adoption possible. The exact position of those supporting actors is often ambiguous in that they can be seen as suppliers with a higher position in the chain or as partners in a non-linear, non-hierarchical network.
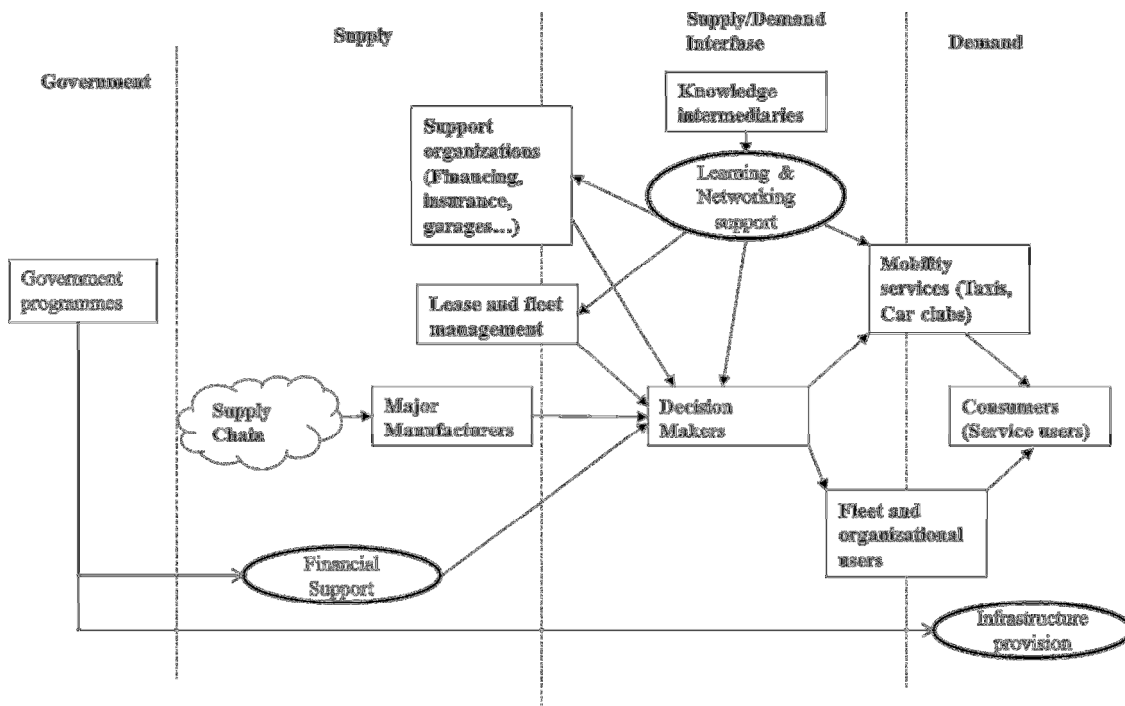
Figure 6.2: The holistic perspective for organizational EV adoption

In the holistic perspective there is not a definite dichotomy separating supply-side actors from the demand side. Only a few actors can be definitively associated with one side or the other. Major manufacturers, for example, can be identified as supply actors. Likewise, few actors can be placed completely in the demand side, although consumers, including home users and users of services based on EVs are clearly so. Most of the actors are situated somewhere in between consumption and production even if they gravitate towards one side or the other of the production-consumption spectrum. Lease companies, fleet management and support organizations are mostly supply-oriented, but they still exhibit features of the consumer perspective. Mobility services (e.g, car-clubs, taxicab companies) see themselves as consumers of EV-related products and services, but they also use them to supply unique services. The organizational decision makers interviewed had to balance both of these perspectives as they integrated EVs into their business operations to create valuable,

competitive offerings. Many of the actors that shape the innovation appear to be situated in this fuzzy interface layer, which is blackboxed in the neoclassical model.

The invisibility fostered by the blackboxing of the supply-demand interfase created a gap in the policy intervention portfolio outlined in King (2008) and funded by the OLEV. The policy is designed to support the industry and stimulate demand, but there is no provision for supporting the actors that do not fit neatly into those categories. This creates an opening for organizations that are not funded by the niche managers, but who are in a position to provide interventions in support of the key learning and networking processes if a mutually beneficial relationship can be created (See candidate theme J, unusual suspects, in Section 5.3.3).

6.2.3 Neoclassical and Holistic Interventions in Milton Keynes

Interventions that were identified as neoclassical during the analysis were those initiated and funded by national government. In consequence, they followed a top-down [8] approach, where decisions are made by authorities and the emphasis in on changing the action of "downstream" actors. In contrast, interventions that were identified as holistic were located "mid-stream", meaning that intervention designers were interested in affecting the choices of their peers or partners. These parties played enabling roles, while also needing the support of a network of enablers themselves. For example, an enabling intervention may involve coordinating the actions of vehicle operators, infrastructure providers, and local policy actors to provide EV-based services :

> *You get all these players, they all got something that they think it is*
>
> *interesting but not one of them will do it because each one of those sees his own*

---

[8] in policy design, top-down approaches are initiated by actors in a position of authority to influence the lowest level actor (target or implementer) . Related to a conception of institutions as predominantly shaped by laws and regulations by leaders.

risk and that risk is too big to bear in their own eyes. It only works if the whole story works... Everybody can see that they have a win there somewhere, but only if some other part of the jigsaw works. (Participant observation of consultant for non-governmental enabling organization).

In contrast to neoclassical actors, who black boxed the demand side, intervention designers and decision makers with a holistic perspective show a rich understanding of the needs, goals and practices of their downstream actors. This understanding is related to the high informational needs discussed under sub-theme C in Section 5.3.7, in which examples illustrate the rich understanding of holistic actors in Milton Keynes. Interventions designed by holistic actors supported a multidimensional learning process, lowering the financial and cognitive costs of adoption for the organizations they supported. In addition to technical concerns, considerable effort was invested in learning about total costs, patterns of use and demand, fitness for operations, market demand, and suitable financial models. Investing in the creation (and co-creation) of EV related knowledge could be justified because knowledge was expected to translate into unique capabilities that would allow adopters to provide services with distinct advantages. This is illustrated by the examples discussed in Section 5.3.7, sub-theme A: "competitive benefits".

For actors following the holistic approach , networking interventions were oriented to development of a support network like the one available for ICEs, including support for financing and insuring vehicles, managing and leasing fleets, and providing maintenance. This approach was oriented towards distributing the risk and uncertainty associated with EV adoption, and it contributed to eroding the perceived lock-in or incumbent advantage of ICEs. A related observation was that expectation management was important for holistic actors because of the uncertainties regarding policies and markets for EVs in contrast to the stability of the incumbent. This expectation management called for the interpretation of sometimes

ambiguous signals about future regulations, expected resale values and market demand, etc. Expectations (and assumptions) of varying degrees of risk were needed for planning over the vehicle's life. Holistic interventions often were designed to shelter participating organizations from the perceived risks of adoption. Relevant examples can be found in sub-theme F of Section 5.3.7, "Risk Management".

6.2.4 Prevalence of Neoclassical and Holistic perspectives in Milton Keynes

Intentionally, no attempt to provide quantitative information was made in the discussion of the thematic analysis provided in Chapter 5. Quantification is suspect in thematic analysis, as it is not possible to establish rules about the size or prevalence required for a pattern to become a theme. Ideally there will be a number of instances of the theme across the data set, but more instances do not necessarily mean the theme itself is more crucial, and there is no hard-and-fast rule about the proportion of a data set that needs to display evidence of the theme for it to be considered a theme. *"It is not the case that if it was present in 50% of one's data items, it would be a theme, but if it was present only in 47%, then it would not be"* (Clarke & Braun, 2006, p 10).

This section will, however, provide basic and broad, quantitative information regarding the prevalence of Neoclassical and Holistic themes in the discourse of organizational actors in Milton Keynes, with an important qualification: It must be stressed that this information cannot be considered useful in any statistical sense because of the relatively small size of the population under study and the purposive nature of the selection approach. Despite this limitation, approximate quantitative information about the prevalence of the themes can provide insight about the developments observed in Milton Keynes. In particular, this thematic analysis suggests that interventions with a bottom-up design, initiated by organizational actors close to the ground often have a holistic conception, while actors in

national government fund top-down interventions and tend to have a neoclassical, abstract conception of the diffusion of innovations.

The neoclassical perspective was predominant in the analysed policy documents (six of the analysed documents were neoclassical, four were holistic). It was also predominant in the publications aimed at advocates or intervention designers (four of the analysed articles in Local Transport Today were neoclassical, and two holistic. Six articles in Green Fleet were neoclassical, four holistic). The holistic perspective was predominant in the articles in Fleet News, a publication targeting organizational decision makers. 19 of the articles in Fleet News exhibited the holistic pattern, and nine had neoclassical characteristics.

Interviews and original research performed in Milton Keynes contributed to a richer understanding of the divide between Neoclassical and Holistic actors. Because this component of the data set was focused on pioneers and prospective innovators, most of the actors observed and interviewed had a holistic perspective: Out of the 16 interviews conducted for this research only three had a neoclassical perspective, while 13 exhibited holistic features. However, the discourse of many of those predominantly holistic actors reflected a tension between both perspectives.

It must be noted that the differences between neoclassical and holistic actors can be understood as a somewhat polarized continuum rather than a clear divide. Some items in the data set, like those produced by actors from the national government, tended to fall near the neoclassical end of the continuum. Conversely, data items produced by business organizations were closer to the holistic perspective. Other data items of particular analytical interest exhibited both holistic and neoclassical features. Entries related to actors in the local administration conveyed a tension between the two positions, as their perception of the issues was close to that of organizations, but their toolkit (and their actions) had to be in line with

the neoclassical approach favoured by the national government (who largely provided the funding for EV initiatives). This situation is illustrated in Fig. 6.1.
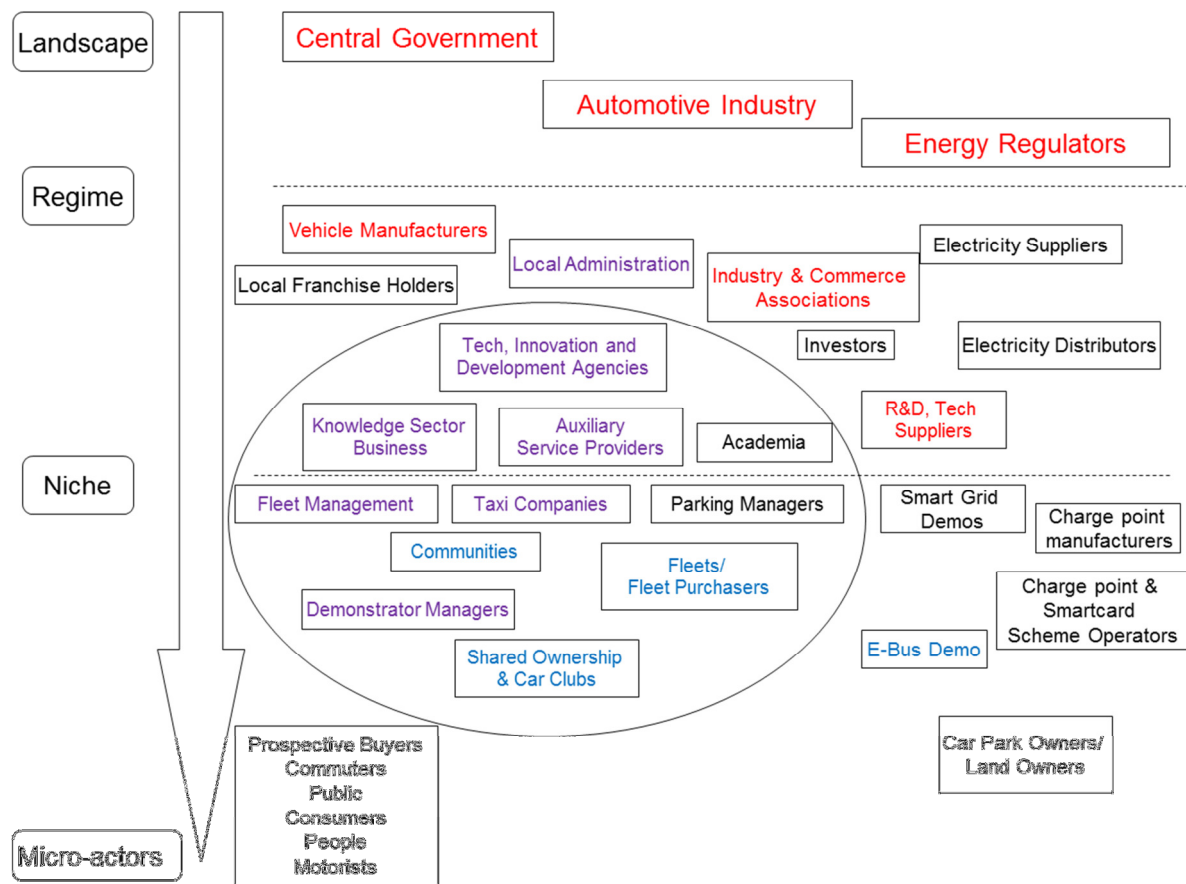
Figure 6.3: Holistic and Neoclassical actor categories in Milton Keynes

| Neoclassical | Holistic | A mixture |

This figure is a development of the diagram first presented in Fig. 4.1, which categorised organizational actors according to their role on the Landscape-Regime-Niche-Micro-actor spectrum. (Actors in the regime are usually associated with the incumbent sociotechnical configuration, while actors in the niche level are engaged in the development of viable configurations around an innovative technology. See Section 3.3 for a discussion of the Multi-Level Perspective of sociotechnical transitions.) Using the original diagram as a guide, data items associated with each actor category were re-examined looking for codes

associated with either the holistic or the neo-classical perspective. Actor categories with a definite neoclassical perspective are highlighted in red, those with a predominantly holistic approach are highlighted in blue, and those that integrate elements of both perspectives are highlighted in violet. Actors for which there is not sufficient data, predominantly those that fall outside the scope of this research, remain in black. Particular attention was dedicated to the classification of actors within the circled portion of the diagram, who were identified as central to the PiP experiment, but there are two groups that could not be readily classified. Parking managers were not found to be sufficiently engaged with the transition, so it was not possible to identify a distinct perspective, while the perspectives of academic actors were found to be too polarized for classification.

This section has started the process of recontextualizing the findings of the analysis reported in Chapter 5. First, it discussed the features of two distinct perspectives that shaped the formation of the early market for EVs in Milton Keynes, contrasting the characteristics of the neoclassical and holistic interventions observed in Milton Keynes. The section also provided some quantitative indicators regarding the prevalence of holistic and neoclassical patterns in the actors interviewed or observed in Milton Keynes. Section 6.3 will continue the process of recontextualization of the analysis. The findings of the research will be linked to the developments that took place in Milton Keynes, using the SNM case study format to discuss the processes that took place in the protective learning space that was created by the Plugged-in Places programme. The case study in Section will illustrate how the resolution of the tension between the neoclassical and the holistic perspectives was crucial for the success of the PiP programme in Milton Keynes.

6.3 MK Plugged-in places – SNM Case Study

This section will provide an overview of the Plugged-in Places Electric Vehicle infrastructure programme that took place in Milton Keynes between 2010 and 2013. Because the programme had the effect of creating an experimental niche, the Strategic Niche Management (SNM) case study format has been used. SNM was discussed in Chapter 3 in considering the method to be adopted for this research. The SNM case study format follows the guidelines developed in Weber et al. (1999) and Hoogma et al. (2002). This format, presented in Table 3.2 in Chapter 3, makes provisions for describing the key structures and processes related to the development of a technological niche. By following this format, this research can benefit from, and contribute to, a growing body of research (Weber et al., 1999; Hoogma et al., 2002; Geels, 2002, and Grin et al., 2010; among others).

The format for the SNM case study was described in Section 3.3.1. The unit of analysis for this format is the "experiment", defined as the open-ended search and learning process taking place within a niche, working towards societal embedding and increased adoption of the new technology (Hoogma et al., 2002, p 4). Each experiment is studied within its context, including regional and national developments, competing technologies, and related experiments. The structure of this section reflects the structure of the SNM case study, with different subsections addressing the following points:

- Setting and Context of the Experiment,

- Objectives and Project Organization,

- Project Management and Relevant Developments,

- Contribution to Learning in the Niche,

- Contribution to Institutional Embedding, and

- Epilogue

Most of the evidence needed to construct the case study has been presented in the previous chapters of this thesis. Chapters 1 and 2 of this thesis (Introduction, Policy Literature) provide information relevant to discussion of the setting, context and organization of the project. Discussion of relevant developments and contributions to learning and embedding is informed by the analysis of documents, interviews and participant observation as presented in Chapter 5 (Data Gathering and Analysis).

6.3.1 Setting and Context of the Experiment

The first stage in SNM analysis is to identify the setting and context of the experiment, which was discussed in depth in Chapter 2. At the beginning of the 21st century the environmental toll of widespread car ownership and use was evident, and there was a growing interest in sustainable transport technologies in developed countries (Bannister, 2005). By 2008, scientific consensus indicated that an 80% reduction in greenhouse gas emissions relative to 1990 was necessary to avoid the worst effects of climate change. Adoption of this target in the UK made radical changes necessary in many fields, including that of transport. The Office for Low Emission Vehicles (OLEV) was formed in 2009 to support the early market for low emission vehicles, including EVs.

At the beginning of the experiment, the only widely available EV was the Reeva/G-Wiz, with yearly sales in the low hundreds (313 units were sold in 2007). However, there were several major manufacturers preparing electric vehicles for the market (See Chapter 1 for a more detailed discussion of the state of technology). Demand for the vehicles was uncertain, and several policy measures were put in place in order to foster adoption of the newly available cars.

36.3.2 Objectives and Project Organization

This section provides a description of the project plan, objectives, the main actors associated with the experiment organization, the choice of location and the main funding sources, complementing the background provided in Section 2.3.

The experiment was funded by the Office for Low Emission Vehicles (OLEV) with two main objectives: to build an early flourishing market for ultra-low carbon vehicles in the UK; and to capture the industrial benefits for the domestic automotive industry and its supply chains (OLEV, 2009). The strategy for achieving those goals closely followed the recommendations of the "*King Review of Low Carbon Cars*" (King 2008, discussed in Section 2.2) and was based on three main instruments:

- Financial incentives for consumers
- Support for research and development
- Infrastructure provision

The priorities defined in the King Review are eminently neoclassical, as they assume a rational decision-making process based on calculations about cost and performance. The neoclassical priorities are reflected in the £400m initial budget for the OLEV, which was assigned as follows:

- £300m for Consumer Incentives (the Plug-in Car and Van Grants, which subsidized the cost of eligible cars by 25% up to a maximum of £5,000 for both private and business buyers);

- £82m for research channelled through the Technology Strategy Board, and

- £30m for infrastructure deployment (the Plugged-In Places programme which is the main subject of this case study).

While the consumer incentives and the research programme were applied at a national level, it was decided that infrastructure deployment would be concentrated in selected areas, providing a critical mass of infrastructure in a number of lead cities or regions. Interested consortia were invited to apply for participation in the Plugged-in Places programme. Provision of infrastructure was expected to address "range anxiety"[9], increasing adoption of EVs in participating regions. Additionally, it was expected that these independently-run regional deployments would generate a body of knowledge that could be useful for future development of a national network of recharging infrastructure.

Milton Keynes, the focus of this research, was one of the eight regions selected for participation in the Plugged-in Places programme. Its implementation was led by the local authority, Milton Keynes Council, in collaboration with local business organizations and academic institutions. The ELVIS, (Electric Vehicle InfraStructure) consortium prepared a detailed, 27-page bid (Constantinides, 2009) following the format outlined in "*Plugged-in Places: The Electric Vehicle Charging Infrastructure Framework Application Form*"(OLEV, 2009). The consortium requested £2.2 million in matched funding (out of a total project cost of £4.9m) to be applied towards the following objectives:

- Exploring the relationship between electric vehicle use and other aspects of low-carbon living;

- Building local, regional and national market for electric vehicles; and

- Identifying, through practical use, factors that help or hinder the introduction of available technologies.

(Constantinides, 2009)

---

[9] Anxiety experienced by EV drivers concerned about the possibility of becoming stranded with a discharged battery in a limited range vehicle (Tate et al., 2008).

These goals seem to reflect a holistic perspective, which acknowledges that adoption depends of multiple complex dimensions that are not captured by simple indicators like cost and technical performance. The key performance indicators for the project, however, did not reflect such a viewpoint. The PiP application submitted by the Milton Keynes team states that only three performance indicators were to be used to measure progress, learn, and improve performance. Those indicators were as follows:

- Number of charge points installed against delivery plans,

- Operational availability of installed charge points, and

- Driver utilisation of charge points (ibid).

This contrast between holistic ends and neo-classical means begins to suggest a tension that was resolved in the later stages of the PiP programme in Milton Keynes.

6.3.3 Project Management and Relevant Developments

This section of the case study provides a discussion of relevant developments in the experiment and project management, including whether the goals were formally achieved, the major difficulties encountered, how the experiment was overseen, and its outcomes communicated to external constituencies.

As indicated in Section 6.3.2, the limited scope of the key performance indicators applied to the project can be seen as one source for tension between neoclassical and holistic perspectives in Milton Keynes. The holistic side of this disjunctive is represented by the original proposal by the ELVIS consortium, which considered nine separate work streams (Constantinides, 2009, p 3):

- Infrastructure,

- Vehicle supply,

- Commercial and private use,

- Public sector and taxi use,

- Public transport,

- Shared ownership,

- Public engagement and education,

- Higher education and skills,

- and Strategy, policy and economics

This mix indicates that project managers had intended to pursue a multi-dimensional, holistic approach, but most of the proposed work streams were taken out of the project shortly after activities were initiated in 2011. Activities that were not directly related to the deployment of infrastructure were ineligible for PiP funding. The local government found mechanisms for implementing their original vision with the support of non-governmental partners (to be discussed in Sections 6.3.4 and 6.3.5) but this was not considered part of the official PiP programme. If the key performance indicators from Constantinides (2009) are used to evaluate the developments that took place in Milton Keynes, the PiP programme had mixed success. From this neoclassical perspective implied by the KPIs, the programme was deployed efficiently but its effect on the market for EVs appeared to be limited.

The first charging points installed under the PiP programme in Milton Keynes were switched on in March 2011. Arup, a consultancy that worked with Milton Keynes from the formal bid stage, was responsible for procuring and installing charging

Figure 6.4: The first EV charging point in Milton Keynes.
The point was installed for the Nissan leaf launch in Central Milton Keynes in March 2011

infrastructure over a three year period (Armitage, 2011). During the three years spanned by the PiP programme, 170 charging points were installed across the borough. However, the deployment of infrastructure did not appear to contribute to encouraging sales of EVs. Adoption was low locally and nationally. For the UK as a whole, in 2011 1,052 vehicles eligible for the Plugged-in grant were registered and 1,383 in 2012. In Milton Keynes, 123 vehicles eligible for the Plugged-in grant were registered between 2010 and 2013. Relative to the 2.2 million new cars bought annually in the UK (SMMT, 2013), sales of electric vehicles were insufficient to justify the £5.6 billion invested by the industry during that period, or to achieve the carbon reduction goals of the programme.

Utilization of charging points was low for the duration of the programme, with reports indicating that some of the charging points were not used at all. In the 524 days between 26/04/2011 and 30/09/2012, 393 charging events were recorded in the 19 charge points being monitored in Milton Keynes (OLEV 2013c). Utilization rates were also low on a national level. In the UK a total of 988 charge points were monitored across the 8 PiP regions between August 2010 and December 2012, and a total of 39,525 events were recorded (ibid). Low utilization of the charging points produced a negative press, with articles like "*Councils spend £1,750 per car on charging points*" (BBC News, Aug 2013) or "*Electric car farce as councils spend £7.2m on charging points that are never used*" (Daily Mail, Aug 2013). National sponsors of the programme appeared to be alarmed by the development:

> *We have spent tens of millions of pounds on a national network of recharging facilities, which are not interoperable and which face private competition, which are arguably more attractive to some people. How can we say that this is a sensible and good use of public money when customers do not seem to want to purchase the goods? Are the customers wrong?...It does seem to have been, as an example of Government spending-what is the polite term for it?-an*

absolute fiasco, particularly given that, parallel to that, the private sector has shown an ability to provide the plug-in points where people want to use them and need them. (Paul Maynard, member of the Transport Committee, in Transport Committee 2013, p 2 of oral evidence appendix)

Participant observation from Milton Keynes and documentary evidence from other PiP locations indicates that low utilization was anticipated by programme managers (indeed, the point of the programme was to provide infrastructure in advance of demand to break out of the chicken and egg conundrum):

There is a chicken and egg situation with electric vehicles. You either have to provide an infrastructure for people to buy cars and use them or allow people to buy cars worrying that there is no infrastructure. It will be wrong whichever way you do it. The solution that we have chosen is to build an infrastructure ready for the cars...The one thing that we have done is tackle all the problems involved in doing that so that, as the commercial sector comes in, we are talking about an industry that understands how to do it. Previously, if we had electric vehicles, we would be struggling with those issues. We have brought those issues to the fore in order to tackle them and share with Government how to do it and how to help local authorities as well. (Dr. Keith Bevis, advisor to PiP programme, in Transport Committee 2013, p 2 of oral evidence appendix)

In the case of Milton Keynes, there was no negative coverage in the local press. Observations from participant observation and documentary sources indicate that the public image issues produced by low utilization of EV charging points had been anticipated and managed by the local authorities, balancing the needs of EV users with those of users of conventional vehicles. For example, parking spaces associated with EV charging points

operated as dual use facility whereby they were reserved for EV's between 7am and 10am and 4pm and 6pm, but could be used by ICE's during the key busy shopping hours of 10am – 4pm. This arrangement was expected to encourage the use of EVs for commuters who otherwise would be unable to commit to daily long-distance trips, but would prevent the potential backlash that would be caused by empty parking spots in premium locations.

Councillor Sarah Bailey declared in a discussion with EV users

This dual use restriction was created in the early days of the scheme (2010) when there weren't that many EV's on the roads and we wanted to prevent criticism that we had reserved loads of spaces (in prime locations as this was a requirement of the grant) that sat empty all day (due to lack of EV's). It was always envisaged that as EV usage grew, we would increase the number of spaces available only to EV's (Bailey, 2014).

The arrangement was reviewed as utilization of the charging infrastructure increased, the arrangement was reviewed. By March 2014, 14 of the 170 EV spaces in the city were reserved solely for EVs at all times and there were plans to increase the number of exclusive spaces to 64.

Starting April 2014, ownership and management of the charging points installed under the PiP programme were transferred to Chargemaster, a private business. A pay-as-you-go scheme took effect on the same date, with charges of £1 per hour for slow charge points and £2 per hour for fast points (Milton Keynes Council, 2014). This step, which in SNM perspective could be considered a withdrawal of protection, produced an immediate decrease in charge point utilization according to information released by Chargemaster (SpeakEV, 2014).
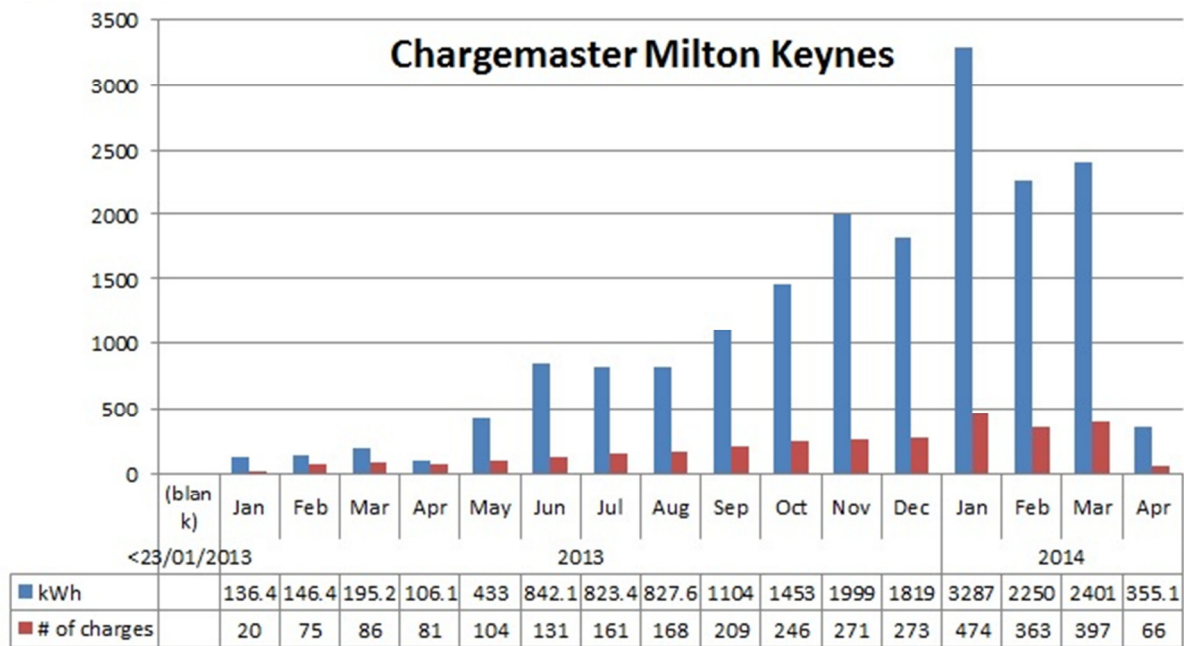
Figure 6.5 – Charging events registered in Milton Keynes before and after conclusion of the PiP programme (SpeakEV, 2014).

It must be emphasized, however, that the official, neoclassical conception of PiP in terms of installed points and charging events fails to capture important processes that were fostered by the programme. The local administration found mechanisms for implementing the engagement, networking and learning aspects of their original vision through alternative mechanisms that were not constrained by the requirements of OLEV's funding criteria. In particular, private partners were empowered to contribute to the learning and embedding processes that will be discussed in sections 6.3.4 and 6.3.5, creating conditions where profitable, scalable business models for EV use could be co-constructed.

6.3.4 Contributions to Learning in the Niche

Hoogma et al. (2002) suggest that the success of early niche development can be evaluated in terms of two measures: Quality of learning and quality of institutional embedding. This section will concentrate on the first point, discussing the learning processes fostered by the PiP programme in Milton Keynes. (Institutional embedding is addressed in Section 6.3.5.) For the purposes of the SNM case study, learning is broadly defined as a range

236

of processes through which actors articulate [10] relevant technology, market, and other properties. Articulation, the collaborative discovery of latent user needs that are not served by existing products and services is crucial for the success of innovative sociotechnical systems. Most users of technology-based products or services have limited technological knowledge, they are often unable to foresee (and/or articulate) their ideas about innovative applications that would create value for them (Kristensson et al., 2008). This learning process is multidimensional, and concerns a number of aspects: technical development and infrastructure, development of user context, societal and environmental impact, industrial development, government policy and regulatory framework. SNM seeks to encourage actors within the niche to go beyond improvements to the existing design. Radically new configurations can be created by questioning and exploring the established assumptions about technology, regulations and user demands (Hoogma et al., 2002).

As discussed in Sections 2.2 and 2.3, PiP took place in the context of a national promotion of more sustainable forms of transport. As part of this exploration of EVs in the UK, some interventions centred on learning took place on a national level, through organizations like the Knowledge Transfer Networks and the EST's "Plugged-in Fleets" initiative (Section 2.2.1). The Plugged-in Places programme was different in that it was implemented and managed by local actors in a limited number of selected regions, but it was designed to produce knowledge relevant on a national scale. In particular, PiP was intended to draw lessons applicable to the future development of a national network of charging points (OLEV, 2011). Additionally, programme managers sought to generate knowledge relevant to the specific needs of the public and industry in their respective locations.

---

[10] Articulation is the process of transforming tacit knowledge into explicit knowledge. Articulation of demand is an iterative, inherently creative process in which stakeholders try to unravel preferences for and address what they perceive as important characteristics of an emerging innovation (Boon et al., 2008).

In the case of the PiP implementation in Milton Keynes, the Public Engagement and Research (PEAR) group was tasked with information dissemination, public education, profile raising, stakeholder engagement and influencing and policy shaping, as well as monitoring and adapting to changing knowledge and attitudes. This engagement was meant to contribute to network-building (to be discussed in Section 6.3.5), but was also meant to initiate a dialogue with the public and with businesses in Milton Keynes and beyond. This dialogue was to seek an understanding of audiences, behaviours, influences and barriers (Wood, 2010). However, as discussed in theme J of section 5.3.3 (unusual suspects), the Government grant was structured in such a way that the funds could only be spent on infrastructure. Because engagement and research initiatives could not be directly funded by PiP, Milton Keynes Council worked around the restriction by providing an environment where others actors, particularly those in private organizations, could support the processes of learning and engagement. Examples include consulting organizations like Arup, community organizers like the Wolverton Steering group, and academic partners like The Open University or the University Campus Milton Keynes (UCMK).

As a result of this tension between national and local conceptions of innovation, it is possible to identify three distinct kinds of knowledge that were produced as a result of the PiP programme in Milton Keynes, with different sets of actors undergoing distinct learning processes. This can be summarized as follows:

On the national level, learning processes related to the PiP programme were narrowly limited to the management of infrastructure. Local administrators in Milton Keynes drew lessons about the management of experimental spaces for the development of innovations. Those lessons were applied in a series of experimental spaces for sustainable innovation that were created in the city after the conclusion of the PiP programme (to be discussed in Section 7.5). A further layer of learning of particular relevance to this thesis was captured by private

organizational actors, who used the experimental space afforded by Milton Keynes to produce knowledge related to the development of competitive operational and business models around innovative technologies.

While consumer-level engagement and knowledge generation falls outside of the scope of this thesis, it is worth mentioning that home users of EVs in the UK self-organized and shared knowledge through online venues (e.g., personal blogs, or forums like speakev.com or leaftalk.co.uk). Pioneering adopters used those venues to contribute their personal experiences into a pool of knowledge regarding, for example, discussing the location of EV-friendly hotels or the pros and cons of different home charger models. Local authorities and EV-related business organizations in Milton Keynes also benefited from the presence of those online mechanisms, as they were made aware of the concerns of consumers and provided answers for their questions regarding EV policy.

The different layers of knowledge that were captured as a result of the PiP experiment (national, local and organizational) will be discussed in the following subsections, labelled A, B and C.

A-   Lessons from Milton Keynes PiP captured by national actors

From the perspective of the project sponsors (OLEV, DfT), PiP was a single-purpose experiment. It was designed to provide an environment for learning about the challenges and implications of infrastructure deployment in anticipation of the deployment of a national network (OLEV, 2011). Learning on the national level was narrowly limited to the management of infrastructure, as evidenced by documents produced after conclusion of the programme: "*Lessons Learnt from the Plugged in Places*" (OLEV, 2013a) and "*Driving the Future Today*" (OLEV, 2013b). Both of these documents will be discussed in the epilogue of this case study in Section 6.3.6. Lessons learnt on this level also included user needs as

directly related to infrastructure, and user's response to it, but some actors in national government objected to this layer of non-technical knowledge generation as exemplified in the exchange between MP Paul Maynard and Under secretary of Transport Norman Baker transcribed below:

> *Paul Maynard: As our witness from the east of England made clear, in his view it was a learning curve. They have discovered, for example, that more people want home charging than public charging locations... Do you not think it might have been better to have tried to establish some of these fairly fundamental issues before we embarked on the project, rather than spending the money to learn what was happening?*

> *Norman Baker: I do not think it was possible to find out exactly what was happening until we tried it. There is only so much you can do on paper on a theoretical basis. How the public will react to a particular technology is difficult to predict, as lots of manufacturers in different industries will tell you* (Transport Committee 2013, p 16).

This knowledge was made publicly available with the expectation that it would "de-risk" subsequent private sector involvement with infrastructure provision. In addition to solving the "chicken and egg" problem the PiP programme was expected to identify and solve the teething pains associated with the adoption of untested technologies, as the example below illustrates:

> *The one thing that we have done is tackle all the problems involved in doing that [deployment of charging points] so that, as the commercial sector comes in, we are talking about an industry that understands how to do it.* (Dr

Keith Bevis, advisor to PiP programme, in Transport Committee, 2013, pp 2 of

oral evidence appendix)

B-   Lessons from Milton Keynes PiP captured by Local Actors

As previously stated, the Government grant that funded the PiP programme was structured in such a way that the funds could only be spent on infrastructure. Actors in the local administration, however, saw engagement and research as crucial elements for the success of the programme, and funding restrictions had the potential to lead to a missed opportunity. Milton Keynes Council worked around the restrictions by providing an environment where other ELVIS partners could act as enablers, and by providing compelling value propositions for private organizations supporting activities conductive to learning and engagement.

The Open University, as a partner to the PiP programme in Milton Keynes, was able to provide support to the learning process in the form of the Business User Workshops discussed in Sections 4.8.3 and 5.2.2. Minutes from, together with the researcher's participation in these workshops, suggests that they produced several lessons of relevance to local actors. This included an awareness of importance of supporting the development of compelling business cases rather than relying on environmental consciousness or social responsibility alone. The workshops also drew attention to the importance of understanding the organizational structure of prospective adopters, as organizational adoption of EVs was sometimes delayed because the incentives of actors in different decision-making silos within the organization were misaligned. In aggregate, lessons from the workshops suggested that the organizational market could be better supported through enabling and empowering actions rather than through funding or regulation.

In addition to the knowledge about user needs that was captured through the workshops, Local administrators in Milton Keynes learned by doing, drawing lessons about the management of experimental spaces for the development of innovations, applied in experimental spaces for sustainable innovation that were created in the city after the conclusion of the PiP programme. The approach based on engagement and learning through empowered local actors, which was implemented out of necessity in the PiP programme, was reproduced out of choice in other components of the Low Carbon Living programme. The enabling and empowering principles that emerged through the workshops and through the management of the PiP programme were present in further low-carbon initiatives by Milton Keynes, with enabling strategies explicitly integrated into "*Future-Ready MK*" (Snelson, 2012) and the feasibility studies of the "*Future Cities Demonstrator Competition*" (TSB, 2013, pp 46-47) which would shape the successful bid for the £16 million MK:Smart project in 2014). As a result of their experience in running city-wide experimental spaces, local authorities learned how to "*establish an open innovation environment in which communities and businesses can devise their own services and solutions* (Snelson, 2012, p 4)"

C - Lessons from Milton Keynes PiP captured by Organizational Actors

Business user workshops and the interviews conducted for this research indicate that, from the perspective of private actors, the PiP as implemented in Milton Keynes effectively created a suitable environment where organizations could develop their own private pilots, testing new business and operational models suited to the characteristics of the new technology.

It is of note that the knowledge generated on this level was not captured by the niche managers, but by organizational actors that had been protected and enabled within the niche.

In many of the cases observed in this research the knowledge thus generated had a positive effect that extended (geographically and temporally) well beyond the niche.

Some of the lessons learned by organizational actors were related to optimization of existing applications. However, organizational learning that resulted in the development of new competitive business models was more relevant to this SNM case study, because such learning produced dynamics of niche proliferation that matched the patterns described in the literature. In a manner consistent with the models of SNM (Section 3.3), and evolutionary economics (Section 3.2.3), profitable applications were identified for an innovative technology that was originally perceived as uncompetitive, and those applications were replicated outside of the original niche. Because several organizations developed distinct applications for EVs, the experimental space provided by PiP had the effect of fostering the development of multiple experimental configurations or business models (the examples observed in Milton Kenyes include novel schemes for financing electric taxicab fleets, novel approaches for community engagement and crowdsourced financing of electric car clubs, a re-examination of cost modelling and employee compensation arrangements for fostering the adoption of electric company cars, the leveraging of EV expertise to gain access to large corporate customers for a fleet management organization, and the design of an enabling organization for sharing the risk during the deployment of electric buses). Developments in Milton Keynes agree with recent SNM work, which has changed the focus from individual to multiple experiments, so that the simultaneous experiments can build on each other over time through a social learning process (Hoogma, 2002; Raven et al., 2010). In this case, the protected/empowering space afforded by Milton Keynes allowed trials of different business models and conceptions of mobility.

The evidence discussed in Chapter 5 (for example, theme H (learning) of Section 5.3.3, and examples in Section 5.3.3 (holistic learning)) already suggested that second-order

learning[11] had potential for developing competitive advantages. However, given the long timescales involved in niche processes, those dynamics had not developed in full at the time of the conclusion of the experiment. Recent developments that illustrate the contributions of niche learning and embedding to niche proliferation will be discussed in section 7.5.

6.3.5 Contribution to Institutional Embedding in the Niche

As discussed in Section 6.3.4, the success of early niche development can be evaluated in terms of two measures: quality of learning and quality of institutional embedding (Hoogma et al., 2002). This section will discuss the processes of embedding that took place in the experimental niche provided by the PiP programme in Milton Keynes. Institutional embedding can be defined as change in the selection environment for the innovation that creates the possibility of changing the regime. This change consists of interrelated developments in complementary technologies, shared visions and inclusion of a broad array of aligned actors (ibid).The process of institutional embedding is fostered through a simultaneous striving to build a support network for innovation and to promote changes in the environment to facilitate innovation diffusion, adding momentum to the introduction and diffusion of sustainable solutions (Elzen et al 2004, p 226)

Before discussing embedding processes fostered by the PiP programme, it is necessary to discuss national developments affecting the embedding processes that took place within the niche. On a national level, EV-related network building activities were centred on the needs of the supply chain. Different departments operating on a national scale provided funding for networking groups and events intended to stimulate technical innovation, transfer

---

[11] First order learning refers to learning that corrects errors or maximizes performance within the framework provided by existing goals, values, plans and rules. Second order learning involves questioning the role of the framing and learning systems which underlie actual goals and strategies.

knowledge from research centres to the industry, and integrate technology providers into the supply chain. (For example, see Section 2.2.1 for more information on the Knowledge Transfer Networks, CENEX and the LowCVP.)

Visioning is also a component of embedding, as shared visions facilitate coordinated action (Weber, 2003). The development of positive, shared visions within Milton Keynes was dampened by mixed signals in national policy which cast doubt on the long-term commitment of policy actors, owing in part to differences in planning horizons. Organizational decision makers had planning horizons of 7 to 10 years and could not rely on policies subject to short term review such as purchase subsidies and tax incentives. The March 2012 Budget provides an example of this, as the Benefit-in-Kind band for zero emission (electric) cars went from 0% to 13%. This was met with expressions of disappointment by the Transport Committee, as the measure reduced the attractiveness of plug-in vehicles to the corporate consumer with little overall benefit to the Exchequer. The disappointment was echoed by industry representatives. The Society of Motor Manufacturers and Traders (SMMT) stated that "*such unexpected announcements cause instability in the fleet market and provide mixed messages on market support*". Toyota was "surprised" by the announcement and said it "*may cause instability in the fleet market and send a mixed message*" (Transport Committee, 2012, p 10). Interviews and participant observation in Milton Keynes confirmed this, as fleet managers had been "burned" before when protection measures were withdrawn after they had invested in cleaner fuels such as LPG. (See example 2 for theme E, "protective intervention", in Section 5.3.3.)

National policy also affected local interventions in support of the institutional embedding of EVs because of funding restrictions, similar to those discussed in Section 6.3.4. PiP funding was only available for one of the multiple work streams required for institutional embedding, namely, that of deploying infrastructure. This arrangement limited the ability of

PiP managers in local government to directly support visioning and networking activities. As was the case with learning processes, Milton Keynes council worked around the restriction by providing an environment where others enablers, partners and private organizations could support engagement processes. (See Section 5.5.1, "holistic visioning and expectation management", and example 2 for theme D, "engagement and intervention approaches" in Section 5.3.3. This is also exemplified by developments that took place after the conclusion of the experiment and that will be discussed in Section 7.5, with the joint venture Mitsui-Arup and the informal "Future Wolverton" group playing an enabling role.)

The inclusion of private actors as agents of engagement is also exemplified by the infrastructure deployment funded by PiP, which contributed to the institutional embedding through several mechanisms. The most obvious contribution, and the one intended by the project sponsors, was the creation of a complementary infrastructure base. Local authorities managed the deployment in a way that contributed to the creation of a wider constituency supporting EVs, building links that reached beyond the original niche. Charging points were procured and deployed by a private actor (ARUP) and manufactured by another (Chargemaster), and those private actors remained involved after the end of the programme and contributed to developing further elements of low carbon living.

Management of the infrastructure was also linked to similar initiatives in other cities with the aim of providing a compatible network of charging points on a national level. During the programme charging infrastructure in Milton Keynes became linked to the Electric Highway and the POLAR network. The Electric Highway programme provided rapid charging capabilities in selected locations along the M1 corridor to enable cross-country travel. Milton Keynes joined the scheme in 2013, linking the city to the larger EV infrastructure network on a national level. Conventional chargers were linked to a national system in April 2014 when Milton Keynes transferred the management of its charging points

to the POLAR network, linking the charging points to a national membership scheme allowing users to access a public network of over 4000 charging points across the UK.

In addition to the embedding processes fostered through empowerment of private actors and through the creation of an infrastructure base, project managers leveraged institutional embedding by making the PiP programme part of a larger, compelling vision for the city. In the words of Councillor Sara Bailey, "The Milton Keynes PiP scheme is part of a low carbon transport initiative within the Borough, which in turn supports the Council's broader low carbon living agenda" (Bailey, 2013).

Integration of EVs with larger low carbon living agenda created a network of constituents in Council, business and academia which would sustain the processes initiated by the experiment after the original project had concluded, taking them beyond the original narrow definition and making it part of a larger push for sustainability and competitiveness. This is best illustrated by the integration of electric cars, electric buses and their required charging infrastructure within the vision for Milton Keynes as a future city (Fig 6.6). Local authorities demonstrated a clear awareness of the importance of integration and engagement (and therefore, embedding) for achieving this vision:

> *As a new and growing city Milton Keynes will integrate its city-wide systems to maximise enterprise and job growth, business innovation, research and technology development. That integration includes community engagement, energy, health and wellbeing, housing, infrastructure planning and regeneration, transport, waste management, the connected digital economy, education, and e-governance. It is only with a smart and holistic approach can MK meet its ambitions to grow the city and its economy rapidly while remaining sustainable and reducing environmental impact* (Snelson, 2012, p 17).
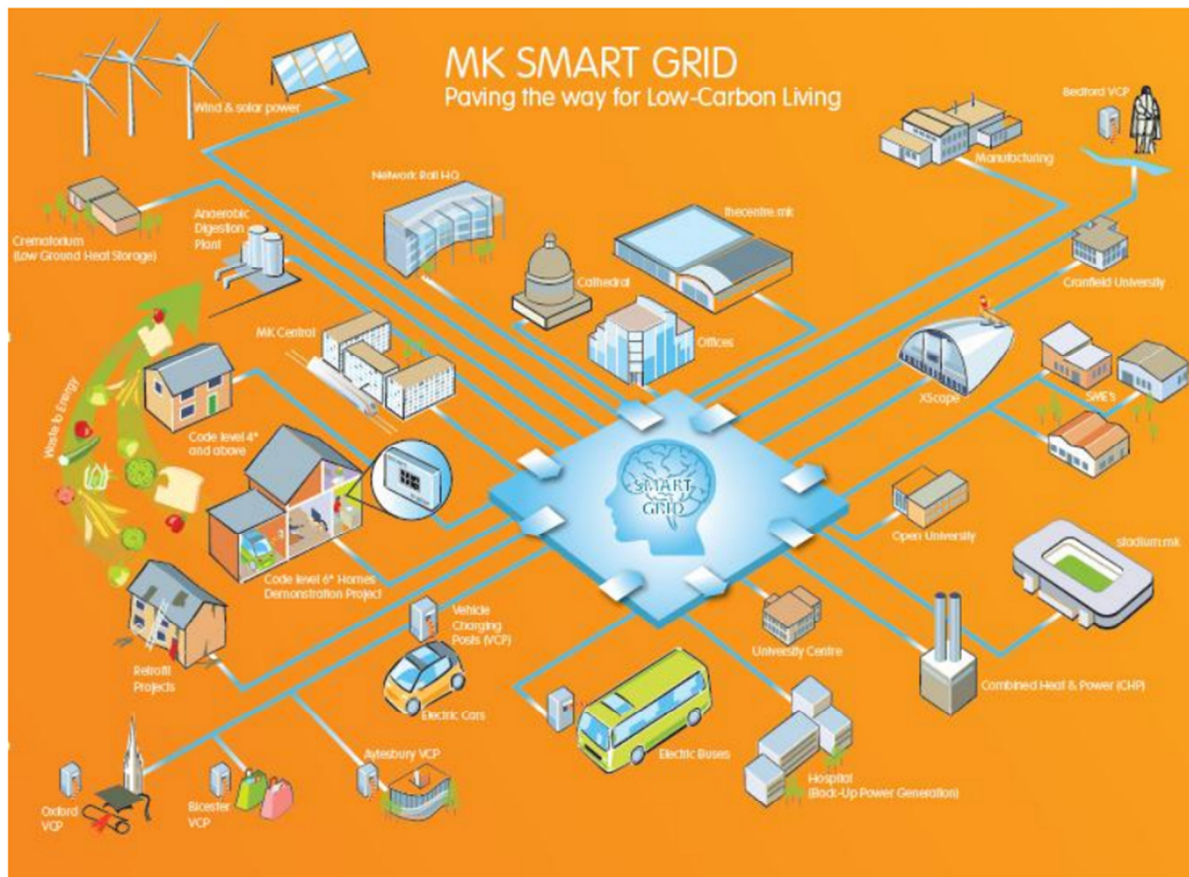
Figure 6.6- Embedding of EVs within a larger vision for MK Smart (Snelson, 2012, p 17).

As a result of activities, the selection environment was effectively changed, creating momentum that contributed to the continuing development of innovative and competitive applications for EVs beyond the duration of PiP. There was a broad network of actors interested in supporting the development of applications and markets for EVs, as business actors saw the possibility of developing unique and competitive business models, while the local administration saw the possibility of creating a compelling vision that contributed to the brand of the city. The immediate results of this change in the selection environment are discussed in the epilogue of this case study (Section 6.3.6), and further developments will be discussed in Section 7.5.

6.3.6 Epilogue

Deployment of PiP infrastructure was planned to proceed in three stages, with each stage benefiting from the lessons learned in the previous one and the advances in technology. Stage 3 reached its conclusion at the end of 2013. A total of 170 charging points were installed over three years (and over 5,500 charging points were installed nationwide as result of the PiP programme). After the conclusion of the programme, Milton Keynes Council installed 50 additional fast charging points, and management of the operation was transferred to a private organization, Chargemaster, on April 1st, 2014.

For most of the duration of the project utilization of the charging points was low. As discussed in Section 6.3.3, only 393 charging events were recorded in the 19 charge points being monitored in Milton Keynes in the 524 days between 26/04/2011 and 30/09/2012 (OLEV 2013c). More recent figures (Fig 6.5) indicate that utilization grew gradually after that, reaching a peak of 474 charging events in January 2014. Utilization appears to have undergone a sharp decrease after ownership was transferred to private business and a "pay as you go" scheme was put in place in Apr 2014, but the long term effect of that development remains to be seen.

As the scheme was nearing its conclusion, it was reviewed by national government. The proceedings of the review (discussed in Section 2.2) were published in a report by the parliamentary Transport Committee (2012). Because utilization of the charge points remained low, results of the programme were perceived to be mixed at best, with the consumer demand for vehicles (1,052 eligible vehicles registered in 2011) being considered disproportionately small relative to the size of the investment (£400 million from OLEV's budget, and £5.6 billion invested by the industry in the 18 months preceding publication of the report). Sales are improving gradually, with the latest figures revealing that there have been 9,606 eligible

cars registered since the launch of the Plug-In Car Grant in January 2011 (SMMT, 2014). This increased figure still represents a small fraction of the total 2,264,737 cars registered in the UK (SMMT, 2013).

Conclusion of the PiP programme was followed by the publication of reports drawing on the experiences of all the participating cities and regions. Documentary evidence suggests that limited learning was captured by the organizations responsible for the project on a national level. Learning was narrowly focused on installing and managing charging points, with no strategic perspective regarding needs of users or lessons for facilitating adoption of EVs. Niche managers learned how to deploy infrastructure and manage the administrative back end efficiently (OLEV, 2013), but learning points regarding future mobility, user needs or transition strategies were not generated or captured by the OLEV. During a parliamentary review on the subject, under-secretary of transport Norman Baker stated that understanding the demand side and monitoring people's change in behaviour is a job for motor manufacturers rather than for the government, as "*It is in their interest to sell more vehicles and it is in their interest therefore to understand who is buying them, who is likely to buy them and where they should aim their market*"(Transport Committee, 2012).

Research of the case of PiP in Milton Keynes provided multiple opportunities to observe the tension between neoclassical and holistic perspectives. This tension was also observed in evidence related to the national level. This can be exemplified by two contrasting reports that reflect on the lessons from the PiP programme. One of them, "*Lessons Learnt from the Plugged in Places*" (OLEV 2013a), distilled the in order to provide guidance to organizations considering the installation a plug-in vehicle charging infrastructure scheme. The lessons addressed in this document are operational and managerial in nature, covering ownership and operation schemes, payment models, procurement, funding and interoperability considerations.

This document is representative of what SNM would classify as "first order learning" (see Section 3.2). It looks for ways of improving the performance of the model as it is, but does not challenge any of its initial assumptions, and does not explore the role of the experiment within the large scale socio-technical change. The document provides instructions for replicating the programme efficiently, but it does not question the usefulness of replicating it and does not reflect on its strategic implications.

The strategic questions were addressed by a document published later the same year, "*Driving the Future Today*" (OLEV 2013b). This document reviewed the strategy first outlined in "*Making the Connection*" (OLEV 2011) in light of the experiences of the PiP regions. Two sections of "Driving the Future Today" of particular interest for this case study are its summary of the lessons learned, and its vision for the way forward.

The lessons learned had what could be considered a holistic perspective. The review concluded that the real success of the programme was in providing the platform for private sector organisations to enter the market. "*We are committed to supporting the development of a flourishing market for ULEVs in the UK...Ultimately, the mass market transition to ULEVs will happen through industry developing and bringing products to market, and consumers deciding which products they wish to buy*" (OLEV, 2013b, p 7). The document also reported that willingness of fleets to embrace the technology depended on the availability of sufficient, inaccurate information demonstrating the benefits and the cost effectiveness of low-emission vehicles.

In contrast, the proposed future strategy for the OLEV states that the existing (eminently neo-classical) policy portfolio was broadly the right one, and suggests a very narrow conception of the market. The focus on the supply chain and on the use of regulation is explicit in the overarching principles of the strategy and in the associated workstreams. In particular,

Workstream 1(Supporting the early market) is based on provision of grants, collaboration with major manufacturers, and communication campaigns designed to raise awareness. The other workstreams are even more industry-centric, as they address infrastructure, regulatory and fiscal measures, automotive capability and energy provision. The strategy does not make provisions for running more niche experiments like the PiP programme.

6.4 Summary

The first section of this chapter reported the results of the thematic analysis documented in Chapter 5. The themes in the original analysis suggested that developments within the experimental space created in Milton Keynes were shaped by the perspectives of the actors that created the space or operated within it. The evidence suggested that the experiment in Milton Keynes gave rise to a tension between two contrasting perspectives, labelled "neoclassical" and "holistic".

The neoclassical perspective has many features in common with the linear model of innovation. Technology developers are assumed to be the source of innovation, driven (or rather, pulled) by the demand for components by major manufacturers who in turn make products available to consumers. Consumers are assumed to make rational choices based on straightforward cost-benefit calculations. In contrast to the neoclassical perspective, the holistic perspective conceptualizes the creation (or rather, co-creation) of the market for EVs as a multidimensional phenomenon involving a very diverse set of actors. Instead of a definite dichotomy separating supply-side actors from the demand side, the holistic perspective sees a fuzzy interface layer where innovative patterns of production and consumption can be created.

The second half of this chapter used the SNM case study format to reconnect the findings of the thematic analysis to their context in Milton Keynes. By using this case study format, attention was drawn to the niche processes that took place within the experimental

space created by the PiP programme. Looking at the developments in Milton Keynes through the lens of the themes identified in Chapter 5 provided insights about the holistic perspective implicit in the strategies of successful organizational adopters.

Contrary to what the KPIs used in Milton Keynes would suggest (Section 6.3.2), the success of strategic niches like the PiP programme cannot be measured as a function of car sales, installed charging points or recorded charging events. Instead, success of an experimental space should be judged by the potential for challenging the regime. In the case of Milton Keynes, the learning and embedding processes described in Sections 6.3.4 and 6.3.5 triggered lasting changes, still ongoing at the conclusion of this research, that suggest that the niche experiment was effective. Within the experimental space provided by the niche several actors succeeded in challenging the dominant conception of mobility, and created new business models that demonstrated their competitiveness and had an impact beyond Milton Keynes. Some of the developments were not immediately obvious at the conclusion of the experiment, but will be discussed in Section 7.5 (Ongoing impact beyond the niche).

Chapter 7 – Discussion and Reflection

7.1 Introduction

This chapter draws on the insights developed through the application of thematic analysis and the SNM framework to reflect back on the original research questions and on the practical and theoretical contributions of this research. The chapter is structured as follows:

Section 7.1 outlines the objectives of the chapter and summarizes its structure. Section 7.2 looks back at the questions that shaped this research project, providing answers supported by thematic analysis in Chapter 5 and the SNM case study in Chapter 6. Section 7.3 addresses the contributions of this thesis, with different sub-sections discussing the contributions of this research to SNM and social marketing, and the contribution that the combined application of both fields can make to innovation and transport policy

Section 7.4 provides a critical reflection and suggests future directions for this research. Because socio-technical transitions can take several decades to develop in full, this thesis can only provide a snapshot of a particular stage of the process, owing to the limitations inherent of a three-year PhD project. This section sheds light on the limitations of this research and suggests promising future directions identified through the research in this thesis. Section 7.5 provides a discussion of recent developments in Milton Keynes that illustrate how holistic support for the development of early market niche processes gave rise to novel business models with an ongoing impact beyond the spatial and temporal boundaries of the experimental niche.

7.2 Reflection on the Research Questions

This section will briefly restate the gap in knowledge that this study set out to explore, as a reminder of the rationale that shaped the research questions.

Socio-technical transitions, like the expected transition towards low-carbon transport, are multi-dimensional, multi-actor transformation processes in which society changes in a fundamental way over a generation or more. Transitions can be also be described as sets of connected changes, which reinforce each other but take place in several different areas, such as technology, the economy, institutions, behaviour, culture, ecology and belief systems (Rotmans et al., 2001). Different social phenomena become more or less relevant for different phases in the transition process This research was centred in the case of the Plugged-in Places programme in Milton Keynes because it was one of the pioneering programmes trying to support the creation of an early-market for EVs produced by major manufacturers, with the expectation that this early-market would develop momentum for the adoption of EVs by mainstream markets. The research setting provided an opportunity to develop insights relevant to an identified gap in the literature of SNM. Because SNM has been predominantly centred on prototype-stage pilots, it is not clear that the key dimensions of the early-market stage have been identified.

This research was guided by two main questions:

- *What dimensions of the niche building process as observed during the early-market introduction of EVs in Milton Keynes are different to those described in the literature of pre-market niches in SNM?(If any)*
- *How should the SNM framework be developed to account for any previously unexplored aspects of early-market niche processes? What are the implications for innovation and transport policy?*

Because of the difficulty of operationalizing the complex concept of "key dimensions", a series of subsidiary questions, more amenable to direct research, were used to

build a case for answering the more complex main questions. The subsidiary questions were as follows:

- *What social, technical and market factors are considered relevant by pioneering and prospective organizational adopters of EVs?*

- *What social, technical and market factors are considered relevant by policy makers (and other intervention designers) supporting EVs?*

- *To what extent are the factors considered relevant by intervention designers reflected in their policy actions?*

- *What are the similarities and differences between the factors addressed by policy and those considered relevant by organizational adopters (who constitute 75% of the early market for EVs)?*

This section addresses the research questions above, discussing the conclusions reached following the thematic analysis and building a case study based on evidence from the policy makers and pioneering organizational adopters who collaborated in the creation of an experimental space in Milton Keynes. The subsidiary questions are answered first, because they can be linked more readily to the findings. These subsidiary questions frame the issue in terms of the factors considered relevant by different subsets of niche actors. As noted in Chapter 5, thematic analysis is effective for identifying the salient concerns of the population under study, reporting the experiences, meanings and the reality of participants, as well as the ways in which events, realities, meanings, experiences and so on are the effects of a range of discourses operating within society (Clarke and Braun, 2006).

A- Subsidiary Questions

What social, technical and market factors are considered relevant by pioneering and prospective organizational adopters of EVs?

In the early stages of the research, the assumption was that pioneering business adopters would have roughly uniform needs, but interviews and participant observation revealed that pioneering and prospective adopters could be broadly classified into two groups according to their perspective (Section 6.2). One of the groups evaluated the vehicles in narrow neoclassical terms. EVs were evaluated on the basis of their cost (either total cost of ownership or, more naively, retail price) and technical specifications. Decision makers belonging to this group found EVs unsuitable, or made token limited adoption for reputational purposes (Section 5.4).

The other group took into account a much wider range of factors. In consequence, their (holistic) decision-making process required more resources. Actors in this group were more likely to adopt, or to give serious consideration to adoption of EVs. Cost and performance were also an issue for them, but in addition to this their decisions were affected by the following interrelated factors (Section 5.5):

- Expectations and risks (e.g. expected long term developments regarding regulatory environment, residual values, future market demand, and future demand for expertise in EV-based products and services) (5.5.1, Holistic visioning and expectations),

- Access to a network of supporting actors (5.5.2, Holistic Network-Building),

- Identification of a potential competitive advantage, often involving a departure from established business and operational models (5.5.3, Holistic Learning),

In consequence, the availability of reliable information was a key issue for this group. The development of suitable models, financial structures and risk assessments was an information-intensive process, but most of the required information was not available initially, was not considered reliable, or could only be acquired through prolonged hands-on experience with the technology that required significant investment (Section 5.3.4, Theme C, "High informational needs").

What social, technical and market factors are considered relevant by policy makers (and other intervention designers) supporting EVs?

The perspective of national policy actors was similar to the group of narrow neoclassical perspective organizational non-adopters. A limited set of key factors was clearly defined in the policy literature (reviewed in Section 2.2). Analysis of King's review (King, 2008) and of the budget for the OLEV suggests that intervention designers assumed that adoption of EVs depended almost exclusively on cost, performance, and availability of recharging infrastructure. Other elements, like technical visioning (roadmaps and standards), regulation and supply chain networking were discussed in policy documents, but their benefits were viewed narrowly in terms of their impact on cost and performance (Section 5.4).

The perspective of local policy actors tended to be more holistic, and closer to that of pioneering adopters. Interventions by policy actors as originally designed made provisions for the identification of suitable applications and the development of suitable models, although implementation of the original designs was sometimes made difficult because of restrictions in funding imposed by the narrow neoclassical perspective of national policy actors (Sections 2.3.2, 6.3.3).

To what extent are the factors considered relevant by intervention designers reflected in their policy actions?

When this question was proposed originally, in section 4.1.2, the researcher had naively assumed that national government and local authorities agreed on the strategy to follow for EV interventions supporting the early market for EVs. Another assumption implicit in the question was that interventions in support of the early market for EVs were predominantly managed by governmental actors. In the course of this research it became clear that national and local policy actors had different perspectives, and that national actors had more power to direct funding towards the areas that they prioritized. In consequence, the national policy portfolio effectively reflected the concerns of national government, while the concerns of local policy actors in Milton Keynes appeared to be at risk of going unaddressed because of funding constraints (Section 6.3.2). However, this research also revealed that intervention design and implementation was not exclusive to policy actors. In the case of Milton Keynes, local authorities resolved the tension between their more holistic perspective and that of national government through partnerships with actors that could act independently from the national government. Private consultants, community organizations and venture investors, amongst others, collaborated in the identification and implementation of suitable, profitable applications for electric vehicles, contributing to the development of an early market for EVs. While those non-policy actors did not have access to the regulatory toolkit available to policy makers, their positions within the industry and the community gave them access to other mechanisms for supporting engagement, network building, risk management, and knowledge co-creation (discussed predominantly in Sections 6.3.4 and 6.3.5).

What are the similarities and differences between the factors addressed by policy and those considered relevant by organizational adopters (who constitute 75% of the early market for EVs)?

As reported in the preceding questions, the thematic analysis documented in Chapter 5 revealed that the issue has complexities that were not initially apparent. Policy actors did not have a unified perspective, and neither did pioneering and prospective organizational adopters. Policy actors on a national level tended to have the perspective that, for the purposes of this research, has been labelled as "neoclassical", and policy actors in local administration tended to have a more holistic perspective.

There was a similar divide in the perspectives of organizational actors, with some of them embracing a neoclassical perspective and others taking a more holistic position. For organizational actors the divide was not attributable to the national or regional scope of their activity (as was the case for policy actors). Instead, observations in Milton Keynes suggest that successful pioneers had a holistic perspective, while organizational actors who found EVs unsuitable or made token limited adoption for reputational purposes were more likely to have a neoclassical position.

For the purposes of this discussion, a pioneering organization is considered successful if it made effective use of the experimental space provided by the niche to identify promising business applications and to develop a definite competitive advantage. From the perspective of evolutionary economics, organizations that develop a competitive advantage are expected to grow, and to give rise to imitators, thus contributing to the diffusion of the innovation.

Keeping in mind the divisions observed in the perspectives of policy makers and pioneering adopters, the question can be answered as follows:

National policy addressed the stated needs of neoclassically minded organizational adopters. Those adopters were pragmatic, and willing to use EVs in their existing operations

if cost and performance were found to be a match for those of ICEs. The subsidies, R&D funding and infrastructure deployment favoured by national policy were intended to make EVs more acceptable to this market, but the magnitude of the effect of these policies was insufficient to change the mind of recalcitrant adopters.

Local policy in Milton Keynes (as originally designed) addressed the needs of holistic organizational adopters. That is, the engagement and research component of the original PiP plan would have facilitated the formation of networks and the production of business know-how required to develop competitive business models. Those elements of the PiP plan in Milton Keynes did not address the needs of recalcitrant actors (and, arguably, were not designed to do so). Instead, they empowered actors that were already predisposed towards adoption, contributing to their success. Holistic interventions were oriented towards ensuring that those early adopters could outperform the competition, often with the explicit objective of setting a positive precedent that would encourage other adopters.

A- Main Questions

Research based on an abductive design does not have a hypothesis, but rather takes an existing framework and forces a confrontation between theory and empirical evidence, which is intended to reveal aspects of the phenomenon under study that cannot be readily made to fit the original frame. The objective is not theory-testing or theory-building, but rather, theory development.

In this case, the dimensions of the niche-building process in the literature of (pre-market) SNM were used to analyse the early-market niche building process taking place in Milton Keynes for the duration of the PiP programme. The original dimensions (from (Schot and Geels, 2008)) are as follows:

- technical aspects and design specifications

- market and user preferences

- cultural and symbolic meaning

- infrastructure and maintenance networks

- industry and production networks

- regulations and government policy

- societal and environmental effects

The concept of "dimensions of socio-technical change" was difficult to operationalize, so this research was designed to identify underdeveloped dimensions in terms of the "key factors" identified in the subsidiary questions. The answers to the main questions are as follows:

- *What dimensions, if any, of the niche building process as observed during the early-market introduction of EVs in Milton Keynes are different to those described in the literature of pre-market niches in SNM?*

The market dimension was underdeveloped in the pre-market framework. This tautological observation must be unpacked, as markets themselves are multidimensional. The following factors are not explicitly addressed by pre-market SNM but were identified as relevant for the construction of an early market for innovations:

- There is limited support for the cognitive dimension of the early market stage. That is, the necessity of co-constructing suitable operational models and business models is not emphasized.

- Related to the previous point, the operational dimension of the innovative technology (fitness for specific purposes) is blackboxed or discussed only in terms of technical aspects.

- Competitiveness is not in terms of one product vs another, but rather in terms of innovative sociotechnical configurations competing for resources against the incumbent. Adopters must be empowered so they can outcompete the incumbents within the selected niches.

The list of relevant dimensions in the literature is written in such a way that it can support a neoclassical conception of niche-building. By listing markets and user preferences one side, and industry and production networks on the other, a neo-classical dichotomy is introduced where the market is seen as a rational collection of producers and buyers. This neglects the role of pioneering organizations that collaborate to develop a business ecosystem, a support network (not necessarily related to the production network) and a variety of innovative business models that make the innovative products and services available to the end user.

- *How should the SNM framework be developed to account for any previously unexplored aspects of early-market niche processes? What are the implications for innovation and transport policy?*

The limitation in traditional SNM that was found to be most problematic in this research was its implied dichotomy between production and demand. It seemed to imply that optimizing supply chain, technology and production was sufficient for addressing production, and that "market preferences" regarding preferred specifications and characteristics of the product are sufficient for addressing demand. This research saw a fuzzy interface where patterns of consumption and production were co-created in the process of developing a

configuration that worked (or, rather, a configuration that worked better than the dominant one).

Because of the role that organizational adopters play in the construction of working configurations, SNM should be developed to understand organizational users and decision makers, and build organizational markets. In the case of EVs, organizational markets are crucial because of the sales volume they represent, but also because organizational users are uniquely positioned support the core niche processes through mechanisms unavailable to governmental actors or to consumers, and because their role as co-creators of the messy interface between supply and demand.

This focus on organizations allows (and requires) an emphasis on empowerment instead of protection. An important observation from the Milton Keynes experience is that innovative organizational actors were not sufficiently incentivized by protection alone. In the perception of some of the actors observed, the fact that protection was needed already implied that the protected product was inferior to the alternative. Additionally, the inherently limited duration of protection measures created uncertainty because organizational actors had longer planning horizons than policy actors.

Empowerment, as defined by Smith and Raven (2012) can be understood as either processes that make niche innovations competitive within unchanged selection environments or as processes that contribute to changes in mainstream selection environments in ways favourable to a path-breaking niche innovation. In the case of Milton Keynes, empowerment was observed to take place through support for the identification and co-creation of effective applications for the innovative technology, leading to the development of unique competitive advantages. This support was not of a financial nature, but was rather centred on networking

and in providing a supportive environment for experimentation and for the sharing of knowledge.

Empowerment, as observed in Milton Keynes, gave a prominent role to community organizations, knowledge businesses and business actors. Competitive business applications cannot be designed by policy, and it may be argued that it is not the role of government, or of SNM managers, to interfere in business. Rather, the best results in Milton Keynes were observed when niche managers engaged business actors with the interest, know-how and capabilities required for the collaborative creation of value.

While PiP in Milton Keynes could be considered as a single experiment, multiple organizational actors operated within it, and every unique business model or novel application of EVs in business operations generated could be seen as a unique experiment. The creation of an experimental space that encourages multiple experimental models is desirable from the perspective of evolutionary economics, as the processes of variation, retention and reproduction lead to proliferation of fittest sociotechnical configurations beyond the original niche, increasing the potential for the experiment to contribute to widespread sociotechnical transitions.

7.3 Contributions of this Research

The key contributions of this thesis come from bringing together two disciplines that have an interest in the same phenomena but provide different, complementary viewpoints. The use of thematic analysis facilitated the construction of links between the evidence and the theoretical frameworks informing this research. Section 7.3.1 discusses the contributions of this research to SNM, Section 7.3.2 the contribution to social marketing, and section 7.3.3 addresses the contribution that the combined application of both fields can make to innovation and transport policy

The central concern of Strategic Niche Management is the application of technology policy in support of the creation and development of niches for promising new technologies. SNM takes a pre-market technology and supports the key processes of learning, networking and visioning in order to bring it closer to market. The literature reviewed in section 3.2 indicated that SNM had been developed and tested on prototype-stage technologies that were not available on the market. In consequence, SNM programmes had a protective mentality involving technical learning, and supply-side network building activities that were intended to put a supply-chain in place in anticipation of an eventual market launch (Section 5.3.4, particularly sub-theme E, "protection").

The analysis of the evidence from the case of Milton Keynes suggests that this protective pre-market mentality is still prevalent, but it does not serve the needs of pioneering adopters, as it neglects the social dimension of the socio-technical system, and fosters a sales mentality (as opposed to a marketing mentality)[12] in the design of demand-side interventions. A social marketing perspective was useful for addressing this gap. The marketing orientation is not confined to social marketing, and indeed originated in the realm of commercial marketing, but social marketing was found more appropriate for this research because SNM, like social marketing, is not oriented towards the pursuit of profit but towards the pursuit of societally beneficial outcomes. At their core, both fields seek to address socially undesirable but widespread choices made by individuals in order to foster the adoption of socially desirable alternatives. A thematic analysis informed by combined sensitivities of SNM and social marketing suggests that the needs of pioneering adopters are not served by traditional protective measures, but by targeted interventions that address the competition and create

---

[12] As discussed in Section 3.4.1, a sales orientation considers the job as one of finding customers for existing products. The marketing orientation prevalent in social marketing, on the other hand, calls for most of the effort to be spent on discovering the current, future and unspoken needs of a target audience and then creating the goods and services to satisfy them (Kotler, 1971; Kohli and Jaworski, 1990)

attractive exchanges. Evidence gathered in the course of this research, analysed through the frameworks of SNM and SM, indicates that it is possible to find scenarios and applications for which a disruptive innovation can be made competitive. However, those competitive applications are not readily evident, and potential users do not have previous experience with the technology and they do not have information about the barriers and potential benefits.

A holistic application of the three key processes of alignment (5.3.12), networking (5.3.13) and learning (5.3.14) was crucial for the co-creation of competitive, innovative applications of disruptive technologies within the experimental niche created by the PiP programme. Pioneering organizational adopters were observed to play a key role in driving the core SNM processes in Milton Keynes. The focus on business users made it possible to observe the complementarities of technical and organizational innovation, and highlighted the role of business actors as enablers, benefiting from their position at the interface between production and consumption. Organizational actors become innovators themselves. In the instances in which the core niche processes were directed effectively, leading to positive changes with an impact beyond the boundaries of the experimental space, marketing thinking was visibly in use.

The development of innovative, competitive business models was linked to a market oriented approach in the articulation of demand. Pioneering organizational actors had an understanding of the adopters, and they also understood the strengths and weaknesses of their competitors (mainly, the ICE as a very entrenched incumbent). By applying this knowledge of their markets and by engaging in the creation of supply and support networks, organizational innovators could create services of superior value around EVs, making them available and desirable to end users. The effectiveness of business actors for supporting the core niche processes in early-market niches suggests that there is a need for further

development of market- and business- oriented toolkits for managing the transition from pre-market to early-market niches.

Traditionally, the formation of an early-market has been considered the stage at which niche protection should be withdrawn. This research suggests that the withdrawal of protection must be complemented by the phasing in of empowering policies. The difference between traditional protective policy and proposed holistic empowering policy is made clearer by reflecting on the transition mechanisms that the different approaches implicitly attempt to reinforce. At their core, both approaches share a common objective, as they seek to take an innovation that has been embraced by a small community of pioneers and innovators, and trigger a series of processes that will lead to its acceptance by mainstream markets and to widespread societal change. However, the neoclassical and the holistic model differ in the assumptions that they make about the suitable mechanisms for crossing that chasm.

In "*Crossing the Chasm*", Moore (2002) suggests that in the process of diffusion of innovations (which begins with innovators and moves to early adopters, early majority, late majority, and laggards) there is a "chasm" between the early adopters and the early majority. The point of greatest peril in the development of a high-tech market lies in making the transition from an early market dominated by a few visionaries to a mainstream market of predominantly pragmatic customers (Fig. 7.1).
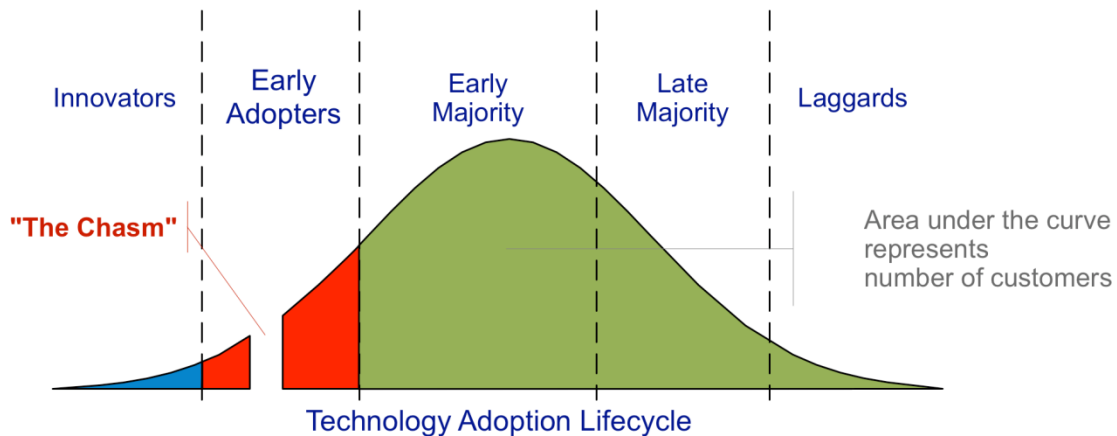
Figure 7.1: The "chasm" in the process of innovation diffusion (Moore, 2000, p 12)

Neoclassical and holistic approaches have different perspectives on the appropriate mechanisms to bridge the chasm from lead users to mainstream market. In the extreme form of the neoclassical perspective, lead users are enthusiasts willing to buy expensive, unproven technology so that economies of scale will engage and technical knowledge will be perfected, facilitating the development of a better, more affordable product suitable for the mainstream market. Under the holistic perspective, lead users are looking for a unique competitive advantage, and the innovation will be successful only if the lead users become successful themselves by identifying or creating competitive applications for the innovative technology. Success will motivate lead users to expand their operations, and will cause competitors to imitate their business models, increasing adoption. This, in turn, will lead to the generation of more knowledge and the development of a wider variety of business and operational models, improving the performance of the innovative product.

The expected transition mechanism in the neoclassical perspective involves using protection to encourage early demand, engaging economies of scale. Fig. 7.2 presents what "Neoclassical" policy makers expected to happen in terms of a microeconomics graph. :
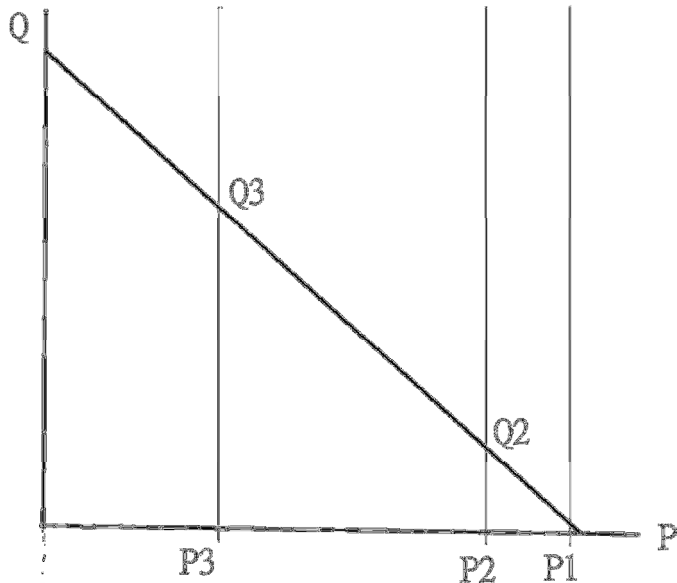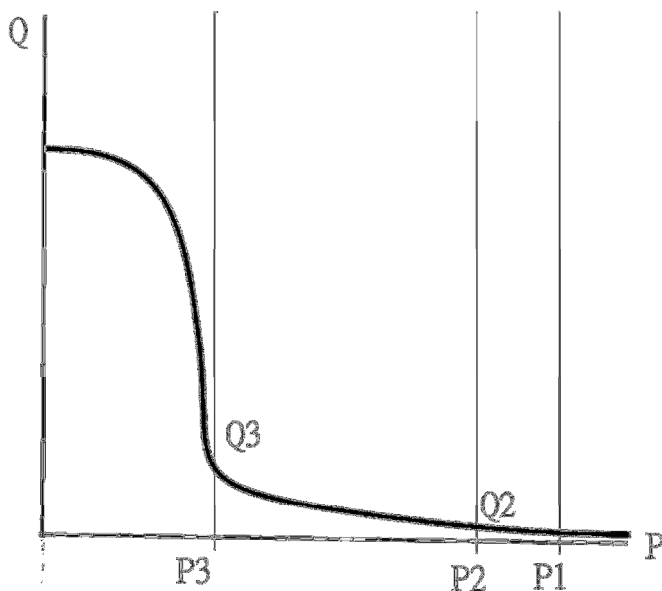

Figure 7.2: Demand curve for EVs

Q= Quantity of EVs sold
P1= Current sales price for EVs
P2= Subsidized price
P3= Price parity w/ equivalent ICE

ICE sales at the unsubsidized cost P1 are negligible. The assumption implicit in policies that subsidize innovative products is that there is a number of users (Q2) which are not willing to buy an EV for current price P1, but will become interested at subsidized P2.The characteristics of these users are not known, but they are assumed to exist because of the neoclassical curves for price elasticity of demand. When sales reach Q2, economies of scale are expected to engage, getting the price closer to P3 and getting demand closer to Q3, initiating a virtuous cycle. However, evidence from potential buyers gathered during this research suggests a different process, represented graphically in Fig. 7.3.

270

Q= Quantity of EVs sold

P1= Current sales price for EVs

P2= Subsidized price

P3= Price parity w/ equivalent ICE

Figure 7.3: Alternative demand Curve for EVs

Neoclassically-minded adopters (that is, adopters making rational choices based exclusively on cost and technical specifications) who were unwilling to consider adoption at P1 cannot justify it at P2 either, because ICEs are perfect substitutes and they are available for a much lower price (P3). The effect of the subsidy bringing the cost down to P2 is minimal. Evidence suggests that for many actors adoption is economically unfeasible unless the sales price gets closer to P3 (and a subsidy of that magnitude would be politically unfeasible). This is illustrated by the following example from an interview conducted as part of this research:

> *The cost of the vehicles is the most significant prohibitive factor to people*
>
> *taking them at the moment because the technology is improving all of the time but*
>
> *for example the Vauxhall Ampera with the government grant cost 32 or 33*
>
> *thousand pounds. An equivalent vehicle of that size would normally be 20*
>
> *thousand pounds, so if we were leasing these cars, I don't know if you know but*
>
> *the lease price of the car is based on what we buy it for, what is it going to be*
>
> *worth in three years time, say, and the customer has to cover the cost of the*
>
> *depreciation of the vehicle plus any of the maintenance plus we have to make our*
>
> *profit. If you got such a high upfront cost for something, and the residual value*

no one is really sure what the car is going to be worth in three years time, because what's the market going to be like in the consumer market for these second hand cars if the infrastructure is not there, so there's uncertainty there, so when they pass that back to the customers and say "this is the monthly price that you have to pay for 36 months for three years" and the cost is quite expensive if I'm being honest and we are getting that challenge all of the time from our customers. Like I said, when it is public sector or the bigger organizations that have got more money, there is more of an appetite because they are likely to take one two or three, small numbers, and they can afford to do it with the budgets they are working on and everything else, but most of the customers that we deal with they can't afford it, because they can get something that's £200 a month versus £400 a month that will do exactly the same thing (Interview with the brand manager for a car leasing group).

Organizational actors that were identified as "holistic" following interviews and participant observation did not have the explicit goal of triggering a transition. However, it is possible to suggest that there is a holistic model for sociotechnical transitions because the holistic actors interviewed expected to build on their knowledge to prepare for larger deployments, and their success was expected to lead to growth and imitation. The holistic model for sociotechnical transitions is also based on an expected virtuous cycle. If holistic actors are empowered, they can identify and develop competitive applications. This initiates a self-sustaining process with the potential for shifting the regime towards the sociotechnical transitions. Success will motivate lead users to expand their operations, and will cause competitors to imitate their business models, increasing adoption. This, in turn, will lead to the generation of more knowledge and the development of a wider variety of business and operational models, improving the performance of the innovative product. Unlike the

neoclassical model, which relies on lead users who are willing to invest in underperforming innovations, the holistic model relies on identifying applications that can be made competitive and profitable in the short term. This model is illustrated by the example below:

> *"What can you do today that moves you in the right direction"? Does it make sense in today's economic environment? That is a difficult question to answer in my view, and that is what my position is about, looking for those things when you can begin to make a movement in what you think is the right direction and you are going down there in a path that in business terms I may call a 'no regrets path'. You can't really be sure about the future, no one can, so if you move off in this direction and your picture of the future is wrong and the economics doesn't work you lost a lot of money for absolutely no results and you get a lot of regrets about that. But if you think this is the right way to go and you can construct a path to get there in today's economic terms and that path is a profitable one, then if the picture changes you have no regrets because you had a profitable path all along* (Participant observation of consultant for non-governmental enabling organization).

7.3.2 Contributions to Social Marketing

This research has been informed by sensitizing concepts from the fields of social marketing and SNM, but the relationship between fields was not intended to be reciprocal. The focus of this multidisciplinary research design was on using social marketing to develop sensitivity towards several aspect of the process of market building that appeared to be neglected in SNM, such as the co-creation of value, the design of mutually beneficial exchanges, and the alignment of individual self-interest and societal well-being. However, it became apparent from the early stages of this research that some aspects of SNM could make

a contribution to the field of social marketing, and that there were several suitable anchor points for building bridges between the fields.

This thesis does not aspire to build that bridge single-handedly, but this section provides a discussion of the common ground that has been identified so far, and suggests a research agenda drawing on lessons from this thesis that may contribute to building a shared understanding between practitioners of both fields. Further research on this joint perspective is required, with the expectation that it will lead to a richer understanding of sociotechnical transformations and behavioural choices. In particular, this research suggests that SNM can provide a useful theoretical framework for upstream social marketing interventions, particularly when the targeted behaviour has a strong sociotechnical component. This interdisciplinary approach is needed to understand and influence situations where behaviour and choice are closely linked to the structural forces exerted by the prevailing socio-technical environment, and where coordinated change in choices, behaviours and socio-technical structural factors is deemed socially beneficial.

One salient gap in the literature of social marketing, identified in Section 3.4.3, is the underdevelopment of the theoretical frameworks for the analysis of structural socio-technical influences on behavioural choices. The use of relevant theories and models is central to social marketing (Lefevbre, 2001; Luca and Suggs, 2012), but behavioural theories for upstream social marketing need further development (Gordon, 2013) and there is a lack of theoretical frameworks for analysing the interaction of technologies and individual choices in the context of sustainable behaviour (Corner and Randall, 2011).

As discussed in section 3.5 ("A Multi-Disciplinary Perspective"), there is a significant overlap in the goals and concerns of SNM and those of social marketing, and in consequence there is also overlap in the toolkit needed by practitioners in both fields. This section will

make the argument that the approach used in this thesis, although ostensibly framed as research on SNM, is equally relevant from a social marketing perspective

The PiP programme in Milton Keynes was not framed as a social marketing campaign but, as discussed in Section 3.4.3, the original design of the programme fulfilled the established criteria for social marketing interventions (see Table 3.3 in Section 3.4.1). The organizational focus of this research may seem like a departure from the domain of social marketing, particularly because most (but not all) of the actors observed were primarily driven by expected profits. However, while social marketing is typically thought of as applying to "final customers" (with traditional examples being teens who smoke or mothers who need their children immunized), for the purposes of this research, final customers would be drivers of polluting vehicles. Thus it is important to realize that a social marketing approach can also apply to bringing about behaviour changes in other key players whose cooperative actions are needed to make programmes successful. Suitable targets for social marketing include, for example, potential partners, funders and policymakers (Andreasen, 2002). The organizational actors that provided evidence for this research fit the criteria by Andreasen, as they contributed to making a social product, namely, low carbon transport, available to end users further downstream. The lessons from the thematic analysis and the case study are relevant to social marketing as they relate to the effective engagement and mobilization of partners in a position to produce beneficial upstream changes.

In the case of Milton Keynes, the managers of the intervention were not allowed to provide funding for activities not directly related to the deployment of infrastructure. Because of this, market research and engagement activities that could be considered as social marketing were performed by private partners that were not funded by the intervention designers, but were empowered through network-building, visioning and learning processes. This approach proved effective for galvanizing and empowering upstream actors who then

participated in the co-creation of valuable exchanges centred on socially beneficial, innovative products that were originally perceived as unattractive to users.

The success of PiP as implemented in Milton Keynes in mobilizing upstream actors despite funding constraints suggests that there might be benefits from the application of strategic niche thinking in social marketing. This does not mean that social marketers would necessarily benefit from following the specific steps of this research or the procedures outlined in SNM workbooks. Rather, on a more conceptual level, social marketing may benefit from framing societal change in terms of multi-level transitions, with a strategy for upstream change where niches are cultivated, developing momentum to challenge a suboptimal but entrenched status-quo. The niche strategy applied in social marketing calls for the articulation of promising applications that can be made viable with appropriate support, and identifying organizational actors upstream that can contribute to the delivery of the said application. The research agenda for social marketing niches would call for further research on the role of holistic visioning, networking and collaborative learning in social marketing partnerships for effecting upstream change.

Perhaps the most important contribution of SNM to the social marketing toolkit is the introduction of niche thinking (as opposed to pilot thinking). Experimental niches must become places for experimentation and co-creation of mutually beneficial exchanges. If upstream actors can achieve a competitive advantage while providing a socially beneficial product, virtuous cycles will be triggered leading to imitation by other upstream actors. Lessons from Milton Keynes suggest that supporting the development of strategic niches with this holistic perspective can be a very resource-intensive process, not in financial terms, but rather in terms of the high level of research and engagement that is required for identifying and empowering suitable partners. Such in-depth engagement with individual actors becomes feasible and cost-effective for upstream interventions because a single organizational actor

can have a big effect on "downstream" access to the selected technologies and behaviours. Once suitable actors have been identified and engaged, interventions seek to make adoption of beneficial behaviours and technologies into a competitive asset, facilitating the alignment of short-term self-interest and long-term societal benefit by initiating positive feedback cycles that lead to further structural (upstream) changes.

7.3.3 Contribution to Innovation and Transport Policy

The qualitative analysis documented in this thesis, drawing on a body of evidence produced by policy and organizational actors, allows for an evaluation of the portfolio of policy measures supporting the early market for EVs. The suitability of the policy portfolio for addressing the needs of pioneering and prospective users was a central concern of this research. The case study documented in this thesis is centred on a niche experiment involving sustainable transport technologies, as is often the case in the SNM literature. However, it must be stressed that niche processes are relevant to innovation on all domains, and there is nothing in SNM that makes it inherently restricted to the domain of road transport. The lessons discussed in this section should be relevant for innovation policy in other application domains.

Examination of the policy literature discussed in Chapter 2 through the framework developed in this thesis indicates that national transport policy during the period under research was predominantly based on a neoclassical model that assumed that cost and technical performance would determine the market acceptance of innovative technologies. In consequence, their toolkit for supporting the early market for EVs was largely restricted to financial subsidies, funding for R&D, and localized deployments of infrastructure.

The policy measures in effect in the United Kingdom between 2010 and 2012 had a very narrow conception of the market as they seemed to be grounded on a sales mentality (finding customers for existing products and convincing them to buy these products) as opposed to a marketing mentality (discovering the present, future and unspoken needs of a target audience and then creating the goods and services to satisfy them). A protection model based on the assumptions of neoclassical economics seemed to fail in fostering electric automobility. Although electric vehicles were considered a socially beneficial alternative to ICE-powered cars, they were not seen as beneficial for individual adopters because the cost and performance characteristics of the new technology were seen as uncompetitive when compared to ICEs. This evaluation revealed that some of the concerns of pioneering users were not addressed by the national policy portfolio (Section 5.3,4, particularly themes A and B). One of the pillars of the policy portfolio, financial support for research and development, was not sufficient because the cost and performance of batteries could not be improved enough in the short term. Another pillar of the policy portfolio, economic incentives, had limited effectiveness because of the very high cost of the new technology, as policy actors would not offer a subsidy that was sufficient to make the new technology cost-competitive in the eyes of potential adopters.

Local policy actors in Milton Keynes had a different perspective, and sought to develop a varied portfolio of support measures that included engagement, network building, and multidimensional learning, measures intended to support the deployment of innovative services based on EVs. However, funding restrictions on a national level prevented the implementation of this portfolio as originally intended. This tension between national and local visions had the unintended (but, in retrospect, fortuitous) effect of encouraging a collaboration between the local administration and a wide network of self-interested non-policy actors. Self-interested actors included academia, business and community

organizations that were willing to implement the networking, engagement and learning processes from the original vision, but expected to achieve tangible benefits from their participation. This arrangement proved beneficial for the development of the niche for two reasons:

- First, non-policy partners seeking their own interests were motivated to develop innovative applications that would achieve definite benefits in the short term while contributing to the transition. (See section 3.2, theme J in section 5.3.4). As a result of this, several niche applications were identified where EVs could provide a competitive advantage relative to ICEs. Additionally, as the competitive benefits for those applications did not depend on government funding, partners continued their activities even after the conclusion of the programme, and expanded their operations beyond the boundaries of the experimental niche.

- Secondly, by facilitating those key niche processes of network-building, visioning and multidimensional learning, and by bringing those processes beyond the original experimental space, innovation enablers contributed to making EVs a credible alternative to a very entrenched ICE-based regime, at least for certain application domains (as suggested by the developments in section 6.2.6).

For most of the duration of the programme, national policy actors remained unaware of this positive aspect of the niche experiment taking place in Milton Keynes, as they were not measuring the relevant indicators. The key performance indicators were limited in scope and were not linked to the stated (holistic) goals. One key lesson from this research is that the development of early market niches cannot be measured in terms of sales nor in terms of the deployment or utilization of infrastructure (although these factors do need to be measured). More recent policy documents, however, suggest a growing awareness of the importance of

local knowledge and entrepreneurship in facilitating the adoption of sustainable transport (Transport Committee 2012, Kramer 2013).

This research suggests that targeted empowering interventions involving local organizations focused on facilitating the development of competitive business and operational models around innovative technologies, can be more effective than the predominant approach based on interventions founded on infrastructure deployment, development of the supply-chain, and simple financial incentives. There is a need for a strategic turn towards the design of transport and innovation policies that are not built around technological artefacts, but around processes.

7.4 Critical Reflection and Future Directions

First of all, this critical reflection on the research documented in this doctoral thesis must assess how this analysis, drawing on concepts from SNM and social marketing, contributed to understanding the processes that affected the construction of an early market for EVs in Milton Keynes, and particularly adoption (or lack thereof) by pioneering business users.

It can be argued that using the SNM framework for studying the early EV market is inappropriate, as the technology is now available in the mainstream market, and supported by major manufacturers. SNM assumes that once a promising technology has reached market stage support is no longer needed and may even be counterproductive, as protection could potentially create uncompetitive "mamma's boys" (Hoogma et al., 2002). However, evidence from Milton Keynes clearly indicates that EVs still need some form of support. In the period covered by this research, EVs were available in the market, but there was only a tiny market for them. The SNM framework was useful to some degree for understanding this transitionary stage, as the positive results achieved by the PiP programme as implemented in

Milton Keynes suggest that experimental niches are suitable spaces for the development of competitive business models. Additionally, the core niche processes of learning, alignment and networking proved crucial for building the uncertain competitiveness of electric transport. Holistic application of the core processes within an experimental space contributed to the identification and development of competitive, scalable applications, galvanizing the actions of a wide network of business and policy actors.

On the other hand, pre-market SNM could not fully account for the early-market dynamics observed in Milton Keynes. This exploration, using the dual lenses of SNM and social marketing to make sense of competitiveness in an early market proved particularly useful when observations deviated from the expectations set by the framework. For instance, the key SNM processes and social marketing activities in Milton Keynes were predominantly managed by private business actors. In the instances in which those processes where facilitated effectively, leading to niche cumulation and proliferation, marketing thinking was visibly in use. In particular, the development of innovative, competitive business models was linked to a market oriented approach in the articulation of demand. This suggests that there is a need for further development of a market-oriented and business-oriented toolkit for addressing the end-game of SNM, and managing the transition from pre-market to early-market niches.

Recent academic literature (Mazzucato, 2013; Wells, 2013) suggests a growing interest in the role of innovative business models and entrepreneurship in socio-technical transitions, an interest that is also found among high-level policy makers in the United Kingdom. The main theme of this section is exemplified by the speech by Baroness Kramer in her first official appearance after being appointed Transport Minister:

While government is providing significant funding to develop the technology, expand the infrastructure, and reduce the cost of electric vehicles to buyers, ultimately building the market requires initiative and entrepreneurial flair at a local level (Kramer, 2013).

Having reflected on areas where this research contributed to further understanding, it is important to acknowledge its limitations and discuss promising future directions.

Reflecting on this research in itself and acknowledging its limitations, it must be said that research on ongoing transitions suffers from the impossibility of developing a long-term perspective. Because the timespan of socio-technical transitions can be measured in decades, this research can only aspire to provide a snapshot of an ongoing process owing to the limitations inherent to a three year PhD project. As section 6.2.6 showed, the process was still ongoing at the time of closing this thesis. Long-term longitudinal studies following the actors and configurations involved in this case study could provide useful contributions to the understanding of early-market niches, and their transition from protected spaces to mainstream, fully-competitive markets.

This research focused on organizational decision makers whose choices affected the options available to downstream users. It would be desirable for future research to expand the scope in order to interview the end users who are affected by the decisions of those organizations; similarly, it would have been desirable to gather first-hand evidence from the actors that shape national policy. Finally, although the SNM framework has been predominantly centred on the challenges of sustainable transport, it would be desirable to explore the importance of niche-building and exchange processes related to other socially-beneficial disruptive innovations in the early market stage, such as rapid prototyping and high-value manufacturing, smart grids, or innovative renewable energy projects.

This reflection will conclude by discussing an area where some major shortfalls in existing theory were identified. Further research is needed in the application of SNM in support of innovations entering the early-market stage. As sustainable technologies are coming of age, challenges related to technical development and usability issues become, perhaps, less prominent, and the challenge of developing competitive business models and building healthy markets gain importance in the eyes of researchers and policy actors alike. In light of the growing awareness of the importance that entrepreneurship has for the construction of markets for innovative technologies, it must be acknowledged that this research, by drawing on sensitizing concepts from social marketing, has barely scratched the surface. Even within the field of social marketing, there is room for a more systematic exploration of the application of social marketing in support of sustainable innovations. This thesis used the core SNM processes to make sense of the strengths and weaknesses of the EV policy portfolio, but a different set of insights might have been produced if the policy portfolio had been systematically analysed, for example, in terms of behaviour change, audience research, segmentation, exchange, marketing mix, and competition (the social marketing criteria in Stead et al., 2007.) However, future research in early-market niches must draw insights from a wider range of business perspectives. There is a clear need for more joint research between transition researchers and scholars and practitioners from all areas of business, including, but not limited to, studies on strategic niches and business models, organizational sense making, entrepreneurship, and corporate strategy. And, given that new knowledge in SNM is predominantly acquired in the process of learning by doing, there is a need for inclusive, ambitious projects where academics, technologists, entrepreneurs and policy actors come together in visionary experimental spaces, and engage in the collective creation of new configurations that work.

7.5 Epilogue – Ongoing impact beyond the niche

The PiP programme came to an end in March 2013. At the time of the conclusion of the experiment, the processes of learning and embedding described in Sections 6.3.4 and 6.3.5 had not reached fruition, and the market for EVs was still in the early stages of its development. In consequence, the programme appeared to have had little effect in building a market for electric vehicles and in generating knowledge. Several developments that took place after the end of the programme suggest that it had lasting positive effects, and that it was effective in contributing to a potential transition towards innovative, sustainable forms of transport.

There are three experiments that took place in Milton Keynes after the end of the PiP programme that merit discussion:

- A) The London expansion of the Wolverton e-car club.

- B) The electrification of the route 7 bus service.

- C) The LUTZ autonomous pods.

The events documented here took place after the programme under this PhD study had reached its conclusion, and after the analysis had been completed. Given the long timescales involved in transitionary processes, experiments developed within an strategic niche cannot be expected to develop in full in the limited timespan of a PhD thesis. However, they merit discussion because they illustrate the contribution of business models and holistic thinking to niche cumulation. A further criticism that could be aimed at this section comes from its choice of subjects, as it brings attention to successful experiments while neglecting to tell the tales of the failures that also took place within the niche. However, under evolutionary economics (and therefore, SNM) it is not necessary, or even important, if a large number of experiments fail as long as some of them succeed. The logic of evolutionary

economics only requires that variation and competition is encouraged, and that some of the experiments taking place prove beneficial. Variation and retention will lead to reproduction of the fittest, and the selected examples suggest that PiP in MK certainly contributed to the development of fit and competitive applications. Each of these experiments on electric mobility was organized by a different coalition of mainly private actors, but they have several points in common: they explore different forms of electric mobility, they steer away from the predominant model focused on the private ownership of automobiles, and they are all framed as small scale trials in protected spaces that, if successful, can be replicated profitably in a larger scale in an unprotected setting.

a) The London expansion of the Wolverton e-car club

The Wolverton E-Car Club is a pay-per-hour car club with a fleet of zero-emission Electric Vehicles. Car-club schemes had been envisaged as part of the original holistic application in the MK ELVIS project, but needed to be financed outside of the PiP programme because of the constraints on OLEV funding. The project was funded by a combination of private venture capital and a grant from the Technology Strategy Board (TSB). Sustainable Ventures, the parent company, brands itself as occupying the space between incubation and venture capital, identifying and developing revenue opportunities in the sustainability sector. The club was formed in September 2011, and launched full-scale operations in autumn 2012. The first location of the club was Wolverton, a town in the northern edge of Milton Keynes. It initiated operations with a fleet of three Nissan LEAF cars, and attracted over ninety members during the first year.

Figure 7.4: A Wolverton eCar Club Leaf on charge in one of the club's parking bays

According to interview data with the organization and participant observation, Sustainable Ventures selected Wolverton after a series of stages designed to assess the fit of the project to the needs of the community, as well as the interest of the community members. A series of telephone interviews, analysis of the geography and urban design, questionnaires and expressions of interest informed the decision process. Engagement between the organization and the community was facilitated by the Wolverton Steering Group, a forum for local residents, businesses and voluntary and community. This intermediation contributed to producing over 3000 expressions of interest from the community, and over 300 completed questionnaires.

Interview data and documentary sources (Particularly Wolverton Steering Group, 2002 and Wolverton Steering Group, 2010) confirmed that the visions of the eCar club and the community were highly aligned. The Wolverton Steering Group, had recently reviewed its community action plan, and had a strong interest in addressing people's energy consumption and making Wolverton a more sustainable place, in line with Milton Keynes' Low Carbon Living initiative. In addition, the community had identified the need to find a solution to its limited provision of parking spaces and congestion issues in Wolverton (Wolverton Steering Group, 2012). The urban design of Wolverton is predominantly shaped

by its development as a rail town from 1838, following the construction of the London to Birmingham Railway. Owing to its Victorian character, Wolverton could not accommodate high levels of private car ownership, and a car-club was identified as a viable alternative for addressing the issue. Thus, the launch of the Wolverton e-car club was not based on a traditional technology-push. It followed the approach recommended by Sustainable Ventures by using insight into customer demand to identify attractive and sustainable revenue opportunities where a low carbon solution offers sustainable competitive advantage.

In October 2012, Sustainable Ventures sought additional investment to expand its operations. A pitch was posted in Crowdcube, a UK based crowd-funding platform that allows for private investors to invest directly in exchange for equity (Crowdcube, 2013a). The success of the Wolverton pilot contributed to making a compelling case for further investment, and £100,000 was sought. The target was reached by February 2013, with contributions of 63 investors (Crowdcube 2013b). The success of the crowd-funding campaign was leveraged to secure additional £215,000 of funding from angel investors (ibid). By October 2013 the club was operating in Luton, Oxford, and the London Borough of Tower Hamlets. From the perspective of SNM this can be described as a case of niche proliferation, as a sociotechnical configuration developed within a niche proves successful and proliferates to niches within other regimes, thus gaining momentum through diffusion and imitation (Geels and Schot, 2007).

The launch of the Tower Hamlets e-car club in October 24, 2013 can be seen as a milestone indicating the proliferation of a regional niche making inroads into the national regime[13]. As such, it attracted the attention of national-level policy makers. The official

---

[13] See http://www.e-carclub.org/latest-news/e-car-london-launch-press-release-october-2013/ There were several reports claiming the London scheme was the UK's first e car club, ignoring that it was a transfer from Wolverton

launch event marked the first public appearance of Baroness Kramer after her appointment as Minister of Transport on October 7. The minister lauded the collaboration between the car club, local authorities of Tower Hamlets and its community association (an approach that, as previously discussed, was central to the Wolverton Pilot) declaring it instrumental for "*growing the market and changing the way we travel*" (Kramer, 2013).

The newly appointed minister also stressed the importance of business actors for building the market and achieving the transition to low carbon transport: "*While government is providing significant funding to develop the technology, expand the infrastructure, and reduce the cost of electric vehicles to buyers, ultimately building the market requires initiative and entrepreneurial flair at a local lev*el"(Ibid).

A) The electrification of bus route 7

The electrification of bus route 7 in Milton Keynes was the result of a five year collaboration between eight organisations led by a subsidiary of Mitsui & Co Europe ("Mitsui"). The objective was to see diesel buses replaced by all-electric vehicles on one of the main bus routes in Milton Keynes, starting January 2014. Electric buses deliver zero emissions, but because of the need to recharge, in operation they require about double the number of vehicles, making mainstream electric bus operations prohibitively expensive (Arup, 2013). The small battery-electric buses that have been used in a number of cities thus tend to operate on short routes and often require a larger fleet to allow for additional downtime for recharging. The research informing the Milton Keynes electric bus demonstration project addressed the challenges of designing a battery-electric bus system matching the technical and economical characteristics of a diesel bus route.

The electrification of Route 7 in Milton Keynes provided a challenging but achievable scenario, as the route is 24 kilometres long, and operates for 17 hours a day at a 15 minutes

daytime schedule recharging (Miles and Potter, 2013). Because the battery is the most expensive component in electric vehicles, the economic feasibility of electrifying the route depended on having a small battery and a high utilization rate. A battery with enough capacity to cover the whole 17 hour shift on a single overnight charge would have a weight of 5 tonnes, and a cost of £270,000 (ibid). A smaller battery, supplying enough power for 8 hours of operation, was selected instead. Rapid wireless inductive chargers capable of replenishing two thirds of the energy consumed by the bus' 24 kilometre route in ten minutes were installed at the route ends, where the 10 minute stop is already included into the timetable in order to accommodate unexpected delays. The charging process is automated so that the driver does not need to take any special action. This opportunity charging scheme extends the range of the vehicle beyond the 18 hours needed for a bus to run all day (ibid).

Figure 7.5: A Milton Keynes eBus in service in April 2014 charging on an inductive plate in Wolverton

While the project depends to a significant degree on innovative technologies, technology by itself was not enough to achieve the goals of the pilot. New institutional structures and business models were crucial for making innovation competitive, and the knowledge about business and institutional aspects was a valuable output from the project. A press release by the consortium (ARUP, 2013b) states that the ultimate aim of the project is

289

use the data collected by the Milton Keynes trial to demonstrate the economic viability of low-carbon public transport. This data could be used to kick-start electric bus projects in other towns and cities worldwide.

B) **LUTZ autonomous pods and the Transport Catapult**

The Autonomous Transport Demonstrator for the Low-Carbon Urban Transport Zone (LUTZ), is a £50m, 5 year programme for the deployment of cloud-enabled autonomous vehicles, or small, driverless electric cars that are expected to carry two passengers plus baggage, and operate at speeds of up to 12mph. It is proposed that over 100 autonomous pods will be introduced into the Milton Keynes city centre in a number of stages, culminating with fully autonomous pods operating along existing broad cycle ways. The LUTZ programme is designed as a space for learning, and the data gathered from the programme is expected to contribute to an "innovation ecosystem" in which city-based alliances of communities, businesses and universities collaborate to devise new services and applications (TSB, 2013). Partners involved in the project are Cambridge University and ARUP, an engineering firm that also oversaw the development of the Heathrow Autonomous PRT Airport Shuttle. British firms already have begun exporting the autonomous PRT technology to other countries and the government hopes that this technology initiative may result in a leading position for the United Kingdom in the upcoming wave of autonomous mobility (Invest Milton Keynes, 2013).

These developments indicate that the initially limited PiP EV charging project has helped to establish a wider programme using Milton Keynes as a testbed for emergent EV systems that reflect a holistic vision. This is particularly reflected in another development that took place after the end of the Plugged-in Places programme in Milton Keynes, which was the selection of the city as the location for a transport innovation centre, called "Transport

Systems Catapult". The £150m centre was announced on July 2013, and was part of a nationwide programme for the development of "Catapult" centres, partially funded through the Technology Strategy Board, in order to foster collaboration between UK's business, scientists and engineers. The aim was to help business adopt, develop and exploit innovative products and technologies, with the initial centres focusing on high value manufacturing, cell therapy, offshore renewable energy, satellite applications, future cities, the connected digital economy, and transport systems.

The Transport Systems Catapult aims to provide a national hub for transport modelling and monitoring – testing latest theories on how transport systems interact and function against real-world demonstrators (TSB 2013).

The business orientation of the LUTZ project, and of the Catapults in general, is made explicit in the metrics, which include expected number of new products and services to be brought to market, social and environmental impact of projects, adoption at scale of new cross-modal technologies and solutions, and number of business clients working with the Innovation Centre (with separate figures for SMEs). The metrics and project objectives signal a shift away from technology development and deployment projects, and towards an exploration of how people and organisations contribute to transport, and how they can best concentrate their efforts in the development of a sustainable and competitive transport system (Transport Systems Catapult, 2013).

The electric bus trial and the LUTZ autonomous pods are related to sustainable electric transport, and it can be argued that the selection of Milton Keynes as a trial space was influenced by the networks and the reputation developed during the PiP trial.

The projects described in this epilogue are based on different business models and different applications of electric vehicle technology, but all of them can be seen as local

experiments, led by private entrepreneurs but made possible by the support of policy actors. All three are designed as pilots to facilitate learning and draw lessons with the aim of expanding on a national or even global level later on. The lessons drawn go beyond the technical, as entrepreneurial actors explore the technical characteristics of the technological artefact and their fit within business and operational models,

The three projects can be described as niches: distinct application domains that are small in scale and scope, providing a key step in the emergence, development, and diffusion of radical innovations.

The projects are in different stages, and bring into relief different aspects of the niche dynamics described in the literature, particularly, niche cumulation and niche proliferation (Elzen et al., 2004; Schot and Geels 2007). The eBus and the LUTZ autonomous vehicle pilot provide examples of niche cumulation: niches building further upon each other like "self-service public transport" developing out of the EV (electric vehicle).The E-car club shows that the Milton Keynes PiP provided a learning space that facilitated the proliferation of an emerging niche, fitting the pattern in which a specific variant used in an internal market niche proves successful and proliferates to niches within other regimes, gaining momentum through diffusion and imitation (Schot and Geels 2007).

This list of developments that took place in Milton Keynes after the conclusion of the PIP programme is not exhaustive. The managers of PiP in Milton Keynes linked the programme to a wider vision of Low Carbon Living (Section 6.3.5). This vision has been central to developments such as the successful bid for a £150 million Transport Catapult Centre or the £16 million MK:Smart programme[14]. This movement of Milton Keynes in a holistic dimension contributes to its economic development, and highlights the rising role of

---

[14] This programme commenced in January 2014. For details see http://kmi.open.ac.uk/projects/name/mk:smart

cities as engines of innovation, discussed by Hodson and Marvin (2010) and Bukeley et al. (2010).

References

Altheide, D. L. (2000). Tracking discourse and qualitative document analysis. Poetics, 27(4), 287-299.

Ames, Kenneth M. "The archaeology of the longue durée: Temporal and spatial scale in the evolution of social complexity on the southern Northwest Coast." Antiquity 65.249 (1991): 935-945.

Andreasen, A. R. (1993). Presidential address: A social marketing research agenda for consumer behavior researchers. Advances in consumer research, 20, 1-5.

Andreasen, A. R. (1994). Social marketing: its definition and domain. Journal of public policy & marketing, 108-114.

Andreasen, A. R. (2002). Marketing social marketing in the social change marketplace. Journal of Public Policy & Marketing, 21(1), 3-13.

Argyris, C., & Schön, D. A. (1978). Organizational learning: A theory of action perspective (Vol. 173). Reading, MA: Addison-Wesley.

Auld, G. W., Diker, A., Bock, M., Boushey, C. J., Bruhn, C. M., Cluskey, M., ... & Zaghloul, S. (2007). Development of a decision tree to determine appropriateness of NVivo in analyzing qualitative data sets. Journal of nutrition education and behavior, 39(1), 37-47.

Bagozzi, R. P. (1975). Social exchange in marketing. Journal of the Academy of Marketing Science, 3(2), 314-327.

Baily, M. N., & Chakrabarti, A. K. (1988). Innovation and the productivity crisis. Brookings Institution Press.

Banister, D. (2005). Unsustainable transport: city transport in the new century. Taylor & Francis.

Bijker, W. E. (1997). Of bicycles, bakelites, and bulbs: Toward a theory of sociotechnical change. MIT press.

Bloom, P. N., & Novelli, W. D. (1981). Problems and challenges in social marketing. Journal of marketing, 45(2).

Blumer, H. (1954). What is wrong with social theory?. American sociological review, 3-10.

Bonoma, T. V. (1985). Case Research in Marketing: Opportunities, Problems, and a Process. Journal of Marketing Research (JMR), 22(2).

Boon, W. P., Moors, E. H., Kuhlmann, S., & Smits, R. E. (2008). Demand articulation in intermediary organisations: The case of orphan drugs in the Netherlands. Technological Forecasting and Social Change, 75(5), 644-671.

Bowen, G. A. (2009). Document analysis as a qualitative research method. Qualitative research journal, 9(2), 27-40.

Boyatzis, R. E. (1998). Transforming qualitative information: Thematic analysis and code development. Sage.

Braudel, F. (1982). On history. University of Chicago Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative research in psychology, 3(2), 77-101.

Bryman, A., & Bell, E. (2003). Business Research Methods, Oxford.

Bush, Vannevar. "As we may think." (1945): 101-108. or Bush, V. (1945). The endless frontier. Washington, DC: National Science Foundation.

Callon, M. (1987). Society in the making: the study of technology as a tool for sociological analysis. The social construction of technological systems: New directions in the sociology and history of technology, 83-103.

Callon, M., & Latour, B. (1981). Unscrewing the big Leviathan: how actors macro-structure reality and how sociologists help them to do so. Advances in social theory and methodology: toward an integration of microand macro-sociologies, 277-303.

Caniëls, M., & Romijn, H. (2006, March). Strategic niche management as an operational tool for sustainable innovation: guidelines for practice. In Schumpeter Conference (pp. 21-24).

Carley, K. (1993). Coding choices for textual analysis: A comparison of content analysis and map analysis. Sociological methodology, 23(75-126).

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition of technological systems. Journal of evolutionary economics, 1(2), 93-118.

Chapin, H., & Deneau, D.(1978). Citizen involvement in public policy-making: Access and the policy-making process. Ottawa: Canadian Council on Social Development.

Chew, F. (2000). Cut From the Same Cloth? Communications Researcher Ethics. Journal of Mass Media Ethics, 15(2), 115-126.

Christensen, C. M., & Bower, J. L. (1996). Customer power, strategic investment, and the failure of leading firms. Strategic management journal, 17(3), 197-218.

Constantinides, A. (2009) Plugged-in Places: The electric vehicle charging infrastructure framework application form.

Corner, A., & Randall, A. (2011). Selling climate change? The limitations of social marketing as a strategy for climate change public engagement. Global Environmental Change, 21(3), 1005-1014.

Cowan, R., & Hulten, S. (1996). Escaping lock-in: the case of the electric vehicle. Technological forecasting and social change, 53(1),61-79.

Curnow, R. C., & Moring, G. G. (1968). 'Project sappho': A study in industrial innovation. Futures, 1(2), 82-90.

Czarniawska-Joerges, B. (1992). Exploring complex organizations: A cultural perspective.

Dosi, G., Llerena, P., & Labini, M. S. (2006). The relationships between science, technologies and their industrial exploitation: An illustration through the myths and realities of the so-called 'European Paradox'. Research policy, 35(10), 1450-1464.

Dosi, G., Llerena, P., & Sylos Labini, M. (2005). Science-technology-industry links and the" European paradox": Some notes on the dynamics of scientific and technological research in Europe (No. 2005/02). LEM working paper series.

Dubois, A., & Gadde, L. E. (2002). Systematic combining: an abductive approach to case research. Journal of business research, 55(7), 553-560.

Duriau, V. J., Reger, R. K., & Pfarrer, M. D. (2007). A content analysis of the content analysis literature in organization studies: Research themes, data sources, and methodological refinements. Organizational Research Methods, 10(1), 5-34.

Elzen, B., Geels, F. W., & Green, K. (Eds.). (2004). System innovation and the transition to sustainability: theory, evidence and policy. Edward Elgar Publishing.

Foxon, T. J. (2007). 9 Technological lock-in and the role of innovation. Handbook of sustainable development, 140.

Freeman, C. (1979). The determinants of innovation: Market demand,technology, and the response to social problems. Futures, 11(3),206-215.

Freeman, C. (1998). The economics of technical change. Trade, Growth and Technical Change, Cambridge, 16-54.

French, J. (2011). Why nudging is not enough. Journal of Social Marketing, 1(2), 154-162.

French, J., & Blair-Stevens, C. (2006). Social marketing national benchmark criteria. UK: National Social Marketing Centre.

French, J., & Blair–Stevens, C. (2010). Improving lives together. Westminster City Council, London.

Gambrell, J. B. (1978). Invention and Innovation Incentives to Meet the Energy Crisis: Playing It Safe Is Too Risky. Hous. L. Rev., 16, 365.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8), 1257-1274.

Geels, F. W. (2002). Understanding the dynamics of technological transitions: a co-evolutionary and socio-technical analysis (p. 426). Enschede: Twente University Press.

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. Research policy, 33(6), 897-920.

Geels, F. W. (2005). Technological transitions and system innovations: a co-evolutionary and socio-technical analysis. Edward Elgar Publishing.

Geels, F. W. (2010). Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. Research Policy, 39(4), 495-510.

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. Environmental Innovation and Societal Transitions, 1(1), 24-40.

Geels, F. W., & Kemp, R. (2007). Dynamics in socio-technical systems: Typology of change processes and contrasting case studies. Technology in society, 29(4), 441-455.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research policy, 36(3), 399-417.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. Research policy, 36(3), 399-417.

Geels, F., & Raven, R. (2006). Non-linearity and expectations in niche-development trajectories: ups and downs in Dutch biogas development (1973–2003). Technology Analysis & Strategic Management, 18(3-4), 375-392.

Geertz, C. (1973). The interpretation of cultures: Selected essays (Vol. 5019). Basic books.

Gephart, R. P. (1993). The textual approach: Risk and blame in disaster sensemaking. Academy of Management Journal, 36(6), 1465-1514.

Gordon, R. (2013). Unlocking the potential of upstream social marketing. European Journal of Marketing, 47(9), 1525-1547.

Gordon, R., McDermott, L., Stead, M., & Angus, K. (2006). The effectiveness of social marketing interventions for health improvement: what's the evidence?. Public health, 120(12), 1133-1139.

Grazi, F., & van den Bergh, J. C. (2008). Spatial organization, transport, and climate change: Comparing instruments of spatial planning and policy. Ecological Economics, 67(4), 630-639.

Greenwood, D. J., & Levin, M. (2007). Introduction to action research, social research for social change (2nd edn). Thousand Oaks, CA: Sage.

Grin, J., & Van de Graaf, H. (1996). Technology assessment as learning. Science, technology & human values, 21(1), 72-99.

Groger, L., Mayberry, P. S., & Straker, J. K. (1999). What we didn't learn because of who would not talk to us. Qualitative Health Research, 9(6), 829-835.

Hastings, G., & Donovan, R. J. (2002). International initiatives: Introduction and overview. Social Marketing Quarterly, 8(1), 3-5.

Hekkert, M. P., Suurs, R. A., Negro, S. O., Kuhlmann, S., & Smits, R. E. H. M. (2007). Functions of innovation systems: A new approach for analysing technological change. Technological Forecasting and Social Change, 74(4), 413-432.

Hendriks, V. M., Blanken, P., Adriaans, N. F., & Hartnoll, R. (1992). Snowball sampling: A pilot study on cocaine use. IVO, Instituut voor Verslavingsonderzoek, Erasmus Universiteit Rotterdam.

Hoffmann, M. (1997, July). Is there a "Logic" of Abduction. In Proceedings of the 6th Congress of the IASS-AIS (pp. 13-18).

Hoogma, R. (2002). Experimenting for sustainable transport: the approach of Strategic Niche Management. London: Spoon Press

Hoogma, R., Weber, M., & Elzen, B. (2005). Integrated long-term strategies to induce regime shifts towards sustainability: the approach of strategic niche management. In Towards environmental innovation systems (pp. 209-236). Springer Berlin Heidelberg.

Huff, A. S. (1990). Mapping strategic thought. John Wiley & Sons.

Hughes, T. P. (1986). The seamless web: technology, science, etcetera, etcetera. Social Studies of Science, 16(2), 281-292.

Hughes, T. P. (1993). Networks of power: electrification in Western society, 1880-1930. JHU Press.

Ieromonachou, P. (2005) Analysing the implementation process of urban road pricing schemes. Ph.D. Thesis, The Open University.

Ieromonachou, P., Potter, S., & Enoch, M. P. (2003). Using strategic niche management to evaluate and implement urban transport policy instruments.

Jacobsson, S., & Bergek, A. (2011). Innovation system analyses and sustainability transitions: Contributions and suggestions for research. Environmental Innovation and Societal Transitions, 1(1), 41-57.

Karakaya, F., & Stahl, M. J. (1989). Barriers to entry and market entry decisions in consumer and industrial goods markets. The Journal of Marketing, 80-91.

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management. Technology Analysis & Strategic Management, 10(2), 175-198.

Kerr, J. B., Nazri, G. A., & Pistoia, G. (2004). Lithium Batteries. Science and Technology, Kluwer Academic Press,(GA Nazri, G. Pistoia-Eds.) Boston.

Kotler, P., & Roberto, E. L. (1989). Social marketing. Strategies for changing public behavior.

Kotler, P., & Zaltman, G. (1971). Social marketing: an approach to planned social change. Journal of marketing, 35(3).

Kromer, M. A. (2007). Electric powertrains: opportunities and challenges in the US light-duty vehicle fleet (Doctoral dissertation, Massachusetts Institute of Technology).

Kuhn, T. S. (1962). The Structure of Scientific Revolutions.

Law, J. (1992). Notes on the theory of the actor-network: Ordering, strategy, and heterogeneity. Systems practice, 5(4), 379-393.

Lazer, W., & Kelley, E. J. (1973). Social marketing: Perspectives and viewpoints. RD Irwin.

Lefebvre, R. C. (2001). Theories and models in social marketing. Handbook of marketing and society. Thousand Oaks, California: Sage.

LEFEBVRE, R. C., DONER, L., JOHNSTON, C., LOUGHREY, K., BALCH, G. I., & SUTTON, S. M. (1995). 12 Use of Database Marketing and Consumer-Based Health Communication in Message Design. Designing health messages: Approaches from communication theory and public health practice, 217.

Levinthal, D. A. (1998). The slow pace of rapid technological change: gradualism and punctuation in technological change. Industrial and corporate change, 7(2), 217-247.

Luca, N. R., & Suggs, L. S. (2010). Strategies for the social marketing mix: a systematic review. Social Marketing Quarterly, 16(4), 122-149.

Lundvall, B. Å. (2005). National innovation system: analytical focusing device and policy learning tool. Center for tillväxtpolitiska studier.

Luukkonen, T. (1998). The difficulties in assessing the impact of EU framework programmes. Research Policy, 27(6), 599-610.

MacFadyen, L., Stead, M., and Hastings, G. B. (2003), "Social marketing". Chapter 27 in Baker, M. J. (ed), The Marketing Book, 5th edition. Oxford: Butterworth Heinemann.

Maibach, E. (1993). Social marketing for the environment: using information campaigns to promote environmental awareness and behavior change. Health promotion international, 8(3), 209-224.

Markard, J., Raven, R., & Truffer, B. (2012). Sustainability transitions: An emerging field of research and its prospects. Research Policy, 41(6), 955-967.

Martin, B. R. (2012). The evolution of science policy and innovation studies. Research Policy, 41(7), 1219-1239.

May, C., Finch, T., Mair, F., Ballini, L., Dowrick, C., Eccles, M., ... & Heaven, B. (2007). Understanding the implementation of complex interventions in health care: the normalization process model. BMC Health Services Research, 7(1), 148.

Mays, N., & Pope, C. (1995). Rigour and qualitative research. BMJ: British Medical Journal, 311(6997), 109.

Mazzucato, M. (2013). The Entrepreneurial State: Debunking public vs.private sector myths. Anthem Press.

McDermott, L., Stead, M., & Hastings, G. (2005). What is and what is not social marketing: the challenge of reviewing the evidence. Journal of Marketing Management, 21(5-6), 545-553.

McKenzie-Mohr, D. (2000). New ways to promote proenvironmental behavior: Promoting sustainable behavior: An introduction to community-based social marketing. Journal of social issues, 56(3), 543-554.

McKenzie-Mohr, D. (2011). Fostering sustainable behavior: An introduction to community-based social marketing. New Society Publishers.

Miller, R. L., & Brewer, J. D. (2003). The AZ of social research. A dictionary of Key.

Möller, K. (2010). Sense-making and agenda construction in emerging business networks—How to direct radical innovation. Industrial Marketing Management, 39(3), 361-371.

Mytelka, L. K., & Smith, K. (2002). Policy learning and innovation theory: an interactive and co-evolving process. Research policy, 31(8), 1467-1479.

Nelson, R. R., & Sidney, G. (1982). Winter. 1982. An evolutionary theory of economic change, 929-964.

Nelson, R. R., & Winter, S. G. (1977). In search of useful theory of innovation. Research policy, 6(1), 36-76.

Niehoff, A. H. (1966). casebook of social change.

Nonaka, I., Takeuchi, H., & Takeuchi, H. (1995). The knowledge-creating company: how Japanese companies create the dynamics of innovation. 1995. New York, NY.

Padgett, D. K. 1988. Qualitative Methods in Social Work Research: Challenges and Rewards. Thousands Oaks, Calif.: Sage.

Pinch, T. J., & Bijker, W. E. (1984). The social construction of facts and artifacts: Or how the sociology of science and the sociology of technology might benefit each other. The social construction of technological systems: New directions in the sociology and history of technology, 1987-17.

Potter, S. (2008). The challenge of sustainable suburbia.

Rip, A. (2002). Co-evolution of science, technology and society. expert review for the Bundesministerium Bildung und Forschung's Förderinitiateve, Politik, Wissenschaft und Gesellschaft, as managed by the Berlin-Brandenburgische Akademie der Wissenschaften, Twente University, Enschede.

Roberts, F. S. (1976). Strategy for the energy crisis: the case of commuter transportation policy. Structure of decision, 142-179.

Robson, C. (2002). Real World Research. 2nd. Edition. Blackwell Publishing. Malden.

Rogers, E. M. (1962). Diffusion of InnovationsThe Free Press of Glencoe. New York.

Rosenberg, N. (1983). Inside the Black Box. Cambridge Books.

Schumpeter, J. A. (1934). The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle (Vol.55). Transaction Publishers.

Schumpeter, J. A. (1939). Business cycles (Vol. 1, pp. 161-74). New York: McGraw-Hill.

Schumpeter, J. A. (1942). Socialism, capitalism and democracy. Harper and Brothers.

Schumpeter, J. A. (1943). Capitalism in the postwar world.

Shinnar, R. (1975). The Effect of the Energy Crisis on the Private Car in the US. Transportation Research, 9(2), 87-95.

Shove, E., & Walker, G. (2007). CAUTION! Transitions ahead: politics, practice, and sustainable transition management. Environment and Planning A, 39(4), 763-770.

Singhal, A., & Dearing, J. W. (Eds.). (2006). Communication of innovations: A journey with Ev Rogers. Sage.

Speh, T. W., & Hutt, M. (1989). Business Marketing Management–A Strategic View of Industrial and Organizational Markets. Chicago et al.

Stainton-Rogers, W. (2006). Logics of enquiry. Doing postgraduate research, 13, 73.

Stern Review (Stern, 2007)

Suarez, F. F., & Oliva, R. (2005). Environmental change and organizational transformation. Industrial and Corporate Change, 14(6), 1017-1041.

Tate, E. D., Harpster, M. O., & Savagian, P. J. (2008). The electrification of the automobile: From conventional hybrid, to plug-in hybrids, to extended-range electric vehicles. SAE International.

Taylor, G. W., & Ussher, J. M. (2001). Making sense of S&M: A discourse analytic account. Sexualities, 4(3), 293-314.

Thompson, S. K. (1997). Adaptive sampling in behavioral surveys. NIDA Res Monogr, 167, 296-319.

Unruh, G. C. (2000). Understanding carbon lock-in. Energy policy, 28(12), 817-830.

Vaccaro, V. L. (2009). B2B green marketing and innovation theory for competitive advantage. Journal of systems and Information Technology, 11(4), 315-330.

Van de Ven, A. H. (1986). Central problems in the management of innovation. Management science, 32(5), 590-607.

Van den Bergh, J. C. (2011). Environment versus growth—A criticism of "degrowth" and a plea for "a-growth". Ecological Economics, 70(5), 881-890.

van den Bergh, J. C., Faber, A., Idenburg, A. M., & Oosterhuis, F. H. (2006). Survival of the greenest: evolutionary economics and policies for energy innovation. Environmental Sciences, 3(1), 57-71.

van den Bergh, J. C., Truffer, B., & Kallis, G. (2011). Environmental innovation and societal transitions: Introduction and overview. Environmental Innovation and Societal Transitions, 1(1), 1-23.

Van Lente, H. (1993). Promising technology. The Dynamics of Expectations in Technological Developments. Enschede.

van Lente, H., Hekkert, M., Smits, R., & van Waveren, B. (2003). Roles of systemic intermediaries in transition processes. International journal of innovation management, 7(03), 247-279.

Vogt, W. P. (1999). Dictionary of Statistics and Methodology. 2nd.

Walker, G. H., Stanton, N. A., Salmon, P. M., & Jenkins, D. P. (2008). A review of sociotechnical systems theory: a classic concept for new command and control paradigms. Theoretical Issues in Ergonomics Science, 9(6), 479-499.

Weber, Hoogma, Schot and Lane, B. (1999) Experimenting with sustainable transport innovations: a workbook for strategic niche management. Universiteit Twente

Weick, K. E. (1995). Sensemaking in organizations (Vol. 3). Sage.

Wells, P. E. (2013). Business Models for Sustainability. Edward Elgar Publishing.

Wiebe, G. D. (1951). Merchandising commodities and citizenship on television. Public Opinion Quarterly, 15(4), 679-691.

Wimmer, R., & Dominick, J. (2013). Mass media research. Cengage Learning.

Woodrum, E. (1984). "Mainstreaming" content analysis in social science: Methodological advantages, obstacles, and solutions. Social Science Research, 13(1), 1-19.

Yin, R. K. (1989). Case Study Research: Design And Methods (Applied Social Research Methods) Author: Robert K. Yin, Publisher: Sage Publicat.

Appendices

Appendix 1- Protocol for the semi-structured interviews of pioneering EV users

Table A1: Protocol for the semi-structured interviews of pioneering EV users

Inform the interviewee about the following:

As a reminder, my research is related to innovation by pioneering businesses exploring LEV use in the UK. I am particularly interested in organizations that are operating or could potentially operate in the region around Milton Keynes and its Plugged-in-Places partners. Your responses are confidential, and you can withdraw permission to use them at any time.

We may also use this information during our biannual Business User Workshops, in the case that your organization has capabilities or experiences relevant to the issues experienced by our participants. You can also withdraw permission to discuss this information during the workshops at any time.

The interview is expected to take approximately half an hour, and consists of six questions. This is a semi-structured interview, so please consider questions as conversation starters and not as rigid guidelines.

Notes for the interviewer:

a) Always ask the main question. Use the sub-questions only if the themes do not emerge spontaneously from the interviewee's answer, and try to insert them naturally as conversational prompts.

b) When possible, do some preliminary research on the organization and use it to fine-tune the questions. Use the note space provided.

Questions:

1-Tell me about your organization, and its experience with EVs.

1.1- When did you start exploring low carbon transport, who initiated this exploration (individual/department) and why?

1.2- What is your current position regarding exploration of low carbon vehicles?

1.3- What are your current and expected capabilities for providing guidance on LEV support networks?

2-Tell me about the fit of EVs to the goals of your organization (and/or your partner's), and their implications for competitiveness.

2.1-Have you identified any benefits, current or expected, making further work on the EV

field desirable?

2.2-Do you know about any issues and challenges that have been identified by your organization and partners and that may be slowing down adoption?

2.3-Do you have any reasons to expect a change in the costs, barriers and benefits?

2.4-Do those expected changes require any adjustments in your LEV strategy?

3-EV technology is relatively new. What can you tell me about the learning process involved in working with EV-related stakeholders ?

3.1-Would adoption of EVs require significant differences in the practices of your organization? (e.g., operations, business models, accounting, regulations, etc...)

3.2-What can you tell me about the learning curve experienced by your organization in its exploration of EVs? (Purposiveness, surprises, resources)

3.3-Do you have enough information on performance, regulations, market trends, etc... for your customers to make long-term decisions on EV investment?

3.4- If not, what is missing, and where would you look for it?

4-Do you need third party support to make work in the field of EVs practical for your organization?

4.1- Do you need support from third parties to learn about LEVs in your business?

4.2- Do you need any practical support and services from third parties?

4.3- Are you receiving support (practical or learning) from any formal networks (e.g., professional, industry or governmental associations)?

4.4- Are any of those support structures different to those required for traditional (ICE) vehicles?

5-Do you have the capabilities required to provide EV-related services and advice, either by yourself or in collaboration with other partners?

5.1- What kind of support can you provide for third parties that want to integrate LEVs into their operations?

5.2- Do you have any partners or networks that can support you in providing EV-related support and services?

5.3- Is there any aspect in your delivery of EV-related services that could be improved by a third party? (e.g., a partner, infrastructure deployment and management, a provider of complementary services)

6- Has your work on EVs benefited directly or indirectly from Milton Keynes' PiP programme?

Appendix 2- Ethics and Consent Forms

Table A2: Risk checklist by the Human Research Ethics Committee of the OU		**Yes**	**No**
1	Does the study involve participants who are particularly vulnerable or unable to give informed consent? (e.g. children, people with learning disabilities)	☐	☒
2	Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of a self-help group, residents of nursing home)	☐	☒
3	Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places)	☐	☒
4	Will the study involve discussion of sensitive topics (e.g. sexual activity, drug use)?	☐	☒
5	Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involve invasive, intrusive or potentially harmful procedure of any kinds?	☐	☒
6	Is pain or more than mild discomfort likely to result from the study?	☐	☒
7	Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?	☐	☒
8	Will the study involve prolonged or repetitive testing?	☐	☒
9	Will financial inducements (other than reasonable expenses and compensation for time) be offered to participants?	☐	☒
10	Will the study involve recruitment of patients or staff through the NHS or the use of NHS data?	☐	☒

| 11 | Will the study involve the collection of human tissue or other human biological samples? | ☐ | ☒ |

☒

Table A3 : Consent form for semi-structured interviews

Consent form – Electric Vehicle Project interviews

Project title: Milton Keynes Electric Vehicle Project

Agreement to participate

I,   (print name)

Agree to be interviewed as part of this research project.

1. I have had the purposes of the research project explained to me.
2. I have been informed that I may refuse to participate at any point by simply saying so. Participation is voluntary and I am free to withdraw from the research any time. I am free to refuse to answer questions.
3. I have been assured that my confidentiality and that of my organisation will be protected. Neither I nor my organisation will be identified in any outputs of this research.
4. I agree that the information that I provide can be used for educational or research purposes, including publication.
5. The interview will be audio-recorded. However, I have the option to decline the recording. I can request destruction of the recording up to two weeks after it is made.
6. I understand that if I have any concerns or difficulties I can contact **Prof. Stephen Potter** at 01908 652634. If I wish to complain about any aspect of my participation in this project, I can contact **Dr. Anne Smith**, who is the Director of Research Programmes at the Business School and her direct line is: **01908 655669**.
7. I assign the copyright for my contribution to the researcher for use in education, research and publication (e.g. an unattributed quote for illustrative purposes).

Signed: Date:

Table A4: Verbal statement of confidentiality used for telephone interviews
Introduction: As a reminder, my research is related to innovation by pioneering businesses exploring LEV use in the UK. I am particularly interested in organizations that are operating or could potentially operate in the region around Milton Keynes and its Plugged-in Places partners. Your responses are confidential, and you can withdraw permission to use them at any time. We may also use this information during our biannual Business User Workshops, in the case that your organization has capabilities or experiences relevant to the issues experienced by our participants. You can also withdraw permission to discuss this information during the workshops at any time. The interview is expected to take approximately half an hour, and consists of six questions. This is a semi-structured interview, so please consider questions as conversation starters and not as rigid guidelines.

Appendix 3- Glossary

Abduction   The process of forming an explanatory hypothesis through a mixture of established theoretical models and new concepts derived from iterative confrontation of theories and empirical evidence."(Hoffman 1997;Dubois and Gadde 2002)

Actor   An actor is an entity that creates and negotiates meaning. According to Callon and Latour (1981) macro-order to consist of macro-actors (institutions, organizations, social classes, parties, states) who have successfully the will of micro-actors (individuals, groups, families) into a single will for which they speak.Because there is no difference between the actors which is inherent in their nature, callon and latour propose that macro and micro actors must be examined using the same tools and the same arguments.

adoption   Uptake of the program or innovation by the target audience.

Alignment   The process gradually linking heterogenous elements (institutions, regulations, expectations, skills, infrastructure, etc.) into a working configuration, building stability and momentum (Geels, 2005; Geels and Kemp, 2007)

Articulation   An iterative, inherently creative process in which stakeholders try to unravel preferences for and address what they perceive as important characteristics of an emerging innovation. (Boon et al., 2008)

Black boxing   Treating a given dimension of a phenomenon of interest "in a highly abstract way as a collection of activities going on inside a black box, the contents of which are never subjected to systematic examination" (Rosenberg, 1994, p 202).

bottom-up   In policy design, starts from the perspective of the target or implementer. Associated to a perspective of institutiosn as emerging spontaneously from social norms, customs, traditions, beliefs and values of individuals within the organization.

CABLED   Coventry and Birmingham Low Emission Demonstrators , The CABLED project ran from 2009 to June 2012. It showcased electric cars across Birmingham and Coventry, making ultra-low-carbon vehicles available to real users and collected data on everyday use.

Command and control   A label, often pejorative, used to describe a top-down policy approach based on reductionist rationality. Its main characteristic is the use of regulation in effort to replace human judgement with the dictates of rules and structures. (Walker et al., 2008)

deficit model   Public makes undesirable choices because of a lack of public understanding or knowledge.In this formulation, it is the public that are assumed to be 'deficient', while science and authority are "sufficient". The obvious implication for policy is that public information campaigns should be instigated, as if the public knew

better they would change their irrational behaviour.

difussion	The overall spread of an innovation, the process by which an innovation is communicated through certain channels over time among the members of a social system.
Disruptive innovation	Innovation that shift a product's key dimensions of merit. Sustaining technological changes are relatively easy for incumbents, while shifting value chains and initiating disruptive technological changes is very difficult for incumbents (Christensen and Bowler, 1996). In contrast, incremental innovations enhance existing dimensions of merit.
Downstream	In social marketing, interventions addressing individual behaviour change.
ELVIS	Electric Vehicle InfraStructure project, a consortium coordinated by the Milton Keynes partership that places the successful bid for participation of the city in the PiP programme.
EST	Energy Saving Trust, a non-profit organisation funded mostly by the British Government, tasked with providign evidence-based insight and advice advice to communities and households on how to reduce carbon emissions, use water more sustainably and save money on energy bills. Activities include programmes aimed at fuel efficiency in fleets, electric vehicles "pluuged-in Fleets initiative" (PIFI).
EV	Electric Vehicle.
evolutionary economics	A class of models that explain societal and organizational change as a process of imperfect learning and discovery, where mechanisms of selection, retention and reproduction cause increased survival of variants that increase "fitness".
Experiment	In SNM, "experiment" refers to the limited introduction of technologies in a semi-controlled environment. To stress the idea that learning is central in SNM we prefer to use the notion of experiment rather than notions such as demonstration or pilot projects. The learning goues beyond the technical, includes dimensions like user needs, societal benefits and regulatory requirements.
First and second order learning	First order learning refers to learning that corrects errors or maximizes performance within the framework provided by existing goals, values, plans and rules. Second order learning involves questioning the role of the framing and learning systems which underlie actual goals and strategies.
ICE	Internal Combustion Engine
Incremental innovation	Innovation that provides new features, benefits or improvements building on established technology and production competences targeted to existing markets and customers.

Innovation	An iterative process initiated by the perceptoon of a new market and/or new service opportunity for a technology-based invention which leads to development, production and marketing tasks striving for the commercial success of the invention.
Intervention	A deliberately initiated attempt to introduce new, or modify existing, patterns of collective action.. Deliberate initiation means that an intervention is: institutionally sanctioned; formally or informally defined; consciously planned; and intended to lead to a changed outcome.
Joined-Cities Plan	An £11m electric vehicle plan, announced Sept 2009, supporting nine cities - Birmingham, Coventry, Glasgow, London, Middlesbrough, Milton Keynes, Newcastle, Oxford and Sunderland – with the rollout of a single national cost-effective and compatible network of recharging points.
Low carbon living	"Milton Keynes Low Carbon Living Strategy and Action Plan", approach outlining a series of measures by city council and strategic partners with target of 40% reduction of carbon emissions per person in MK by 40% by 2020 and intended to place MK at the forefront of low carbon living, nationally and internationally.
Market niche	A distinct application domain for an innovation, with substantially different functionality and price sensitivity, where adoption for a product unsuitable for mainstream markets becomes feasible.
MLP	Multi Level Perspective of socio-technical transitions, a framework for understanding the interplay of nesting macro, meso and micro levels of structuration and coordination involved in sustaining or changing sociotechnical systems.
Model	Assumptions about a limited set of variables and parameters to derive precise predictions about the results of combining these variables using a particular theory.
OLEV	Office for Low Emission Vehicles. The office was formed in 2009 in order to coordinate the efforts of the Departments for Transport; Business, Innovation and Skills; and Energy and Climate Change. It is tasked with providing support the early market for ultra-low emission vehicles (ULEV)and positioning the UK at the global forefront of ULEV development, manufacture and use.
PIFI	Plugged-in Fleets Initiative. A programme funded by the DfT and managed by the EST, based on a bespoke analysis on 100 fleets to identify specific applications were EVs use can be beneficial to organization.
PiP	Plugged-in Places. programme that ran between 2010 and 2013, suporting deployment of EV charging infrastructure concentrated in selected areas of the UK (East of England, Greater Manchester, London, Midlands, North East England, Northern Ireland, Scotland, and Milton Keynes), to address "range anxiety" of pioneering EV users. Additionally, the programme was expected to

generate a body of knowledge that could be useful for future development of a national recharging network.

Protected niche	'Experimental spaces' not affected by the prevailing market forces, designed to provide opportunities to learn about an innovation.Protection prevents the rejection of the innovation because of a too harsh selection environment, and the expectation is that the protection will be removed once the cost and performance characteristics of the innovation have improved.
Radical innovation	Innovation that obsoletes much of the existing investment in technological skills and knowledge, designd, production techniques, plants and equipment. Usually they do not address a recognized demand but instead create a demand previously unrecognized by the consumer.
Regime-shift	A change in the prevailing set of routines used by the actors in a particular area of technology
SNM	Strategic Niche Management, a framework for managing of the process of niche creation, development and breakdown to enable regime shifts. SNM seeks identify and reinforce protective spaces where promising technologies can be tested and developed for competition in unprotected mainstream markets.
Socio-technical niche	Loosely defined sets of formal and informal rules for new technological practice, usually explored in societal experiments and protected by a relative small network of industries, users, researchers, policy makers and other involved actors
Socio-technical regime	A relatively stable configurations of institutions, techniques and artefacts, as well as rules, practices and networks that determine the "normal" development and use of technologies. Regimes fulfil socially valued functions, which they also help to constitute.
Socio-technical systems	Networks of agents interacting in a specific technology area under a particular institutional infrastructure to generate, diffuse and utilize technology. Technological systems are defined in terms of knowledge or competence flows rather than flows of ordinary goods and services. It takes the inter-organisational community or field as the unit of analysis, and focuses on the social infrastructure necessary to develop, commercialise and use innovations.Socio-technical system builders travel between domains such as economics, politics, technology, applied scientific research and aspects of social change, weaving a seamless web into a functioning whole.
Stylization	One important difficulty in research is to find an appropriate level of abstraction. The model should be parsimonious enough to avoid distraction by minor details and at the same time rich enough to capture the relevant aspects of the phenomenon. In this context, "stylization" refers to the simplified presentation of an empirical findings concentrating on broad tendencies and

ignoring individual detail.

top-down | In policy design, start from the highest level policy maker and design a policy to influence the lowest level actor (target or implementer) . Related to a conception of institutions as predominantly shaped by laws and regulations by leaders.

Transition | a process of evolution and transformation leading to fundamental changes in society over a generation or more.

Upstream | In social marketing, interventions addressing the structural environment (circumstances) and its effect on the behaviour and choices available to individuals.