"The imagined electric vehicle user: insights from pioneering and prospective buyers in Milton Keynes, United Kingdom"

Authors
Valdez, AM (corresponding author, a..m.valdez@open.ac.uk),
Potter, S. and Cook, M.,
Department of Engineering and Innovation, Open University, United Kingdom

Abstract

This research explores how socio-technical imaginaries about electric vehicles and their users developed in the context of the Plugged-in Places programme in Milton Keynes, UK. Jasanoff and Kim (2009, 2013) define socio-technical imaginaries as *"collectively imagined forms of social life and social order… reflected in the design and fulfilment of nation-specific scientific and/or technological projects"* and draw attention to the capacity of imagined futures for shaping the technological search space and social responses to innovation.

This research focuses on the imaginaries of pioneering and prospective adopters of EVs in business organizations in Milton Keynes. The imaginaries of organizational buyers and fleet managers subtly shaped their exploration of early-market vehicles as they articulated the demands, barriers and motivations of users within their firm. This research draws on a thematic analysis of interviews with business and governmental actors, policy documents and trade literature discussing the early-market adoption of EVs by business organizations.

The results identify the processes through which business adopters make sense of the new technology as well as the policies and organizations that supported their learning process. In addition to technical concerns, key aspects concerned patterns of use and demand, fitness for operations, and new business and operational models suited to the characteristics of EVs. Thus, it is concluded that the imaginaries of business adopters and of the organizations supporting them increasingly envision adopters not just as rational optimizers but also as complex problem solvers working out new ways to embed EVs in innovative, competitive configurations that work for them.

Introduction

In the last ten years, the electrification of transport has emerged as an important part of UK policy for energy and climate change (DECC, 2009; DECC & OLEV, 2011; DfT, 2018). Following the Climate Change Act of 2008, decarbonization of transport became key to the UK's stance to avert catastrophic climate change. Battery-powered Electric Vehicles (EV), however, had serious disadvantages compared to internal combustion engine vehicles owing to their significantly higher cost, limited range and long charging times. Thus, UK government supported the formation of an early market for EVs through interventions such as consumer subsidies, regulatory support and programmes for the deployment of vehicle charging infrastructure. This research takes one such initiative, the £4.9m *Plugged-in Places* programme in Milton Keynes, as a point of departure to explore how prospective EV adopters were imagined and how this affected the design and outcomes of a series of EV interventions made between 2008 and 2018. This research has a particular focus on pioneering and prospective business adopters, involving fleet managers and other organizational decision-makers engaged in systematic early-market assessments of the competitiveness of EVs. In order to provide context for this city-based case study, national policies and discourses regarding low carbon and electric vehicles were also studied.

This research draws on documentary and interview data spanning the period 2000 to 2018. Our interviews of pioneering and prospective adopters took place between 2010 and 2013, consistent with an understanding of the early market for EVs. Nonetheless, we have augmented these data with documentary analysis covering a period between 2000 and 2018, providing an understanding of the policy context and the lasting impact of the Plugged-in Places programme. The originally purpose of this research was the identification of stated and implied demands of pioneering and prospective adopters of EVs in business organizations and the assessment of the degree to which existing interventions addressed those demands. Early adopters (Rogers, 1962) or lead users (Von Hippel,

1986) are motivated to adopt technologies ahead of the market and can demonstrate the demand for technologies before the mainstream. Here we use the term "pioneering and prospective adopters" to indicate that important learning and assessment processes are performed by actors who may ultimately decide not to adopt a new technology (and therefore cannot be rightfully called users or adopters). The research focused on organizational buyers and fleet managers interested in EVs; this was because they had established vehicle acquisition systems and professional staff who had a solid awareness of the demands, barriers and motivations of their organisation's end users. It quickly became apparent that government-led interventions made a number of assumptions about imagined EV pioneers and tensions arose when actual adopters failed to behave as envisioned. One noticeable feature was the lack of engagement with, or understanding of, users and consumers beyond the assumption that they would respond rationally to economic stimuli and to the increased availability of vehicle charging infrastructure.

Some limitations of early EV policy in the UK may be attributed to failures of imagination, and so could be analysed in terms of socio-technical imaginaries. Jasanoff and Kim (2009, 2013) draw attention to the capacity of imagined futures for shaping the technological search space and also their impact on shaping social responses to innovation. They define socio-technical imaginaries as *"collectively imagined forms of social life and social order… reflected in the design and fulfilment of nation-specific scientific and/or technological projects"* (Jasanoff and Kim, 2009, p. 120).

It is worth noting that socio-technical imaginaries are also shaped by experts' perceptions of present and future publics (Ballo, 2015). Perceptions or imaginaries of an anticipated 'public' can be invoked for various purposes within technical, industrial and policy networks and be present at key decision-making points in evolving trajectories of technology development. The mechanisms through which innovations are supported are designed in function of the specific characteristics attributed to imagined publics (Ballo, 2015; Barnett et al, 2012).

This research contributes to an evolving conversation about the effect that imaginaries have on the adoption of sustainable innovations in general and electric vehicles in particular. Brown (2001) already observed that assumptions about the criteria that users would use to evaluate EV technologies had a defining impact on the delivery of the Zero-Emission vehicle programme in California. Of particular relevance to this research is an observation that still holds twenty years later: Brown noted that early market EVs would not offer ranges comparable to internal combustion vehicles, and that instead of presenting them as direct replacements it might have been more productive to emphasize the differences, such as the new convenience of home recharging, the quiet motors, and the decreased need for maintenance. Nykvist and Whitmarsh (2008) and Bergman et al. (2017) undertook purposive analysis of visioning documents prepared by or on behalf of a variety of actors in industry, government and various transport coalitions and observed that the dominant vision, one of simple technological substitutions, would diminish the transformative potential of EVs. Visioning documents published 2002-2015 overwhelmingly imagined the public as rational and economic-oriented consumers, improving the efficiency of existing patterns of use, envisioning a low-carbon version of business-as-usual rather than exploring a variety of futures. Bergman et al. (op. cit.) suggest that there is a significant risk that actual behaviours will not conform to the rational optimising model and, consequently, that interventions based on such an imaginary will not help diffuse the innovations they discuss. Ryghaug and Toftaker (2016) reached similar conclusions through interview-based research that drew on insights from key stakeholders (including local authorities, governmental and non-governmental organizations and EV manufacturers) to explore how user imaginaries influenced the way strategies and policies were formulated to promote the future of electric mobility in Norway. Interview data largely suggested that imagined laypeople were generally constructed as cost-concerned, rational consumers, although a small number of interviewees mentioned the need to change mobility practices more fundamentally.

This research therefore seeks to contribute to a developing body of literature exploring the impact of imaginaries on shaping EV policy and ultimately encouraging the widespread adoption of

more sustainable transport technologies. The remainder of this article is structured as follows: First we introduce the national policy context in the UK (Section 2), taking the Climate Change Act of 2008 and the subsequent formation of the Office for Low Emission Vehicles as a crucial junction in the making of EV policies and imaginaries. We identify a tension between infrastructure-oriented interventions and knowledge-oriented demands that shaped early-market EV policy in the UK during the period under study and suggest that government-led interventions made several assumptions about imagined EV pioneers, with tensions arising when actual adopters failed to behave as envisioned. Then we present a conceptual framework for studying that tension through the conceptual lens of sociotechnical imaginaries. We suggest a suitable methodology for their study based on thematic analysis of policy documents and interviews with pioneering and prospective adopters, particularly those in business organizations (Section 3). This is followed by a case study centred on the Plugged-in Places programme supporting pre-market and early market support for EV adoption in Milton Keynes between 2010 and 2012 (Section 4). The case study is followed by an analysis and discussion (Section 5) and conclusions (Section 6).

2-Policy Context- Rational and sensemaking adopters in UK policy imaginaries

The EV policies and associated socio-technical imaginaries observed through the case study in Milton Keynes must be studied within the context of successive policy actions by the UK government following the passing of the 2008 Climate Change Act, which initiated widespread shifts in industrial and governmental priorities. Several new institutions were created, with the Office for Low Emission Vehicles (OLEV) being particularly relevant to this research. OLEV was formed in 2009 to coordinate the efforts of the Departments for Transport, Business, Innovation and Skills and Energy and Climate Change in support of the formation of an early market for ultra-low emission vehicles. While a variety of ultra-low emission vehicle technologies were considered (including, for example, hydrogen fuel cells), plug-in battery-powered EVs were identified as the most feasible solution for decarbonization of transport in the medium to short term. OLEV's programme portfolio for developing an early market

for EVs seemed to be a direct answer to the King Review on low carbon cars commissioned by the UK government, which concluded that *"in addition to making plug-in vehicles more affordable and stimulating technological innovation, having the right infrastructure in place to support plugin 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 was allocated as follows:

- £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)

Broadly these three funding allocations have since remained central to EV policy in the UK. These three components suggest a relatively simple functional understanding of the stimuli and barriers to EV adoption. High initial costs and range anxiety were assumed to be the major barriers for adoption. Those barriers were addressed through a two-pronged approach based on financial incentives and infrastructure deployments. One noticeable absence was in the lack of engagement with or understanding of users and consumers, beyond the assumption that they would respond rationally to economic stimuli and to the increased availability of charging 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:

> *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 the Plugged-in Places programme, in Transport Committee 2013, pp 8,9 of oral evidence appendix).

One notable exception, and an example of a more knowledge-oriented intervention, was the Energy Saving Trust's Plugged-in Fleets Initiative (EST, 2013) through which Transport for London and the Department for Transport provided funding to support twenty organisations with analysis into their real-life fleet data. Plugged-in fleet advisers selected a diverse range of fleets in order to achieve a range of insights that could be shared with fleet managers, policymakers and other interested stakeholders. Participating fleets received a tailored report with recommendations on where EVs could replace existing petrol or diesel vehicles and add value to their business operations. The Plugged-in Fleets Initiative programme had relatively limited reach, working with the commercial providers of 20 fleets in 2012 and adding a further 100 in 2013. The relatively limited reach of the initiative is largely attributable to the labour-intensive nature of the programme, which required in-depth face-to-face interaction with fleet managers (EST, 2013, p14).

This tension between infrastructure-oriented interventions and knowledge-oriented demands that shaped early-market EV policy in the UK can be usefully explored through the conceptual lens of socio-technical imaginaries. The following section will develop a conceptual approach and introduce the method used for this research. Thematic analysis was used to identify the dominant imaginaries and to explore how they shaped policy interventions and strategic decisions by pioneering and prospective adopters of EVs in business organizations.

3- Research methods and conceptual approach

This research draws on documentary and interview data spanning the period 2008 and 2018. Our interviews of pioneering and prospective adopters span a period between 2010 and 2013, consistent with the development of the early market for EVs in Milton Keynes during the Plugged-in

Places programme. The documentary component of the analysis is focused on the period between 2008 and 2018, providing an understanding of the policy context, its evolution, and the lasting impact of the Plugged-in Places programme.

The documentary component of this research involved transport practitioner literature and transport policy documents. The practitioner literature provided 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.

The policy and industry documents that informed the context for the Plugged-in Places programme were also analysed. Priority was given to documents discussing or enacting policy actions with a direct impact on actors in Milton Keynes and the surrounding region. The year 2000 was selected as the starting point for this review because of the enduring influence the report "Energy: The Changing Climate" (RCEP, 2000) had on UK energy policy and, by extension, on transport policy. Other key documents included Eddington 2006, Stern 2007, King 2007, 2008, DECC 2011, Transport Committee 2012 and DfT 2018.

Given the low market penetration and relative lack of maturity of EV technology through the period under study, only a limited number of business organizations using EVs could be identified in Milton Keynes. To identify potential interviewees, the research extended to organizations supporting the EV market and organizations exploring the possibility of adapting their business models for EVs. In total, 17 organizations exploring the use of EVs or supporting the EV market operating in Milton Keynes and the surrounding region were identified. Given the relatively small number of organizations involved, a total population purposive sampling strategy (Etikan et al., 2016) was pursued instead of a representative sample. Anonymous semi-structured interviews were arranged with decision makers in 13 organizations. Follow-up interviews took place for three of the interviewees after the initial

contact indicated that the organization was undergoing processes of particular interest. The interviews provided evidence related to the decision-making process of actual and prospective EV adopters from the following broad organizational categories:

- Local Government (3 interviews),
- Fleet Management (3 interviews),
- Fleet Drivers (2 interviews),
- Private Hire Taxicab Companies (2 interviews),
- Auxiliary Service Providers (2 interviews),
- Consultancies (2 interviews),
- Innovation and Development Agencies (1 interview),
- Community Organizations (1 interview),
- Shared ownership car clubs (1 interview)

Interviewees were asked to describe their organization and their role within it, the fit of EVs to the demands of their organization (barriers and benefits), the networking and learning process experienced and their partners and supporting organizations. An interview guide was used (Appendix A2) but the tone of the interviews was conversational, and interviewees were encouraged to provide their own insights and suggest other issues of relevance to their organization.

The interview transcripts and documentary materials were subject to thematic analysis (Braun and Clarke, 2006), a qualitative method based on coding and clustering for identifying, analysing and reporting patterns (themes) within symbolic materials. Relevant passages from the selected documents and interviews were coded in systematic fashion following an iterative analytical process. Initial coding was informed by a variety of literatures about interventions related to public-private innovation experiments (e.g., Hoogma, 2002; French, 2011; Geels, 2010; Mazzucato, 2013). While academic literature provided the starting point and ensured the work was theoretically grounded, new codes found in grey literature and primary data were allowed to emerge through the analysis. The initial list had 75 codes in total, including for example: *'Economic pressures on internal combustion*

vehicles, '*Economic pressures on EVs*', '*Technical Lock-in'*, '*Infrastructure barriers to adoption*', '*benefits valued by adopters*', '*benefits caused or reinforced by interventions*' and '*articulation of demand*'. Illustrative examples of the data associated with selected codes are provided in Appendix A1.

Following several iterations of coding and clustering, the emerging themes eventually clustered into two major perspectives. The first involved interventions addressing the perceived concerns of rational, optimizing adopters and the other was where interventions supported the perceived concerns of pioneering sensemakers. Both clusters were present in interviews of pioneering and prospective adopters as well as in documentary materials produced by policy actors.

The dominant imaginary was one where potential adopters were viewed as rational, optimizing decision makers largely concerned with technical specifications and price signals. This 'ideal' adopter might be called a 'Rational Resource Man' (Strengers, 2013), or '*homo economicus'*, who responds perfectly to price signals and seeks to optimize his/her behaviour. Strengers concludes that 'resource men' optimize for the system as it exists but they do not challenge the underlying assumptions. In consequence, early interventions influenced by this imaginary were largely focused on addressing the technical and financial shortcomings of EVs. This attended to 'range anxiety' (the concern with running out of electricity while driving) and with providing financial incentives such as purchase subsidies to reduce the high capital cost of an EV. A contrasting imaginary, however, conceptualized early adopters as sensemakers. This saw adopters as making collective sense of the new technology and building a shared vision of its potential, developing an understanding of the capabilities of the technology in itself together with its potential roles within its socio-technical context and its business ecosystem.

Sensemaking refers to the process of placing novel or unexpected stimuli into frameworks (Weick, 1995; Maitlis and Christianson, 2014). When a new situation arises, where existing organizational practices cannot continue to rely on automatic information processing, it is

sensemaking that enables them to comprehend, extrapolate and make projections. New stimuli are iteratively made sense of through a process of framing. Framing (Ostrom, 2011) identifies:

- the elements and general relationships among these elements that one needs to consider;
- theories that enable the analyst to specify which elements of a framework are particularly relevant to particular questions;
- models that involve making precise assumptions about a limited set of variables, and
- parameters to derive precise predictions about the results of combining these variables

The frameworks, theories and models produced as result of sensemaking processes may inform unwritten rules of the organization or may be formalized as operational and business models. Sensemaking is most visible when assumptions break down and ongoing activities are interrupted. Interruptions such as those caused by the introduction of innovative technologies initiate a process of information-seeking, meaning adscription and action. Alternatively, sensemaking activities may result in an understanding that action should not be taken or that a better understanding of the situation is needed (Weick, 1995).

Rather than rational optimizers, potential adopters of EVs could be imagined as sensemakers, learners and creative problem solvers who experiment with the new technology and develop new business and operational models for it. Interventions shaped by this socio-technical imaginary conceptualized barriers to adoption beyond the technical or financial, emphasising informational barriers resulting from a lack of information concerning EVs, their potentialities within specific socio-technical contexts and their potential role in the practices of the organization.

The case study presented in the following section suggests that both imaginaries were reflected by the strategies pursued by pioneering and prospective EV adopters. Many prospective EV adopters effectively thought about their task in terms of rational optimization, evaluating costs and

benefits of adopting EVs and attempting to offset the high initial cost against lower maintenance and per/mile costs. However, crucially, 'rational' adopters largely found the incentives insufficient to compensate for the perceived downsides of EV adoption. However, some pioneering adopters engaged in sensemaking activities as they developed new business and operational models and sought to enter or create new markets. Sensemakers perceived an opportunity for developing leadership and a competitive advantage, thus these creative problem solvers were more likely to develop and execute long term-strategies for the adoption of EVs. Whereas conventional subsidies and infrastructure investments addressed (albeit inadequately) the demands of the rational resource adopters, sensemaking adopters required a very different kind of support of a type that was largely unacknowledged and absent.

4- Milton Keynes as a Plugged-in Place

There are relatively few examples of urban-scale pro-EV interventions in the UK. Most of the measures enacted by the OLEV, such as the consumer incentives and the research programme, were applied at a national level. Sensemaking activities (e.g. those supported by the Energy Savings Trust) were applied on a business by business case. The OLEV-funded *Plugged-In Places* (PiP) programme was intended to provide a critical mass of infrastructure in a number of lead cities or regions, to complement the national level consumer incentives (Figure 1).

Figure 1 – Locations selected for deployment of the first stage of Plugged-in Places Programme (DECC & OLEV, 2011: 17)

Milton Keynes (MK), the focus of this research, was one of the eight regions selected for participation in the first round of the Plugged-in Places programme in 2009. A coalition of MK-based actors from local government, business and academia submitted a bid in response to the OLEV call,

seeking £2.3 million in matched funding out of a total project cost of £4.9m. This was to be applied towards:

- 1. Providing charging infrastructure to encourage the take-up of electric vehicles as part of a low carbon living concept;
- 2. Through point (1) help overcome public concerns related to 'range anxiety';
- 3. Explore and understand the relationship between electric vehicle use and other aspects of low carbon living, such as smart grids;
- 4. Assist in making Milton Keynes and the UK an attractive place for electric vehicle manufacturers to deliver product to;
- 5. Through points (1), (2) and (4) to help build the local, regional and national market for electric vehicles;
- 6. Introduce all available technologies, existing and emerging, so as to understand the pros and cons of each and identify through practical use those factors that help or hinder their introduction;
- 7. Introduce a range of operational models to understand through practical use the pros and cons of each;
- 8. Trial the interaction between the various elements of the infrastructure, including vehicles, charge posts, and associated communications systems.

  (Constantinides, 2009: pp ii-iii)

Following its successful £4.9m bid, Milton Keynes' first charging points installed under the PiP programme became operational in March 2011. However, in contrast to the user-centric goals outlined in the bid, the key performance indicators set by OLEV to guide the deployment suggested a much narrower conception of the project. Only three performance indicators (ibid, p 25) were to be used to measure progress, learn and improve performance:

- Number of charge points installed against delivery plans,
- Operational availability of installed charge points, and

- Driver utilisation of charge points

The key performance indicators were selected in response to restrictions in the government grant, which was structured in such a way that the funds could only be spent on infrastructure. Milton Keynes Council worked around the restriction by providing an environment where other actors, particularly those in private organizations, could support the processes of learning and engagement. Examples include consulting organizations such as Arup, community organizers and academic partners. The University Centre Milton Keynes, in partnership with the Open University and Cranfield University, supported the project in a number of related areas, including low carbon technologies, traffic analysis and planning and user behaviour, providing guidance to the project and incorporating the experience of the project into their courses.

The PiP programme in MK formally concluded at the end of 2013. Under this scheme, 170 electric vehicle charging points were installed and later transferred to the private sector to ensure continued operation, maintenance and expansion. Demand for EV charging infrastructure gradually increased and by 2018, 5 years after the conclusion of the programme, 300 charging points had been installed within the MK borough area, largely provided commercially by the private sector. The provision of charging infrastructure was successful, particularly in the sense that it raised awareness and attracted the interest of a variety of organizations that saw MK as a welcoming place to explore the capabilities of EVs. 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. The Wolverton e-car club (Crowdcube, 2013) is notable as a PiP-related initiative that attracted significant private investment and was replicated with commercial success in other locations. Other EV-related pilot programmes include the commercial electric bus route (Miles and Potter, 2014) and the LUTZ pathfinder pods (TSC, 2018). City authorities considered the PiP largely successful but acknowledged that further efforts would be required to demonstrate the capabilities and promote the uptake of EVs. Proposals drafted by the city council emphasized the importance of providing users with sufficient information, experience and support to

enable purchase or lease decisions to be made (MKC, 2016). In 2016 OLEV awarded an additional £9.18m in funding leading to the foundation of the EV Experience Centre as part of the MK Go Ultra Low City scheme.

In contrast to the infrastructure-centred PiP programme, the EV Experience Centre reflects a predominantly information-centred agenda explicitly informed by the LowCVP good practice guide "Local measures to encourage the uptake of low emission vehicles", with the section on education and communication (LowCVP,2015: pp 33- 37) being particularly relevant for understanding the activities of the centre. The LowCVP practices were largely aligned with a deficit model that attributed lack of interest in EVs to a lack of understanding (Schultz, 2002; 2014). Thus, the guide stated that low demand for EVs was linked to a low level of awareness and understanding of EVs and that for an individual or organisation to consider using an EV they first need to know that this is an option. Consequently, the recommended interventions were largely based on the provision of basic information such as vehicle options, range, incentives, infrastructure, costs. However, the guide also began to suggest the need for sensemaking activities, acknowledging that potential adopters might need support in order to understand how EVs would fit with their lifestyles or business needs and how they would go about switching (LowCVP, 2015). Information-centric best practices from the LowCVP are reflected in the activities of the EV Experience Centre. In addition to providing independent advice, allowing potential customers to experience and learn about EVs, the centre also targets the owner/operator private hire fleet, providing advice concerning the options which meet their demands to remove the perceived 'blockers' to long-term ownership (MKC, 2016, pp 16,17).

Locally, the deployment of the EV Experience Centre following the more infrastructure-centric PiP programme suggests that policy actors in Milton Keynes were developing a more nuanced approach to understanding of user demands, with a growing awareness on the role of innovative business models and entrepreneurship in the transition to more sustainable forms of transport. Nationally, this was 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, u*ltimately building the market requires initiative and entrepreneurial flair at a local level*"(DfT, 2013).

5 Analysis and discussion

The Milton Keynes case study provides examples of two significantly different user imaginaries linked to specific forms of intervention and to specific outcomes. This section will provide an analysis of how those imaginaries were embraced by pioneering and prospective adopters and by private and governmental organizations supporting them. The main findings will be illustrated through data in the form of selected quotes.

The dominant imaginary revealed through this analysis was one where EVs were exact replacements for internal combustion vehicles, with patterns of mobility, logistics and organizational structures identical to the existing ones. This sociotechnical imaginary was associated with a user imaginary where adopters were rational, optimizing decision makers who would make the transition only if EVs could match the technical and cost performance of internal combustion vehicles.

> *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, 2012).

Interventions designed to address such perceived barriers initially had limited impact for various reasons. The financial incentives that could be realistically provided were insufficient to outweigh the significant price difference and the existence of the financial incentive in itself was seen by some as a signal that the emerging products were not competitive. Additionally, the temporary nature of the programme engendered a lack of trust among business actors that had suffered the consequences of unstable policy environments before. The rapid withdrawal of the tax concession on liquified petroleum gas as a vehicle fuel in 2005 was an experience that led fleet managers to be cautious about moving to another non-commercially viable fuel entirely dependent on continuing government subsidy.

> *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, 2011).

> *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* (Interview with the head of strategic development of a fleet management organization, 2012).

This functional, like-for-like petrol-to-electric vehicle replacement imaginary, contrasted with a more dynamic imaginary that saw the potential to develop completely new products, services and patterns of mobility that could make full use of the advantages of EVs while offsetting their potential downsides. Organizational users that embraced this imaginary saw themselves as sensemakers, taking risks and investing in an emerging technology not only to develop a first-mover advantage, but also to make collective sense of EVs and develop new business and operational models. Interventions informed by this imaginary saw that some of the most pressing concerns of pioneering adopters were informational rather than technical or financial.

> *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).

> *… 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).*

> *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 Webinar)

Information about the new technology was highly valued by organizational users. Fleet managers and actors in similar positions had access to a very large body of knowledge regarding internal combustion vehicles but had very limited knowledge about EVs. They found that making significant investments and/or institutional changes in the absence of such a body of knowledge carried an unjustifiable degree of professional risk.

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 orde,r 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, 2012).

As mentioned previously, the Plugged-in Fleets initiative by the Energy Savings Trust was one of the leading programmes addressing the informational concerns of organizational actors. More recently, the EV experience centre in MK has concentrated on addressing the informational needs of households and organizations considering EV adoption. However, the Plugged-in Fleets initiative and the experience centre were not active in Milton Keynes as the early market was developing in the context of the PiP programme. This led to a situation in which infrastructure deployments and financial incentives stimulated the interest of various organizational actors in MK, but they found limited governmental support for sensemaking activities regarding fleet and business use of EVs. Faced with this situation some prospective business adopters only superficially engaged in sensemaking activities, assessing the suitability of EVs for their existing business and operational models. Others, however, engaged in a more profound form of sensemaking characterized by a willingness to interrogate and reconfigure their existing routines and frameworks. Such pioneering organizations made the newly acquired knowledge about EVs available to their customers and end-users. Meanwhile, other prospective business adopters received support from consultancies, academic actors and community groups, among others.

> *Really, the reason that we are doing this [running a limited EV pilot at their own cost and risk] 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, 2012).

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 at 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 local community group supporting a private EV initiative, 2012).

Because the learning process was not focused on the vehicle itself but on its use within its socio-technical context and its business ecosystem, early sensemakers found that knowledge about EVs in use was best produced collectively. This introduced a degree of tension owing to the competitive-collaborative nature of their undertaking, which called for a careful process of consortium-building often supported by trusted third parties such as consultants, community groups and public-private organizations such as the Energy Savings Trust and the Low Carbon Vehicle Partnership.

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, 2011).

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 stops 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 won't be lost (Participant observation of consultant for non-governmental enabling organization, 2014).

Making sense of the emerging EV technologies required significant planning and investment of time and money. EV adoption was also perceived to carry significant professional risk to the track

record and reputation of its champions, as a failed pilot programme could easily harm the career of a fleet manager. Several interviewees remarked that the negative experience of fleet managers who had championed liquified petroleum gas made them very cautious about aligning themselves with another alternative fuel. Despite the potentially high cost and the risk involved, pioneering EV adopters considered that organizational pilot programmes could be valuable investments for the future. Through these they could develop a first mover advantage and a positive reputation that could open the door to larger deployments as acceptation of EVs by mainstream markets increased.

> *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, 2013).

6 Conclusions

Overall, development of the early market for EVs in Milton Keynes suggests that direct financial incentives and infrastructure are insufficient to encourage widespread EVs adoption by fleets when they are considered as exact replacements for internal combustion vehicles. As long as imagination and socio-institutional innovation lag behind technical change and the new vehicles are forced to fit the same mobility patterns , a large number of users will find their cost and capabilities uncompetitive. Nevertheless, the PiP programme in MK was successful in that it stimulated the imagination of a small but dedicated number of organizational actors and initiated a collective

exploration of the capabilities and potential competitive advantages of the new technology, largely by fleet managers and other business adopters. While this collective exploration could have benefited from more governmental support (and indeed, policies and imaginaries are moving in that direction), a variety of pioneering business adopters succeeded in demonstrating that EVs can be used in compelling and competitive commercial applications. Such explorations open up the possibility that socio-institutional innovation will catch up with technical change, on the condition that organizations are willing to experiment and question the assumptions embedded in their business and operational models.

Importantly, such innovative approaches to electric mobility are entirely missed if users are imagined as actors that individually seek to rationally optimize existing ways of working. Early adoption of EVs was uncertain and unstable from such a strictly rational, optimizing perspective, and in consequence adoption by business users only succeeded when imaginaries made room for user innovation. While rational optimization is indeed a form of sensemaking, and a necessary one, disruptive innovations may call for more profound forms of sensemaking and organizational innovation characterized by a willingness to imagine radical reconfigurations. Thus, transport innovation should not be defined in ambitious but also narrow terms, with innovation appearing largely as a result of technological developments by technology centres, universities and automakers. An innovation imaginary based on collective practical learning acknowledges the role of pioneering adopters as innovators. Because such socio-technical innovation is predominantly acquired in a collaborative process of learning by doing, we argue that the development of truly novel forms of electric mobility can be encouraged through the creation of inclusive, ambitious experimental spaces where academics, technologists, entrepreneurs and policy actors come together and engage in the collective creation of new configurations that work. The experience of PiP in MK suggests that the creation of such spaces may not necessarily depend on the deployment of large-scale (and expensive) infrastructure deployments, but on a facilitative role that develops willingness to engage in collective acts of socio-technical imagination. This may depend on the role of local authorities as they establish

formal experimental spaces and act as neutral mediators (Smart Cities World, 2018), but effective, collaborative sensemaking also benefits from the participation of citizens and community groups (CAMK, 2017) and of business actors with the skills and resources required to face the risks associated with innovation experiments as they develop new and more competitive business models (Miles and Potter, 2014). Within urban-scale learning spaces, such as the one provided by PiP in MK, it becomes possible to imagine innovative applications for emerging and still imperfect transport technologies. Within such spaces and such imaginaries, a multiplicity of collective exploration, innovation and sense-making practices can be nurtured, potentially forging pathways toward more sustainable urban futures.

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APPENDIX A1 – Sample codes in documents discussing early market pro-EV interventions targeting fleet users

Appendix 1 – Sample codes in documents discussing early pro-EV interventions
Sample Code 1- 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). *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).
Sample code 2 – 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, 2010)

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)

APPENDIX A2 – Guide for the semi-structured interviews of pioneering EV users

Inform the interviewee about the following:

As a reminder, our research is related to innovation by pioneering businesses exploring EV use in the UK. We are 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 will be anonymised, 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.

Questions:

1-Tell us 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 EV 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 EVs 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 (internal combustion) 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 EVs 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?