Transition Pathways of Commercial-urban Fleet Electrification in the UK

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Abstract: Road transport accounts for 90% of UK transport emissions; by 2027 this is targeted to be reduced by 50% (OLEV, 2011). Electric vehicles offer a substantial opportunity to reduce road emissions, particularly to decarbonize the fleet market due to the sheer number of new registrations for business applications. However the diffusion of electric vehicles requires a transition across a large spectrum of societal and economic dimensions. The relationship between transition pathways and technological lock-in in the transport sector is under-researched, particularly in the field of e-mobility.

This paper explores the pathway for electric vehicles, identifying the development blocks and technological lock-in of existing vehicle types, in order to understand the opportunities for technology diffusion within commercial fleet applications. This study takes a small sample of cases to achieve an in depth exploration of the motivations and barriers to this technological change. Three UK commercial-urban fleets in differing sectors are examined to understand their individual contexts and the level of correlation with the challenges experienced by the fleet market as whole, and how these have or have not been overcome.

The multi-level perspective was used to determine the dynamics of change for fleets towards electric vehicles, and the roles of different stakeholder types were explored through the ‘action space’ of government, civil society and market logics. It is evident from the cases that an ‘innovator logic’ is competing to unlock EVs through technology innovation that extends beyond the transitional role of hybrids.

Keywords: Competing logics, Electric vehicles, Innovation, Multi-level perspective, Lock-in, Path dependency, Road transport

JEL Classifications: L20, M00, O30
Abbreviations: Electric Vehicles – EV,
Internal Combustion Engine – ICE,
Alternatively Fuelled Vehicles – AFV

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1. Introduction

Road transport accounts for 90% of UK transport emissions; by 2027 this is targeted to be reduced by 50% (OLEV, 2011). Within the Government’s Carbon Plan (2011 p,5) “ultra-low emission vehicles including fully electric, plug-in hybrid, and fuel cell powered cars are being developed” to decarbonize transport. An opportunity to reduce UK emissions is through the electrification of the fleet market; fleet vehicles comprise over 50% of all vehicles sold in the UK; this proportion has steadily increased over recent years and now accounts for approximately 14 million vehicles (SMMT, 2012) (Maslen, 2012).

This suggests that a decarbonization of the UK is impossible without substantive changes to transport and that a decarbonization of UK transport is impossible without serious attention to the fleet market. For many companies, fleet logistics impose the greatest financial and environmental burden due to the procurement, operations and maintenance of vehicles. Therefore this paper will focus on fleets adopting alternative vehicle types, specifically electric vehicles.

Fleets have used EVs for numerous reasons, including:

- Commercial fleets often have high utilization rates, centralized parking facilities as well as managed and known use patterns (Pike Research, 2010)
- Most fleets have space to accommodate charging infrastructure and are expected to have specific and known charging requirements derived from their drive cycle, destinations, time schedules and fleet size
- The concentration of buying power associated to fleets and the relatively small number of influential decision makers within the industry (Electrification Coalition, 2010)

However, a step change is required for EVs to gain further momentum in the fleet market. This may be best understood using the concept of path dependency and technological lock-in.

Therefore this paper will explore this field, asking:

(i) What are the current drivers and barriers of the fleet market towards EV?
(ii) What is path dependency and technological lock-in and how can this explain the evident lack of take-up?
(iii) What are the policy options to support a greater take-up?

In addressing these questions the paper will consider the broader extent to which UK fleets contribute to the transition to EVs and recommend how to enhance the rate at which this happens.

The paper is organized as follows: Section 2 explains the existing research in this field, including transition pathways, path dependencies and technology lock-in; set within the wider approaches of the multi-level perspective and competing decision logics; Section 3 explains the methodology of the three UK commercial-urban fleet case studies; Section 4 applies the ideas from technology lock-in and path dependency to the cases; Section 5 evaluates drivers and barriers that may explain the lack of take-up; and Section 6 concludes with a discussion of how technology lock-in can be addressed in this context.

2. Theory

This section will question (i) what are the current drivers and barriers of the fleet market towards EV? And (ii) what is the nature of path dependency and technological lock-in in the fleet transport context as well as (how) can this explain the evident lack of take-up? In order to explore
these questions, this section will make use of the multi-level perspective and competing logic theories to organize the analysis; along with lock-in and path dependency theories that assist in defining a successful transition pathway.

2.1 Transition pathways

Transition pathways can be defined as “a shift from one socio-technical system to another i.e. a system innovation” (Geels, 2005 p.682). It is further explained as the analytical framework utilized to examine a transition process and considers the key dynamics (Geels, 2011). Such a shift requires fundamental changes in market concepts through governance, social practices and business models that have been developed upon past and present technological systems (Foxon et al., 2012).

Transitioning within the automotive sector is extremely difficult due to “a wide range of powerful positive feedback processes that confer substantial advantage to the incumbent ICE technology” (Struben et al., 2008 p.3). The conversion from ICEs to EVs relies heavily on the bidirectional relationship between users and technology with influence from factors such as price, availability and convenience (Epprecht et al., 2014). In order to encourage technology diffusion within the automotive sector there are a number of mechanisms that could be implemented; remove market entry barriers, remove technology lock-in factors, focus on non-technical factors that prevent transitioning or focus on path-dependent technologies that may actually support the transition.

Transition pathways are influenced by a complex dynamic of economic, legal, social and technology concepts. There is a need to consider these market concepts further to establish the necessary changes that will lead to a transition pathway for the electrification of fleets. The policies in place today are appropriate for the early stages of the market, attempting to encourage EV uptake through monetary incentives, these however are not directed to commercial fleets.

2.2 Lock-in

Since the 20th century the car has been the dominant form of transportation, this has led to “a society, economy and culture tightly bound to [the] ICE” (Epprecht et al., 2014) (Koch et al., 2009 p5). This is central to the concept of technological lock-in, in which “technologies and technological systems follow specific paths that are difficult and costly to escape”, thus forming path dependencies (Perkins, 2003 p.1). Technology lock-in is further described as the impact on the market and standard for future designs from a dominant technology (Vooren et al., 2012). The key aspect this paper considers is the restriction lock-in places on new innovations entering a market i.e. electric vehicles in the automotive sector. More specifically, it considers the extent to which the car and the ICE rely on, and reinforce, systems, practices or habits that prevent the diffusion of EVs.

Lock-in is defined most frequently in pure technology terms such as battery capacity and vehicle design. However it is useful to consider social and cultural constraints such as range anxiety, status, driver expectations and brand allegiance. Such barriers are not overcome by technological innovation and regulation independently but require a combined approach within market specific conditions (Epprecht et al., 2014). This is particularly relevant with infrastructure-dependent vehicles which rely on investment in advance of use and non-exclusive to the funder, thus introducing economic lock-in intensified by sunk costs (Vooren et al., 2012). Unlocking vehicle technology requires humankind’s perspective of undesirable change to be adequately challenged using a collective methodology of economic, societal and technological change management models.

Vooren, et al. (2012) suggests there are 3 stages for infrastructure-dependent vehicles to enter mass market, starting from a position of lock-in; (i) a technology-push from Government in which variety is stimulated through aligning regulation and financial support for research & development,
(ii) Government influence in bringing the technology to the market through large scale pilot projects, (iii) consumer adoption which ultimately determines technology substitution, dependent on price and consumer fit. The role of Government is important for the longevity of new technologies as it “can affect the probability (and speed) of the technological substitution process” and it is at this point when innovations can fail (Vooren et al., 2012 p.114).

Jänicke (2000) emphasizes the relationship between technology and policy is extensive and varied, and that technology diffusion can result from any sequence of policy innovation, policy diffusion or technology innovation. Government is able to use the electrification of transport to contribute to climate change targets through the gradual reduction in carbon emissions aligned to the incentives for low emission vehicles.

Applying the concept of technological lock-in to EVs, three questions arise:

(i) What are the factors that lock technology in?
(ii) How significant are these factors?
(iii) What can be done to change these factors?

Answering these will establish the extent to which EVs are locked-out of the automotive based mobility system in the UK and the implications of a mutually reinforcing structure dominating vehicle manufacturing, procurement and use, has restricted opportunities to decarbonize and enhance efficiencies. This deserves further research to determine the transition pathway that can be pursued to overcome ICE dominance.

2.3 Path dependencies
Path dependency refers to “a dynamic theory assuming that initial events can increasingly restrain present and future choices” (Koch, et al., 2009, p. 67). Ahman et al. (2008) further explains the embedded characteristics from previous and existing markets govern new innovations, determining the route, speed and success of a new entrant to a market. Path dependencies are “generally seen as a barrier to change, but ... also a precondition for change” (Ahman et al., 2008 p.7). Therefore to understand the EV market and the diffusion of technology in fleets it is essential to explore path dependencies that are inherent to the automotive sector.

The car market has very strong path dependent characteristics that have become ingrained within society since the production of the motor car in the 1900s (Cowan et al., 1996). These have been stimulated through the mutually reinforcing social system of road transport encompassing infrastructure, service stations and roads. These contribute to the culture of road transport by which drivers are susceptible to and have engrained behavior as a result.

Path dependencies of cars range from design, specification, price and (sunk) technological costs. These path dependencies relate to the cost of manufacturing a car but also to the substantial infrastructure costs that allow the ICE to operate effectively. Path dependencies play an important role on innovation and entrepreneurship and are often fueled by low cost of entry, low unit costs and flexible and broad channels of supply.

Existing literature explains the significance of path dependency on new innovations; however it at times fails to consider the extent to which new (niche) and mainstream technologies can comparatively compete within a new market. EVs are entering a well established industry that is dominated by path dependencies of the ICE; it is these characteristics of lock-in that are limiting EV uptake. This research will begin to explore the extent path dependencies are restricting the transition to EV fleets; there is a need for further research specifically on this subject matter.
2.4 Multi-level perspective

The multi-level perspective (MLP) as a framework has been used to understand past transitions and consider current and future transitions (Mazur et al., 2014). The MLP argues transitions are a result of interactions between processes at three levels (Geels et al., 2007):

- Niche-innovations that build internal momentum through learning processes, support, price and performance improvements
- Destabilization of the regime creating opportunities for niche-innovations
- Changes at the landscape level creating pressure on the regime

Niche-innovations are alternative technologies, organizing systems and/or adapting behavior that can destabilize the existing market and achieve a transition. The transition to EVs is influenced by a broad and extensive range of factors; literature has yet to explore these in the context of the multi-level perspective. Alternatively, landscape pressures referring to, for example, climate change awareness results in action taken by governments leading to national and international targets towards a low carbon economy. Despite this, the automotive industry remains relatively stable; the lack of sector instability makes it more difficult for EVs to enter mass market and influence the wider landscape (Geels, 2004).

The processes internal dynamics and interactions can lead to a breakthrough in mainstream markets and existing regimes allowing competition to gain market share (Geels, 2004). EVs are being introduced within a path dependent innovation system, considered as niche-innovations that have begun to challenge and potentially destabilize the existing regime.

2.5 Competing logics

Foxon argues “transition pathways arise through the dynamic interaction of technological and social factors at and between different levels, mediated by the actions of actors within an action space” (Foxon, 2012 p.1). Foxon et al. (2012) introduces this action-space concept based on a conceptualization of there being three principle sets of competing actors in the governance of a low carbon system, each with their own governance logic; (i) market actors, (ii) government actors, (iii) civil society actors.

Foxon’s three logics represent the influence on the transition of new innovations as well as the fate of incumbent technologies but it is unclear whether this approach include all the dimensions associated to, and all possible pathways available to, a niche technological market. Innovation requires support from all of the existing three set of actors but it is important also to consider actors directly associated with technological change and technology availability, as they underpin the market. This argument is particularly relevant when applying the theory of competing logics to the automotive sector which suffers from extensive lock-in, both in terms of the technology itself and its conventional infrastructure (Foxon et al., 2013). This could be considered primarily as an element of the ‘market logic’ but there are such fundamental differences between the incumbent market actors (e.g. gasoline suppliers compared to EV charging equipment suppliers) that differentiation between market actors and innovators is warranted.

The EV market is currently relying heavily on the investment and promotion of niche players that are commercial entities but that sit outside of the set of current market actors, and have a distinct logic in their approach to the low carbon transition. This is largely due to the size or financial impetus of these organizations despite the realized or potential impact on the market. Therefore a fourth logic is proposed, the ‘innovator logic’, a technology innovation led approach to a low carbon transition in which niche players respond rapidly to market needs. Although the innovator logic may have relatively small market shares, the actors have significant influence on the
action space. This research draws attention to the role of the innovator logic within the EV market that has been responsible for significant progress of the niche technology. As in Foxon’s use of the original three logics, the ‘innovator logic’ is not assumed to operate exclusively, but is intertwined with the logics of the other set of actors, with innovators being reactive to the dynamic processes of path dependencies and structural changes.

3. Methodology

The research took a considered approach to gathering data on the niche technologies, choosing to create three in-depth fleet case studies. Case study research was appropriate to employ in order to help reveal how actors - in this case fleet owners and operators - influence the transition to a new dynamic and the impact of an ‘innovator logic’.

The fleets were chosen based on the diversity between characteristics of sectors, operations, vehicle procurement and EV experience. Considering the transition to EVs across a diverse mix of fleets operating in different sectors identifies the extent to which EVs are locked-out and the similarities in the challenges of EV adoption. The case studies explore procurement of vehicles, the company fleet strategy, employee reaction to vehicle and technology change, charging considerations and future projections of the fleet’s activities and transition to low carbon vehicles.

To examine the extent to which UK fleets contribute to the transition to EVs, the concept of path dependency and technological lock-in has been applied to three UK commercial-urban fleets:

- TNT Express Services UK & Ireland - the UK’s leading business-to-business express delivery operator
- Schneider Electric UK & Ireland - an energy management technology company
- Green Tomato Cars - a London based environmentally conscious private hire service

Interviews were conducted across a range of employees, including key decision makers, managers and, where possible, drivers experienced in using EVs. It was important to interview a range of employees that were involved with the company’s fleet and that were positioned across the business at different levels to ensure triangulation, reliability and objectivity to the results. The “corporate interview method is particularly appropriate in periods of economic and social change that challenge traditional analytical categories and theoretical principles” (Schoenbergera, 1991, p. 180). This is particularly relevant to the introduction of new technologies responding to legislation associated with climate change, as alongside the transformative change of vehicle type it has broader social implications. Questions were focused on the strategic intent and extent of EVs use and the associated targets, along with the challenges and barriers experienced and integration strategies.

A semi-structured approach with open-ended questions was used to achieve a level of comparability between the fleets as well as flexibility to encourage the embedded knowledge of fleet managers and fleet specific behaviors to be incorporated within the research. The contribution from practitioners strengthens the data and its analysis. All interviews were conducted by telephone for convenience of the interviewee whilst also gaining a level of rapport and flexibility. Interviews were recorded either using computer software or a Dictaphone to allow for uninterrupted conversation and reliability of data recording. In analyzing the interviews, content analysis was used in the broad sense that inferences were made through “objectivity and systematically identifying specified characteristics of messages” (Holsti, 1969 p.14). This approach enabled similar concepts within the text to be identified as well as consistent relationships and individualities specific to a certain environment.
This qualitative research is inductive, ensuring the nature of the relationship between theory and research is analyzed and highlights core strategies to fleet operations (Bryman, 2008). The scope of this research extends beyond the immediate fleets involved as analyzing fleet behavior across different sectors will provide an insight into varied fleet strategies. Regarding the interviews, content analysis was used in the broad sense that inferences were made through “objectivity and systematically identifying specified characteristics of messages” (Holsti, 1969 p.14). More specifically, summative content analysis was applied to compare the content and interpretation of the underlying context of each fleet (Hsieh et al., 2005).

The transition to EVs is based on the interaction between competing logics upon the action space; therefore the MLP was applied to the case study examples to explore structural change across these dynamics (Geels, 2011). This explores more broadly the process of environmental and system innovation.

4. Results

This section will analyze each fleet’s current positioning on EV procurement, which will then be discussed in the context of transition pathway theory in Section 5.

4.1 GTC

Green Tomato Cars offer “an environmentally friendly private hire minicab service in London for corporate accounts and one off bookings” (GTC, 2013 p.1). The business model aims to demonstrate that a ‘green’ business can be commercially successful within a competitive market with AFVs mainstream rather than niche. Within the fleet there are 410 vehicles; 8 bio-diesel people carriers, 6 bio-diesel executive cars (run on 30% vegetable oil) and 396 hybrid cars. All of which do an average of 120-150 miles per day mainly within central London. GTC trialed two Renault Fluence’s on the fleet in 2012 for six months. These vehicles had an effective, actual range of 60 miles (Renault states 99 miles) and were charged nightly without the ability to rapid charge. As a result, the vehicles could only be used for half a day and were limited to certain journeys, with greater emphasis on the destination rather than the pick-up point. However it was “logistically difficult to manage and was not commercially viable” (GTC, 2013). Ultimately “the Fluence did not have the range to be a viable component part of a fleet of an established private hire company” (GTC, 2013).

GTC’s experience demonstrates the embedded path dependent characteristics of ICE vehicles within the market that instigate the need to have 300+ miles and refueling within 5 minutes. This is particularly challenging if routes are unpredictable and requires flexibility. A driver at GTC who has trialed various EVs, bio-diesel vehicles and hybrid vehicles, stated the pure EV’s “range was very limiting, although it was suitable for city driving, motorways proved challenging” (GTC, 2013). The Driver did not think that EVs were suitable for a taxi provider if it were a driver’s sole vehicle. This is due to the battery capacity as “the working hours can be long and you would not be able to earn money whilst the car is charging” (GTC, 2013).

Strategically, GTC see themselves as a pioneering brand and consequently feel “they have a responsibility to be test beds of new technology” (GTC, 2013). This ‘innovator logic’ approach, indicates as to why GTC did not wait until an EV taxi was brought to market but focused on vehicles that already offer a less polluting solution. When the management are forward thinking in this way it begins to eliminate technological lock-in in the market and begins to entrench new behaviors in society, thus giving the market the opportunity to gain momentum and learn from operational problems.
However, GTC found two main barriers against a wider use of EVs:

(i) Charging infrastructure – despite profiling the drivers to best suit the vehicles, the cars will still need to be charged every day (compared to once/twice a week for the Prius);
(ii) Winning over the stakeholders – “a compelling argument is necessary for new technology and requires a change in behavior and a level of confidence that the vehicles will work operationally and be a good business decision” (GTC, 2013).

This supports the case for the technological unsuitability of existing EVs for a private hire fleet, but these are also very relevant to the general market of EVs. Range, infrastructure and perception are three very influential elements that need to be addressed for EVs to compete with the ICE. This highlights the strength of GTC’s business model, to use hybrids as a flexible bridging technology and EVs as a USP aligned to innovative progress (GTC, 2013).

4.2 TNT

TNT is a parcel delivery company to the UK, Europe and beyond. This research focuses on the 1,398 rigid 7.5 tonne trucks that on average travel 56,000km per annum, used for UK local deliver and collection. In 2006 the Board of Directors instructed the fleet managers to procure EVs to contribute to the zero emission targets of the company. After trials TNT procured fifty 7.5 Smith Electric trucks with sodium nickel batteries. Due to unreliability, in 2010 ten were converted to lithium ion batteries despite the conversion costs being greater than a diesel equivalent.

TNT experienced two key barriers:

(i) The limited range of the vehicles introduced inflexibility and further requirement for logistical planning
(ii) The “increased unladen weight that affects the payload due to the weight of the battery, meaning less weight can be carried, requiring more planning on which loads can go in which vehicle” (TNT, 2013)

Both challenges affect the core business of TNT and the efficiency of operations. TNT did not intend to make these vehicles more economical to run but to be cost equivalent with a diesel vehicle over a 5 year life span. However, it was evident by the third year that that did not prove to be the case due to the unreliability and the subsequent conversion costs. TNT considered the procurement as a moderate logistical success but cost prohibitive.

Regarding hybrids, TNT has previously trialed prototypes for various auto manufacturers. TNT found these vehicles much easier to run due to the available petrol tank; but a total cost of ownership analysis revealed the hybrids would need to be in operation for 13 years to be cost neutral with a diesel. As the replacement cycle for TNT is 5 years, these vehicles are not economically feasible within this business model.

Unfortunately for TNT, the electric truck market is not as advanced technologically as is required for full integration within the fleet. There is more focus on efficient diesels due to EU regulations (i.e. Euro 6 Regulation (EC) No 715/2007 (Europa, 2013), than the ‘innovator logic’ for EVs. The case shows the lack of economic stability of EVs to support technology lock-in, whereas the discussion to pursue hybrid vans is arguably an expression of the strength of path dependency as a guide for technology innovation. This indicates the strength of the ‘government logic’ on the automotive sector at a landscape level compared to that of niche-innovations. This relationship is creating mutually enforcing path dependencies as EVs cannot break through the ICE technological and societal lock-in.
Nonetheless, the environmental motivations to utilize EVs has led TNT to begin challenging lock-in within the courier industry, despite it being cost prohibitive. This demonstrates the importance of sponsorship and support from senior management to transition to a niche technology. In order to sustain change within an organization’s regime, when it fundamentally challenges the function of the business and the profitability, it is necessary that the initiative demonstrates a greater contribution that leaders can identify value in.

4.3 Schneider Electric

Schneider Electric is an energy management company providing automation, electrical distribution and installation systems. Schneider Electric has approximately 5,000 employees based in the UK & Ireland and 1200 vehicles in the country’s company car fleet. The vehicles vary broadly in specification, but there are only 2 AFVs.

In the company car scheme, employees are graded depending on their role and the number of miles driven (at least 10,000 miles p.a or out the office more than 3 days/week) which decides if and what car the employee is entitled to and at what contribution rate. Drivers can choose vehicles up to 25% above their allowance with the majority of drivers trading up rather than down.

The company reimburses the driver one penny per mile based on +15% of the mpg. This is to encourage drivers to drive more efficiently and potentially contribute to their private mileage which is not paid by the company. The new scheme is influenced by Government regulation and is clearly the motivations for Schneider Electric’s policy, however the cap of 160g/km on vehicles is still relatively high. Schneider Electric are aware that Government are to enforce more stringent limits but Schneider Electric are clearly comfortable reacting when necessary in order to maintain satisfied employees.

Within the scheme the Benefit in Kind tax is now based on the P11D and the CO\textsubscript{2} emissions of the specific vehicle. This “encourages drivers to base vehicle choice on efficiency rather than maximizing the fixed BIK” regardless of the CO\textsubscript{2} level (Schneider Electric, 2013). As a result the fleet may start to see more hybrids in the fleet due to incentive of low emissions and associated BIK.

In regards to the company car policy there seems to be little motivation to adapt the policy to incorporate EVs at present. While the P11D is still expensive on EVs it will not be a competitive option for employees, regardless of whether EVs are on Hitachi Capital’s vehicle portfolio. Although this is not the norm, economics is still important for employees in monthly costs, residual values and the emissions bracket of the vehicle due to option-to-buy at the end of the four year contract. The low cost of electricity is not a particular draw to the employee as the company reimburses company mileage, removing a key incentive of EVs. In this respect there are few economic barriers to the adoption of EVs as financially they can provide a more robust business case over time than an ICE. This has been strengthened in recent months with greater knowledge on the residual values of EVs.

Schneider Electric analyzed the financial and operational viability of EVs in their own company car fleet. This analysis was done in conjunction with Energy Saving Trust, EDF Energy and Route Monkey, funded by Transport for London and the Department for Transport. The analysis was on 49 company cars based in London due to the opportunity city driving provides EVs with shorter distances and regular regenerative braking. The analysis revealed:

“At the prestige end of the choice range, the financial analysis shows that although the list price of a car like the Vauxhall Ampera or Chevrolet Volt is well above a prestige economical diesel like a BMW 320d, the lease rates of the cars are relatively similar but if it was just based on lease rental alone, the EVs may
erroneously be ruled out as marginally more expensive. However, once the taxation costs are considered, there are considerable financial savings to both Schneider and their drivers of selecting an EV alternative” (EST, 2013 p.3).

Although the analysis put forward a business case for the Ampera to replace the BMW 3 Series, it is very unlikely Schneider Electric employees will begin adopting these vehicles as it is a price sensitive decision and the contribution required by employees will be high. Furthermore due to the disputed residual values of electric vehicles the higher depreciation may mean again they would be too expensive compared to efficient alternatives. This emphasizes the unattractiveness for Schneider Electric employees to sign a four year contract for an electric vehicle. However if Schneider Electric were to encourage EV use, the necessary marketing materials would need to communicate across the business the new policy, vehicle type, choice and the implications.

The key challenge to Schneider Electric is likely to be “driver acceptance for the use of vehicles for private mileage” (Schneider Electric, 2013). This is due to range restrictions, thus reinforcing the path dependencies that restrict EV use. Even if the contribution each month for an EV was considerably lower than an ICE, it is thought employees would not sacrifice flexibility and the practicality of the vehicle, suggesting technological lock-in (Schneider Electric, 2013).

Additionally, it is clear that within Schneider Electric “badge consciousness and psychological kudos with its customers” (Schneider Electric, 2013). This emotive dimension of the ‘civil society logic’ is much harder to address than technological or ecological factors and is arguably a development block that is pointing at the existence of a separate ‘innovator’ logic of which EVs are currently excluded due to social drivers. Arguably the lack of commitment demonstrated by Schneider Electric is a reflection on weak government policy regarding the environmental impact of company car fleets.

5. Discussion

This section evaluates drivers and barriers of EV take-up in the context of transition pathways. Using the case study evidence, it will question the extent to which UK fleets contribute to the transition to electric vehicles.

Diverse approaches are required to stimulate the sustained transition to EVs in conjunction with an understanding of the dynamic implications and reinforced feedbacks (Struben et al., 2008). It is reasoned that in order to ensure transformative change, as a basic premise new vehicle technologies must be economically attractive for market acceptance (Kley et al., 2010). The interviews conducted with the three commercial-fleets highlighted common challenges: the economics, range, vehicle suitability and driver behavior. These are fundamental elements to the success of removing ICE lock-in and increasing the use of EVs within fleets. The case studies have demonstrated the importance of senior management support to begin challenging the traditional fleet dynamics and overcome technology lock-in. In the case of Schneider Electric where high level sponsorship from management is lacking, there is clearly little motivation to enforce emission limits below those stipulated by Government.

There are substantial transition barriers to EVs building momentum that could destabilize the regime. A particular challenge highlighted within the cases is the market perception of EVs, which remains relatively negative due to reliability issues and social pressures of ‘luxury’ cars. This requires a cultural shift that will be achieved using a number of market techniques. However, these cases have questioned the existing approach taken by Government to orchestrate a transition to EVs within fleets.
Within individual path dependent characteristics companies utilizing EVs are challenging business and social practices and changing behavior at work. Considering these dynamics at the multi-level perspective, a company appears to build momentum through ‘niche-innovations’, whilst employee behavior destabilizes the regime to make the ‘niche-innovation’ possible, and social practices create pressure on the existing regime at the landscape level.

However, it is argued that “avoiding undesired lock-ins and creating a beneficial institutional context for sustainable mobility cannot be pursued at the transition path level” (Farla et al., 2010 p.1260). Hence a systemic approach should be applied to assess the interdependencies between transition paths, consequently sustainable mobility can be considered in its entirety (Farla et al., 2010). However, as Mazur et al. (2014) highlights there is greater complexity than a systems perspective, innovation theory requires a socio-technical system approach to investigate the impact of transitioning.

The case study evidence suggests that in order to instigate a considerable shift in behavior and company strategies, the policy field of sustainable innovation and technology should focus on social and environmental benefits (Norberg-Bohn, 1999, Kemp, 2010). Here, a new socio-economic approach is required within the existing regime, for example through introducing a tax for carbon emitting cars, rather than the currently incentivizing low emitting vehicles.

The current UK Government position of financial incentives appears to have had little influence on the three fleet case studies; since both GTC and Schneider Electric lease their vehicles they have been unable to take direct advantage from the incentives, similarly TNT will not be compliant with the funding due to the size of the vehicles. However until 2014 all three fleets would have been able to utilize funding for EV charging, this was a significant factor contributing to GTC’s business case for EVs.

EVs challenge the technological lock-in of ICEs, competing on efficiency and specification and removing the associated range-anxiety with current electric drive trains. Both the ‘lack’ of charging infrastructure and the restricted range of EVs is argued to be key challenges for the adoption of EVs by all three fleets, in particular GTC and TNT.

It is desirable fleet vehicles will return to a depot as highlighted in the TNT case study. In this instance publically available charging is not as important as journey planning to ensure sufficient mileage for the return journey. However, in the cases of GTC and Schneider Electric, publically available charging would need to be considered both during working and non-working hours. This change would need to be supported through the ‘civil society logic’ as adapting behavior and driving culture requires a long term strategy at the community/employee level. As demonstrated by GTC and TNT it is thought hybrid vehicles have a “transitional role...in the sequence of technology adoption” as the vehicles operate within the locked-in range of possibilities (Collantes, 2007 p.270). The introduction of the Toyota Prius in 1997 increased versatility and flexibility within the market through unlocking the historical market of restricted designs and specifications (Ahman et al., 2008). This exemplifies the ‘innovator logic’ challenging traditional status allegiance with luxury vehicles despite the preconceived sacrifice of performance (Griskevicius et al., 2009).

Despite a slow rate of Prius sales in the early years, the Prius is now the most successful ‘green’ car in history, accounting for over half of hybrid sales (5 million) in 2012 (Shirouzu et al., 2013). In 2014 there were over twenty hybrid car models in the market, highlighting the result of manufacturers’ innovation and desire to provide the market with their responses to perceived market need as well as the growth in acceptance with drivers both in the commercial and private sectors. The hybrid market could be the transitional, interim technology to ease acceptance of the EV market and used to manage expectations of the rate of vehicle mode acceptance. The EV market is currently following the ‘transformation path’ and ‘technological substitution’ by which
the existing regime is being modified and innovative activities are responding to moderate landscape pressures; thus developed niche-innovations are entering the system (Marletto, 2014, Geels et al., 2007). This further highlights the case for an ‘innovator logic’ as EVs act as a niche innovation with interdependent dynamics upon the ‘action space’.

Adapting the ‘competing logic’ theory from the energy sector to the EV market, highlights that the transition of EVs is more closely focused on innovation and technology. Examining the case studies it is evident the three existing actor-logics are insufficient in explaining the process of EV utilization within fleets. Regarding GTC the unsuitability of EVs for a taxi fleet has resulted in the continued use of hybrids, this indicates the need for further innovation which cannot be directly stimulated by government, market or civil society logics. In the case of Schneider Electric, the company car fleet will continue to rely on the ‘government logic’, reactively rather than proactively. Despite this there is significant opportunity for the company car fleet to progress along the ‘innovator logic’, incentivizing employees to adopt the technology where a ‘fit’ exists. Thirdly, TNT’s approach to electrifying 7.5 ton trucks is an ambitious feat that will require technological advances in regards to both the vehicles and the charging, as well as support from Government regulation.

Considering these factors, it is concluded that the transition from ‘conventional’ vehicles types to EVs will not merely be “a technological process, but a more general process of technology transfer, in which each technical step requires action or has organisational, economic, social, and cultural implications” (European Commision, 2011 p.16). This reflects Foxon’s theory of ‘competing logics’ but again infers the benefit of incorporating a fourth ‘innovator logic’, by which more explicit representation is accredited to niche innovations. Close attention to the roles of innovators will assist in unlocking EVs within the fleet market and further destabilizing the existing regime and introducing it allows further study of this technology and innovation-driven pathway.

The case studies demonstrate the dynamic relationship between the four logics and the importance of these actors competing upon the action space. However it questions the current role of the government logic as fleets have limited access to EV incentives and grants, this suggests regulatory change is necessary to optimize the opportunity of fleet electrification. Today, those fleets that are transitioning to EVs are acting within the innovator logic and are challenging path dependencies and lock-in of ICEs. However the case studies suggest that within commercial-urban environments there are limited scenarios whereby EVs are currently suitable hence the importance of the innovator logic.

6. Conclusions

This paper has explored the transition of fleets to electric vehicles, exploring existing literature on approaches taken to analyzing transition pathways, with particular attention to path dependencies and technology lock-in. This provided a basis to question the drivers and barriers of EVs for the fleet market and suggest policy options to increase the uptake. The three case studies demonstrate different levels of engagement with EVs yet the development blocks experienced are similar, namely range and driver acceptance.

This paper suggest that the slow uptake of EVs is due to the success and dominance of the internal combustion engine (ICE); there are a number of path dependencies surrounding industry structure, vehicle architecture and driver expectations. Vehicles are part of an inter-dependant technology system along with roads, service stations, parking facilities and a social status system that are all dependent and mutually reinforcing. This research explores the extent to which this has caused technology lock-in within the industry or within individual sectors, preventing the uptake of
EVs. The fleet case studies demonstrate the integration of EVs requires an extensive transformation across a large spectrum of societal dimensions including policy, behavioral change, fiscal models and technology dissemination. As a niche market a range of factors will determine the rate of EV sales in the UK, this includes consumer acceptance, oil prices, battery technology and infrastructure (OLEV, 2011).

This paper demonstrates that the automotive industry is fundamentally built upon path dependant characteristics and has embedded and strong preconceived notions of vehicle design and specification suited in to customers’ expectations. Thus technological lock-in is limiting the available market to EVs resulting in niche applications that can benefit from the available grants and incentives. The paper argues that greater attention to the role of ‘innovators’ and an innovation-led logic in the low carbon transition for fleets is useful for representing the technological change of a niche innovation with interdependent dynamics. An ‘innovator logic’ can provide a technological focus on examining lock-in and market development, stimulate traction across the other three sets of actors as well as providing a heuristic perspective, thus expanding upon Foxon’s theory.

It is arguable that currently the market would not be self-sustaining without government support, but if there were to be more support for businesses, uptake would be considerably higher. Government incentives and regulations relating to emissions have been key catalysts in beginning to unlock ICE vehicle dominance within the market. Such measures put pressure on the existing regime providing an incentive for adoption, thus resulting in the transformation path developing to technological substitution (Mazur et al., 2014; Geels et al., 2007). Existing regulations on carbon emissions are particularly effective within business but it is questionable how long the UK Government will be prepared to continue incentivizing EVs. It could be recommended to introduce the ‘polluter pays’ strategy as part of the whole-system, to encourage fleets to question the concept and sustainability of mobility modes and more broadly the transformation to a low carbon economy.

References


