CROSS RIVER PARTNERSHIP

Electric Freight Vehicles in Central London: Local Grid Capacity

REPORT FOR THE CENTRAL LONDON SUB REGIONAL TRANSPORT PARTNERSHIP

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Acknowledgements

This report has been prepared by Cross River Partnership on behalf of the Central London Sub Regional Transport Partnership, a collective of transport specialists from eight central London boroughs, convened by Cross River Partnership on behalf of Transport for London (TfL).

The report is based on research, meetings and interviews with stakeholders. The authors are grateful for the time and information of the experts who have contributed to this research, without whom this report would not have been possible. The content of the report is based on the authors' understanding of the issues explored, and any technical errors or misunderstandings are the responsibility entirely of the authors. None of the views expressed by the stakeholders interviewed necessarily reflect the views or policies of their organisations.

Executive Summary

The rise in number of Electric Freight Vehicles coming to market in the UK is to be welcomed in the efforts to tackle the well documented impacts of urban air pollution, given road transport's disproportionate contribution to this environmental and public health issue, which is particularly acute in Central London. With zero tailpipe emissions, fully electric vans and trucks offer an alternative to the traditional diesel Internal Combustion Engine (ICE) freight vehicles, and a partial solution to the problem of road transport emissions. However, significant barriers to the transition to electric vehicles for freight fleets have yet to be fully acknowledged and addressed by industry and policy. This report examines one such issue, that of the significant potential need for operators to upgrade the local electricity grid infrastructure to enable sufficient supply for the simultaneous charging of electric trucks.

The report finds that at the national supply level, there is anticipated sufficient capacity for the widespread electrification of vehicles. At a local level, supply constraints exist due to the limited infrastructure that supplies sites. Upgrading this infrastructure is costly, and requires capital investment by the end user in third party assets. The difficulty and costs associated with local grid infrastructure upgrades hamper any large scale, strategic freight fleet transition to electric vehicles in central London.

Fleet operators appear largely unaware of this issue, with more attention still focussed on the operational suitability and performance of electric vehicles. Despite this, the Electric Freight Vehicle (EFV) sector has significant growth potential over the next decade, and evidence from previous Cross River Partnership projects suggests that over the lifetime of a vehicle, there can be a viable business case if the potential costs of electricity grid infrastructure upgrades can be managed. The experience of early-adopters is a deterrent, but market-based solutions are emerging to help operators resolve this issue. It is not clear that smart charging and timed charging alone will solve this issue, so greater understanding by operators, policymakers and the energy sector is still required, which this report has begun to address through the process of engaging with key stakeholders, and adding to the existing guidance for operators on the transition to EFVs. A 'do nothing' approach risks stalling the transition to EFVs, and ignores the challenges of London's land use and planning as set out in the Mayor's draft London Plan. A more transparent and open-access understanding of the existing local capacity requires liaison between national policymakers and electricity Distribution Network Operators. Increasingly, the concept of 'Infrastructure as a Service' is becoming part of the wider energy sector's view of the future of energy distribution. Attractive and long-term financial offerings for 'Infrastructure as a Service' are emerging which can support the business case for electric vehicles. Awareness of these solutions are identified as key, before the issue becomes a barrier to the widespread and accelerated uptake of Electric Freight Vehicles in the coming years.

With air quality recognised as a key policy issue, central London boroughs have a role in encouraging the transition to EFVs due to the reduced pollution impact compared to diesel equivalents. Boroughs can use this research and its associated dissemination activities to facilitate the incorporation of electric vehicles in to fleets of freight vehicles in central London. The findings demonstrate that with the appropriate preparatory work, bespoke, viable solutions are likely to be available for the infrastructure required for EFVs, and this perceived barrier is therefore surmountable for freight operators. Boroughs can also incorporate this knowledge in to their own procurement specifications for fleet vehicles, as the findings have value beyond the freight fleet sector.

About Cross River Partnership

Cross River Partnership (CRP) is a public-private partnership originally formed to deliver cross-river infrastructure projects such as the Millennium Bridge. CRP has since diversified to deliver a wide range of innovative, multi partner regeneration projects, and has expertise in Air Quality, Freight Management, Smart Infrastructure, Sustainability and Transport. In recent years, CRP has co-ordinated major pan-European urban freight programmes such as FREVUE and Freight TAILS. In London, CRP co-ordinates the OLEV/Innovate UK funded Smart Electric Urban Logistics project, as well as facilitating the West End Partnership's Deliveries and Servicing Programme, and working with a number of London boroughs on the Low Emission Logistics project.

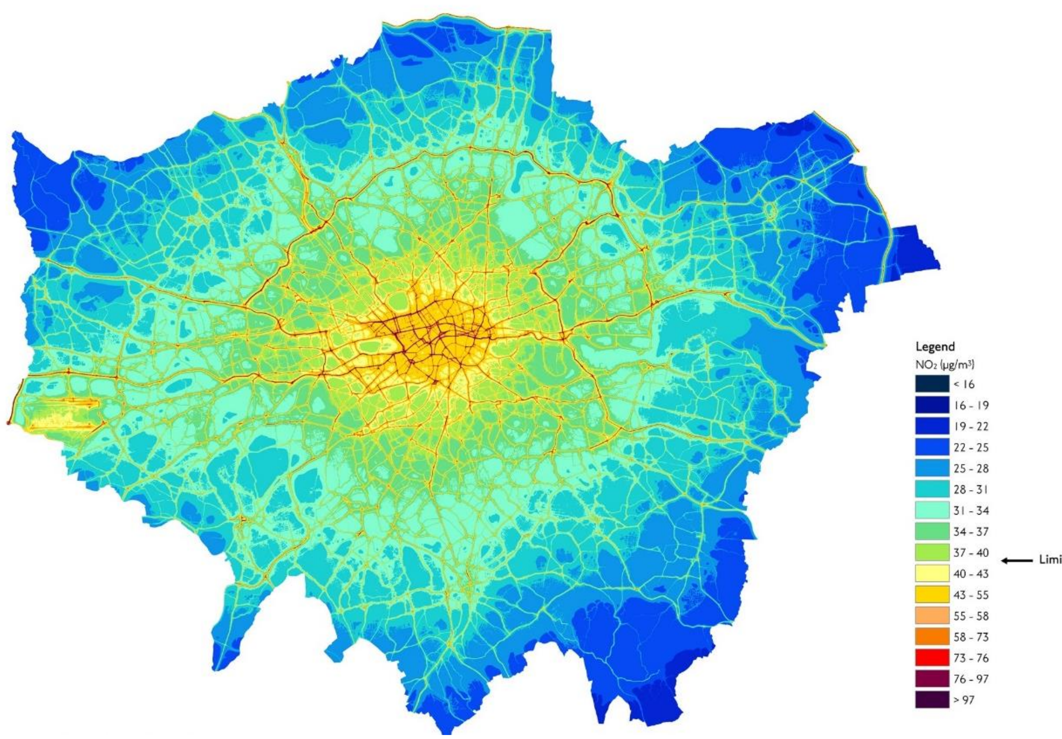
For further information about this research, please contact Tom Linton-Smith (tomlintonsmith@crossriverpartnership.org)

Photo: Michael Macor

Introduction

Background

The negative health impacts of air pollution in inner urban areas are well documented. London-wide, a King's College London report from 2015 estimated that there are the equivalent of around 9,000 premature deaths per year from the combined health impacts of $PM_{2.5}$ and NO_2 (Walton et al., 2015). One of the major sources of air pollution is from road transport emissions. Whilst the understanding and applicability of electric passenger cars, and to some extent public transport such as buses and taxis is fairly well understood and is being addressed by a number of stakeholders, the freight sector is typically under-researched. Yet freight vehicles contribute disproportionately to road transport emissions, since vans and trucks cover 16% of total vehicle kilometres, but produce an estimated 22% of total road CO_2, and 35-40% of local air pollutants (TfL, 2013). Furthermore, van traffic is expected to increase by 20% in London by 2030 (Allen, Piecyk and Piotrowska, 2016).



Greater London Annual Mean NO_2 concentrations, 2013. Source: London Atmospheric Emissions Inventory (2013)

Current and upcoming emissions standards will require the use of Euro 6/VI vehicles otherwise operators will face additional charges to operate in London. Yet the proposed accelerated timetable and geographical extension of the Mayor of London's Ultra Low Emissions Zone should serve as a message to fleet operators that regulations could further tighten at a faster rate than anticipated. When replacing or upgrading current fleets, they should therefore consider moving beyond Euro6/VI standards and look to Alternative Fuel Vehicles for the majority of their urban operations over the next decades.

WITH ZERO TAILPIPE EMISSIONS, FULLY ELECTRIC VANS AND TRUCKS OFFER AN ALTERNATIVE TO THE TRADITIONAL DIESEL INTERNAL COMBUSTION ENGINE (ICE) FREIGHT VEHICLES, AND A PARTIAL SOLUTION TO THE PROBLEM OF ROAD TRANSPORT EMISSIONS.

Developments in vehicle and battery technology continue, bringing down prices and increasing availability. As illustrated by the LoCITY Commercial Vehicle Finder, in the van market a range of electric vehicle models is already available and suitable for urban operations. However, for larger freight vehicles of over 3.5 tonnes, prices for electric versions remain higher than their conventional ICE counterparts, and comparably there is limited availability. Many of these issues are increasingly being addressed by policy, for example through congestion charging exemptions and the plug-in van grant which subsidise the cost of vehicle operations and purchase.

Other issues remain unresolved. For those fleet operators aiming to convert or grow their fleet of Electric Freight Vehicles (EFVs), there is clearly a requirement for them to charge their vehicles, in many cases at a depot. Projects like UK Power Networks' Low Carbon London, examined the distribution network's capacity to supply the additional power required for Electric Vehicles (residential and commercial) and concluded that there is reasonable system level capacity to meet this demand. However, certain parts of the network could require reinforcement to make this capacity available depending on the demand from EV charging. EV fleet operators in particular may have high demand for capacity, given the potential need to charge a large number of vehicles simultaneously.

When charging requirements at fleet depots do hit existing local electricity grid infrastructure limits, the responsibilities and costs of a grid upgrade currently lie largely with individual fleet operators.

LOCAL GRID RE-ENFORCEMENT CAN INVOLVE HIGH POTENTIAL COSTS AND SIGNIFICANT DISRUPTION TO BUSINESS OPERATIONS. AT THE END OF THE PROCESS, THE OPERATOR WILL NOT OWN THE UPGRADED ASSET.

Evidence from projects to upgrade the infrastructure that Cross River Partnership (CRP) has been involved with, notably the experience with global logistics company UPS at their depot in London during the FREVUE project, suggests that:

THE DIFFICULTY AND COSTS ASSOCIATED WITH LOCAL GRID INFRASTRUCTURE UPGRADES HAMPER ANY LARGE SCALE, STRATEGIC FREIGHT FLEET TRANSITION TO ELECTRIC VEHICLES IN CENTRAL LONDON.

It is not currently clear that this issue is well understood by industry or policy stakeholders, or that an obvious, settled solution currently exists. Figure 1 demonstrates that the key stakeholders in this issue are the freight fleet operator and the Distribution Network Operator (DNO).

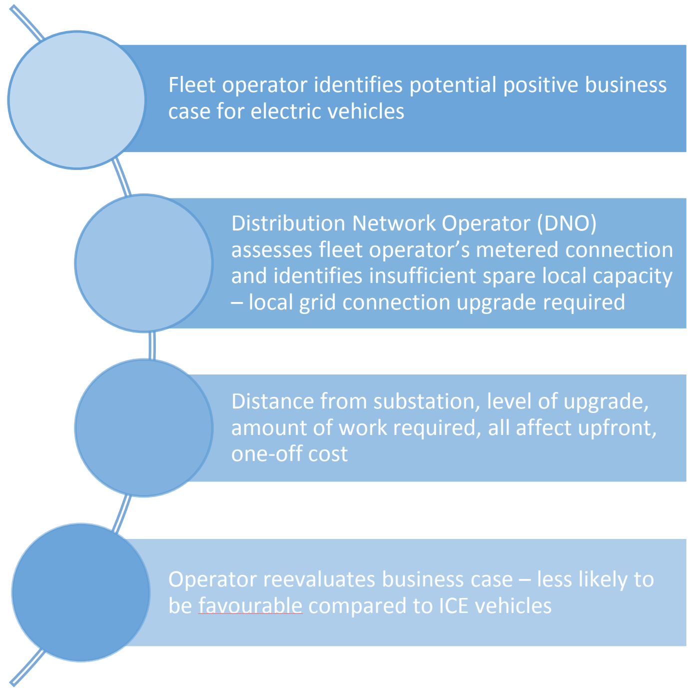


Figure 1. Source: Author

One of the motivations for the research was considering possible solutions to this perceived problem. In particular, one potential approach to facilitate the electrification of fleets is a third actor:

AN INNOVATIVE, ENTREPRENEURIAL BODY TO SET UP AND TAKE THE RISKS AND REWARDS OF IMPROVING THE ELECTRICITY SUPPLY / CAPACITY BETWEEN THE DNOS, AND THE INDIVIDUAL FREIGHT FLEET OPERATORS.

However, it is unclear who this body might be and other approaches might also exist.

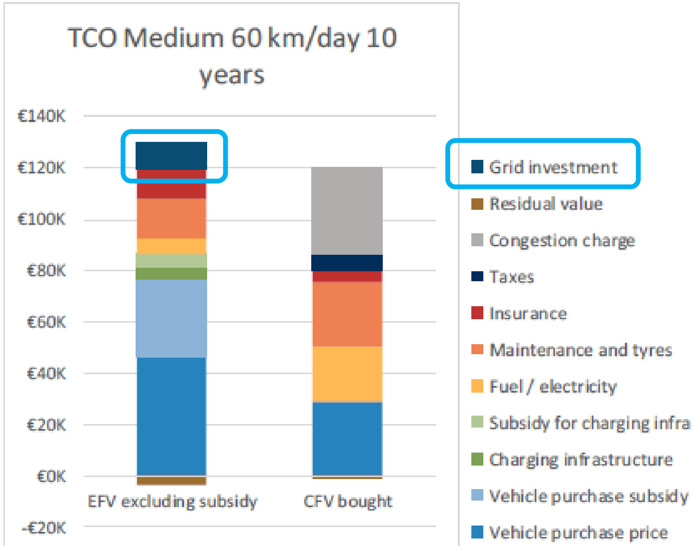


Figure 2. Total Cost of Ownership EFV vs CFV for a 3.5-7.5 tonne freight vehicle. Source: FREVUE (2017a)

Figure 2 above shows findings from the FREVUE project, highlighting that over a 10-year period, the difference in total cost of ownership between a conventional fuel vehicle (CFV) and an electric vehicle can be the capital cost of the investment in the grid (circled). Any model which either reduces these capital costs, or moves them to a marginal operational cost is of interest, given the other lower ongoing costs associated with electric vehicles compared to their diesel counterparts, such as fuel, maintenance, congestion charging and taxes. The residual value of an EFV at 10 years compared to a CFV is also favourable, which further highlights the opportunity of a positive business case if grid investment costs are minimised.

At the national level, there is particular policy interest from the UK Government Department of Business, Energy and Industrial Strategy (BEIS), as well as the Office for Low Emission Vehicles (OLEV), which sits jointly between BEIS and the Department for Transport (DfT). At a regional level in London, the Mayor of London's office has an interest in the deployment of low emission vehicles as it is responsible for the combined transport authority, Transport for London (TfL), and responsible for policies such as emissions based vehicle charging zones, as well as a major landowner with an interest in the provision of electric vehicle charging infrastructure. The Mayor in his Transport and draft Environment Strategies has ambitions for zero emission transport by 2050, and all newly registered heavy vehicles driven in London to be zero emission by 2040 (GLA, 2018 & 2017). The Mayor further intends to work with the logistics industry to set a plan to phase out fossil fuels powered vehicles. This research which targets low emission heavy vehicles sits within the framework and timeline identified in the Mayor's Transport Strategy (GLA, 2018, p.109).

Methodology

Desktop based research of the existing literature and the backdrop of the current and future situation in the UK informed a qualitative exploratory study engaging with stakeholders to develop an understanding of the existing situation and discuss potential alternative models for the transition to Electric Freight Vehicles in London.

Through the range of contacts gathered through experience in other projects, particularly the FREVUE and SEUL projects, meetings were secured with experts from across policy, regulation and industry, including Ofgem, UK Power Networks Services, LoCity, the Green Investment Group (Macquarie) and Office for Low Emission Vehicles (OLEV).

Literature Review

The existing literature available for this study is limited, with most texts considering the EV sector mostly in relation to passenger cars, and not commercial vehicles, in perhaps a reflection of the size of the global car industry and the understandable media and policy coverage that it receives. As a result, this literature review considers texts that make specific reference to commercial vehicle fleets, as well as drawing on the wider EV literature where appropriate.

After considering the problem as it exists in London as identified by Lyons and Chatterji for LoCity and Transport for London, the changing UK energy sector is considered in relation to the transition to electric vehicles. Learnings from other global contexts, including China (the world's largest auto market), the USA and Europe are identified in Appendix 1.

The problem in London

Lyons and Chatterji (2016) identify barriers to providing charging infrastructure in London, including difficulty in identifying sufficient demand to provide confidence for a viable business case, as well as the availability and access to land. There is also a clear recognition of the problem that motivates this research (pp.27-8):

> ***"Capital costs of infrastructure can be very high and cannot always be covered by UK Government funding (i.e. for depot installations, workplace charging points, or public gas stations). Many fleets don't own their depots or have a short lease, limiting their appetite for significant investment in infrastructure. […] Fleet operators seeking to charge multiple vehicles simultaneously at high power have to pay high costs of upgrading the local electricity distribution network, paying for assets which are still owned by the network operator.***
> *Lyons and Chatterji, 2016.*

They also acknowledge the space demands on depots that is necessitated by charging infrastructure. There is a recommendation to liaise with regulatory and government bodies to address the issues faced by commercial vehicle operators, but as yet there is no evidence of any actions being taken, or measures taken to mitigate these barriers.

The draft new London Plan, (GLA, 2017), the strategic spatial planning strategy for London, recognises that the mayor should seek to ensure that public and private sectors work collaboratively to take an integrated approach to the delivery of strategic and local infrastructure, including electricity. There is concern that "the electricity network and substations are at or near to capacity in a number of areas, especially in central London" (ibid., p.352). Energy masterplans are proposed as a solution, identifying where action should be taken, with the Mayor working with boroughs, the energy industry and developers to safeguard the provision of low carbon energy supply.

The UK energy sector

The wider context is the current energy backdrop – a regulated, highly defined system, but one which is changing towards a more dynamic, operational one. This new system is likely to require provision of investment and infrastructure which lies beyond the current scope of the regulated DNOs, such as managing local energy generation, transport and storage.

Across England and Wales, the high voltage transmission network is owned by National Grid, moving power direct from power stations around the country. Typically, the electricity is then delivered directly to industrial, commercial and domestic users via distribution networks run by the regional Distribution Network Operators (DNOs).

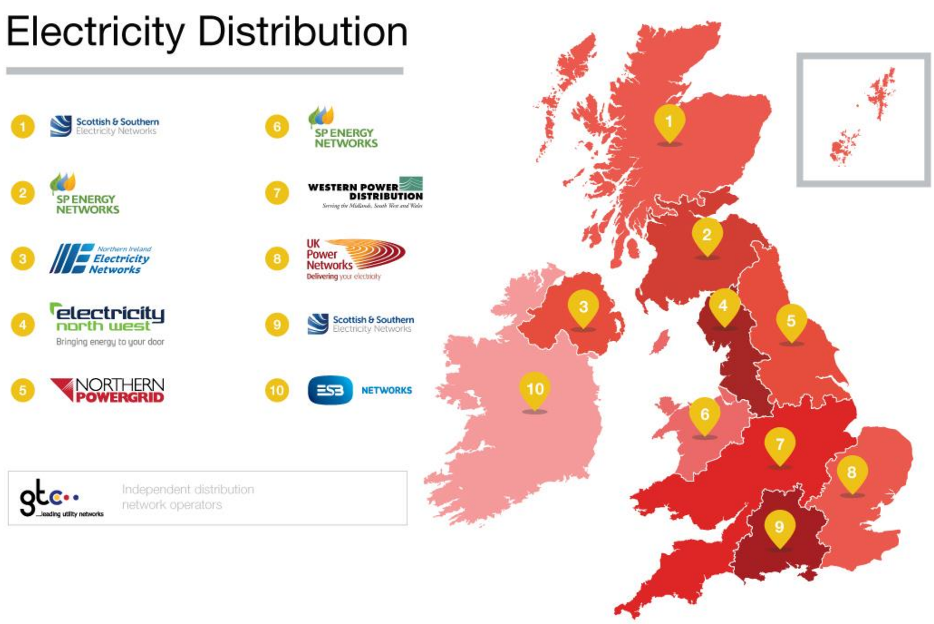


Figure 3. UK Electricity Distribution. Source: Energy Networks Association (2018)

The Energy Technologies Institute (ETI) has published scenarios on how the wider energy system in the UK might evolve out to 2050. They have developed two contrasting scenarios referred to as Clockwork and Patchwork[1], considering how the energy system might evolve to meet the UK's 2050 greenhouse

[1] "Clockwork" describes national level, coordinated planning leading to large-scale investment in the network, that sees increased but partial electrification of transport. The growth in plug-in cars and vans requires electricity networks to carry as much as eight times as much electricity as is currently used by the rail sector. The increase in demand will require peak power demand management at the distribution network level. In this scenario upgrades to the distribution network are undertaken on a planned basis, "including through the implementation of network operator instigated smart technologies and systems, with capacities increased to accommodate electrification of heat and transport (ETI, 2016, p.8)."

gas emissions targets (ETI, 2016, p.6). In either scenario, the growth in plug-in cars and vans will require electricity networks to carry between eight and ten times as much electricity as is currently used by the rail sector today.

DESPITE PREDICTIONS THAT OVERALL THE UK CAN GENERATE SUFFICIENT ELECTRICITY FOR THE PROJECTED GROWTH IN ELECTRIC VEHICLES, UPGRADES TO THE NETWORK WILL BE REQUIRED LOCALLY.

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> ***Knowing where, when and to what extent to enhance the network's capacity, will be a major challenge. This will be particularly acute for the distribution network, where information on the existing state of the network is not as widely available.***
> *Energy Technologies Institute, 2016.*

Growth in loads will not be spread equally across the existing parts of the network, and some parts of the network are closer to their existing capacity limits than others. Of particular relevance for CLSRTP are "factors such as available physical space or land value, which are specific to local areas and will differentially affect the viability of the enhancement options in those locations" (p.19). Inner London land values and the existing demands on the local electricity network are key considerations.

On the other hand, Element Energy, in their infrastructure roadmap report for the Low Carbon Vehicle Partnership, believe that, as is the case today, over 60% of light commercial vehicles (vans) will likely continue to be charged overnight at homes rather than workplaces (Cluzel & Hope-Morley, 2015). There is a need to consider provision for electric van charging at homes, but **for approximately 40% of the van sector, the need for depot charging, and risk of reaching local capacity limits, remains.**

Other nations are experiencing similar challenges in the transition to Electric Vehicles (see Appendix 1). The USA is an interesting case for comparison, where individual states operate different rules around the provision of utilities, and **some states are moving to allow utility companies to provide some underground infrastructure provision and spread this cost across the broader customer base**, whilst

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"Patchwork" is led at a local level, with appreciable increases in the electrification of transport alongside significant use of hydrogen. Local capacity expansion requires greater flexibility and energy balancing from the network. The growth in plug-in vehicles requires electricity networks to carry as much as ten times as much electricity as is currently used by the rail sector. A mixture of measures to mitigate distribution network capacity constraints are required, from conventional reinforcement to smart energy solutions.

leaving the above-ground charging infrastructure costs to customers. These types of arrangements should be monitored as they develop to understand their applicability to the UK context.

The ETI's scenarios for the UK energy sector envisage "Greater interaction (and potentially competition) between a range of energy vectors for power, heat and transport, entailing more complex trade-offs in investment choices and greater flexibility in the operation and balancing of different infrastructure networks" (2016, p.36). They contend that **an efficient transition to low carbon energy will "require substantial reform of existing approaches to the governance, regulation and incentives for investment in network infrastructures**" (p.36). They are keen to point out, however, that there is a real risk that market failures and misaligned economic signals will drive investment choices that ultimately increase costs for consumers. For example, choices may be influenced by how costs are socialised across users of networks. This is equally applicable to commercial users looking to make the transition to electric fleet vehicles. This has implications for how the market is regulated, and the role of the regulator.

Summary of the Literature Review

- The energy sector, on aggregate, is expected to have the necessary capacity and resilience to deal with the expected growth in the EV sector, however at a local level there is uncertainty which should be further explored in the enquiry.
- A better understanding of the responsibilities, interactions and level of agency of stakeholders is key to identifying those able to take effective action.
- Distribution Network Operators do not have sufficient visibility of the local network to enable effective management of demand and supply in the future.
- Lyons and Chatterji (2016) highlight the need to raise these issues with regulatory and government bodies

Findings

Cross River Partnership contacted a number of stakeholders with an interest in this issue, including representatives from a DNO, a regulator, a low carbon fleet expert, an investment group and others. This helped to improve detailed understanding of the issue in terms of its importance, urgency, and the key influencers needed to effect changes required for a best case scenario for the transition to EFVs.

Understanding the issue: Importance

Lessons from the FREVUE project demonstrated that the issue of local grid connection capacity can have a significant impact on the feasibility of converting a large fleet of vehicles due to the potential disruption and costs involved with upgrading the local grid connection. The experience of UPS at their Kentish Town depot (see case study) demonstrated that even for a global logistics brand, this issue is a major hurdle to overcome.

As evidenced in the FREVUE project, under current operational patterns, both medium and large EFVs tend to be charged once per day, in the late afternoon, at the operator's depot (FREVUE, 2017a, p.5). This differs from the evidence from cars and light commercial electric vehicles where there is greater diversity in charging patterns.

This late afternoon charging also tends to coincide with a peak in household demand, which can put a strain on the network. Conversely, limited variability in charging and driving of EFVs allows electricity network operators to plan infrastructure effectively, if the demand is well managed.

Case Study - UPS

As part of the Freight Electric Vehicles in Urban Europe (FREVUE) project, global logistics company UPS discovered that their implementation of Electric Freight Vehicles (EFVs) was hampered by insufficient electricity supply to their site. They took the decision to upgrade the grid connection, allowing them to simultaneously charge up to 63 EFVs. Problems included; dealing with a three-tier system of landlords, a lengthy process of approximately 2 years, significant disruption, costs of over £600,000 and effectively investing in a third party asset belonging to UK Power Networks.

Understanding the issue: Urgency

There are signs that the market for EFVs is gathering momentum with a recent McKinsey report suggesting that **the light truck/van sector could reach 25-35% of the market for new sales by 2030 in Europe** and China. Yet according to industry experts at LoCity, most operators are not yet actively pursuing EVs to meet their fleet requirements, due mainly to the fact that Euro 6/VI standards are what is required to meet regulations such as ULEZ. This may be short sighted, as investment decisions taken now will likely affect fleet compositions until the late 2020s in some cases, especially for larger vehicles. However, it has been reported that there are signs of increasing levels of vehicle leasing, allowing for an alternative to long term investment decisions.

There is a risk that if policy and stakeholder engagement programmes such as LoCITY encourage operators towards electrification without addressing local grid reinforcement, this might lead to significant frustration and the conclusion that electric doesn't work. Changing perceptions at that point might be challenging, and is a real risk to the momentum behind the transition to electric vehicles.

Understanding the issue: Influencers

Low demand connections to the network (those under 7kw) are currently installed on a 'fit and inform' basis, whereby chargepoint installers establish for their customers whether a suitable connection is available, and notify the Distribution Network Operator (DNO) once the installation has taken place. Larger connections, such as those for the majority of EFV operators, will most likely require a metered connection, requiring prior assessment and agreement with the DNO. **There is little evidence to suggest that operators recognise the importance of this stage in the process of considering electric vehicle adoption**.

There is concern from a policy and regulatory perspective that there is currently a deficit in transparency and ease of understanding of the costs involved of a local grid infrastructure upgrade. One suggestion is asking DNOs to publish more information such as local heat maps, to enable better end user planning. To permit better understanding, DNOs would require more localised data on energy consumption than the current anonymised, higher level postcode area data.

> ***Currently, DNOs do not have sufficient visibility of the local, low voltage level network, and there is limited understanding of the demands from EVs of all kinds, meaning that any heatmap or similar information is not as useful as it would need to be***

Possible solutions

Business as Usual – with better understanding

Discussions with the energy sector regulator, and Office for Low Emission Vehicles (OLEV) suggested a reluctance to consider intervening in the current market, or significantly change existing regulations. However, there is a desire to see this issue better understood, through the advancing of understanding through research projects such as this, trials and stakeholder workshops. A stronger evidence base will aid the case for useful, targeted policy, and in turn aid the uptake of fully electric freight vehicles. The need for improved transparency is understood by most stakeholders, with Distribution Network Operators able to improve transparency by publishing more local analysis as they carry out assessment work to enable future prospective customers to check upfront if a capacity assessment has been carried out. There is potential for unintended, and possibly undesirable consequences, however, such as local capacity status affecting logistics land values. Nevertheless, this fits in with the draft London Plan goal of using energy masterplans to identify areas for investment.

Smart charging

The potential costs of a conventional grid infrastructure upgrade are a deterrent, and solutions which minimise the need for one are likely to be favourable for most operators. Developments in smart charging technology allowing for smarter use of the infrastructure already in place is likely to be a development of great interest to fleet operators keen to avoid the costs, complexity and disruption of a conventional upgrade. Indeed, UPS together with UK Power Networks and CRP are currently pursuing an innovative project to enable the remainder of their fleet to be electrified using a combination of smart charging, local energy storage and active network management, called Smart Electric Urban Logistics (SEUL). This will enable UPS to lift its existing limit of charging 63 vehicles simultaneously, to its entire 170 vehicle fleet, without the need for a further grid infrastructure upgrade.

HOWEVER, EVEN WITH DEVELOPMENTS IN SMART CHARGING TECHNOLOGY, IN VERY MANY CASES THE NEED TO UPGRADE THE CONNECTION TO MEET THE ENERGY DEMAND OF A VEHICLE FLEET, WILL STILL EXIST.

Socialisation of costs / DNO deregulation

One solution to the problem of the cost involved, is a change in regulation to allow socialisation of costs across the broader customer base, given that the imperative for vehicle operators to have EFVs is based on social benefit in reduced harm from vehicle emissions. There does not seem to be much appetite for this as things stand, as this would involve cross-subsidisation of private firms, despite the demonstrable social benefits of cleaner road transport operations. The societal benefits become commercial incentives when the end consumers of freight products – individuals or businesses receiving goods and services – have greater visibility of the industry and the ability to make choices about the environmental impacts of freight movements they are responsible for, such as through preferred supplier schemes, or environmental delivery options.

Alternative financial models

Discussions with a major investment organisation provide some cause for optimism, as there is a recognition that for large fleet operators in particular, there is a viable business case for providing a finance model for infrastructure solutions based on the idea of vehicle leasing, which could include a whole range of EV solutions, from local grid infrastructure upgrades, onsite generation and storage solutions, as well as vehicles themselves, paid back over a 10 to 15-year period. During the course of conducting this research, new players in the energy consultancy and finance sectors have entered the market for financing commercial electric vehicles and electricity infrastructure, and are beginning to reach out to the industry with this offering. For the operators, this radically changes the prospect of investing in electric vehicles, from a capital expenditure problem, to a marginal operational, or total cost of ownership, solution. There is increasing interest in commercial vehicle leasing, for which this model is a natural extension.

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Other expert organisations, such as DNO subsidiaries, are also reported to be exploring this kind of model to provide tailored solutions for customers based on their local context, capacity and ambitions. **This fits in to a changing energy sector, where DNOs are moving their operations towards the role of DSO, or Distribution System Operator, which will involve a more active, flexible approach to the management of electricity supply, and generation**, on a more decentralised basis.

Conclusions

Evidence from the literature review suggests that at the national level, the energy sector has the capability of providing for the rise in electric vehicles. At a local level, the situation is more nuanced, with capacity needing to be assessed on a case by case basis where operators hold or require a metered connection with their DNO. New developments in smart charging and timed charging will go some way in minimising the extent of costly grid infrastructure upgrades, but for most operators of medium and large-sized fleets some degree of grid infrastructure work will still be required.

The issue of the potential need for grid infrastructure upgrades is not yet well understood by fleet operators. At the time of writing, guides for the transition to electric fleets are being published, with recognition only given to the cost of charging infrastructure, that is, the visible units which vehicles are plugged in to. Without prior knowledge of the EFV industry, many fleet operators are unlikely to anticipate this potential significant barrier to their chance of successfully operating electric vehicles.

More transparency through the use of capacity heatmaps would be beneficial to fleet operators, landowners and local authorities alike. To a limited extent, the regulator already encourages DNOs to publish this kind of resource, however DNOs do not currently have the level of data necessary for their effective use.

OVER THE PAST MONTHS, THE MARKET HAS DEVELOPED TO BEGIN TO PROVIDE THIRD-PARTY SERVICES WHICH WERE UNAVAILABLE WHEN THIS PIECE OF WORK WAS FIRST CONSIDERED.

Alternative finance models[2] will spread the upfront cost burden for the operator, and when combined with investment in associated assets such onsite electricity generation and storage, can be an attractive business proposition, as a third party absorbs some of the risk associated with the initial investment. This offering is increasingly being known as provision of 'Infrastructure as a Service'. Better understanding and publicity of these packages to operators will be key in aiding the next stage of transition to Electric Freight Vehicles.

Next steps

As noted above, over the past months significant developments have taken place in this field and CLSTRP members are therefore required to take fewer next steps than originally foreseen. However, there are things member boroughs can do to further accelerate and support these developments:

There is a need to communicate this issue to fleet operators at an early stage so that their options for electrification can be explored with the right agencies in good time, with realistic understanding of how the business case should be constructed, which is likely to differ from traditional models. LoCity expressed an interest in including this research in the form of a joint workshop in the near future. If requested, Cross River Partnership as authors of this report will be well-placed to provide support to LoCity in publicising this issue. CRP will produce short dissemination documents to accompany this work suitable for the logistics industry and fleet operators.

[2] Provided by, for example, UK Power Networks Services and the Green Investment Group/Macquarie

- **CLSRTP members should seek to support future events and publications which highlight this issue or reference this work. Further, boroughs should direct fleet operators to the relevant DNO at an early stage in order to assess their capacity for incorporating electric vehicles at their site(s). In London, this means signposting to UK Power Networks.**

Greater understanding of Infrastructure as a Service and the alternative financing models available will be beneficial to operators considering a transition to electric vehicles. As these become more visible, boroughs should support and encourage fleet operators to consider electric vehicles for their urban operations, knowing that support and resources are available to enable a thorough and competitive business case development.

- **CLSRTP boroughs should support operators who approach them by informing them of the process of converting fleets to electric vehicles, including information on some of the options for financing Electric Vehicle acquisition and infrastructure upgrades.**

DNOs should be both encouraged and enabled to improve their understanding of the local, low voltage network in order to provide more transparent information such as heatmaps about local spare capacity in the future. Continued communication with DNO staff with specialist understanding of this issue is recommended, to enable targeted literature to be produced in the future, as well as addressing the policy and regulatory bodies responsible for the sector.

- **Boroughs should use any access to regional and national policy making bodies to request DNOs publish local capacity heatmaps, improving transparency, and for all required data to be made available to DNOs.**

Cross River Partnership is able to support CLSRTP by co-ordinating further research or trials in this area, including liaising with DNOs to examine local capacity at the low-voltage level where boroughs have identified strategic locations for transport and logistics activity, or operate their own vehicle fleets. This could be in line with 'Energy Masterplan' proposals in the Mayor of London's draft London Plan.

Cross River Partnership will continue working with some of the key stakeholders interviewed for this work, and will be able to advise the CLSRTP boroughs on developments in Electric Freight Vehicles and innovations such as 'Infrastructure as a Service', including considering whether there are options suitable for public sector fleet requirements.

For further information please contact Tom Linton-Smith (tomlintonsmith@crossriverpartnership.org)

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Appendix 1 – Review of alternative global contexts

China

The world's largest auto manufacturer, China, went electric for more than 30% of its new bus sales in 2016 (Heid et. al, 2017). Indeed, at the time of writing, all 3 fully electric single decker bus routes in London operate Chinese vehicles. Yet despite the nationalised energy system in China, government owned charging infrastructure tends to be sited in lower land value areas and there is a lack of standards for the charging equipment itself, reflecting some of the issues in the wider UK EV sector.

China has become the largest auto market in the world since overtaking the USA in 2009. But the EV ecosystem is only comparable with that of the UK, according the McKinsey Electric Vehicle Index (Gao et al., 2015, p.8). Despite having a nationalised state grid, the vehicle charging infrastructure remains inconsistent, with no agreed standard or level of service (Krieger, Radtke & Wang, 2012), though the Sino-German Electric Vehicle Charging Project is going some way to address this (Retzer, S., n.d). In addition, government-owned charging points are in areas of lower land values, where there is low demand for EV charging (Gao et al., 2015, p.18).

With China being the largest bus maker in the world, the market has the opportunity to achieve economies of scale faster than other EV manufacturing countries. In 2016, the share of EV new bus sales in China exceeded 30% (Heid et al., 2017). The predictability of use, distance and charging requirements enable reasonable assumptions to be made about the Total Cost of Ownership (TCO) which is key to commercial decisions about vehicle purchasing, in contrast to private vehicle purchase decisions. Heid et al. list three critical assumptions for the TCO breakeven points for EVs versus diesel vehicles: "the development of fuel and electricity efficiencies for ICE or BECV technologies, the cost of batteries, and the cost of fuel and electricity". The first two of these factors are relatively stable in the short term, but the cost of fuel and electricity is the largest variable in a UK context depending on the need or not for a local electricity network upgrade where a sizeable fleet is being considered. Especially in the heavy duty truck sector, which would include buses, major technology upgrades will be necessary even without network upgrades.

New, stricter commercial vehicle regulations introduced in China for medium and heavy duty vehicles in 2015 should be observed for their effectiveness in stimulating a transition to commercial electric fleets between now and 2025.

Masiero et al. (2016) raise the question in a China context of what automakers are doing to leverage the development of the EV industry. The question is pertinent to consider in this study also. If the upgrading of electricity infrastructure is prohibitive to the uptake of electric vehicles, what, if anything, is being done by manufacturers to highlight the issue? The limited number of freight EV manufacturers in the European market may be a factor, as well as the size of the consumer market as it stands today.

USA

In the USA, individual states operate different rules around the provision of utilities, and some states are moving to allow utility companies to provide some underground infrastructure provision and spread this cost across the broader customer base, whilst leaving the above-ground charging infrastructure costs to customers. These types of arrangements should be monitored as they develop to understand their applicability to the UK context.

Consultants from A.T. Kearney Energy believe that, assuming 64% of the global fleet is electrified by 2040, developing the battery plants and charging infrastructure to fund an electrified global vehicle fleet could require an investment of USD $2.7 trillion by manufacturers and governments (Carey, 2018).

Regulations around provision of utilities are seen as a barrier in the USA, and similar problems exist in the UK. According to Carey (ibid.) the lack of national standards for recovering the costs of electric vehicle charging infrastructure means that most states do not permit utility companies to spread the cost of electricity infrastructure across their customer base. The state of California is a notable exception, which recently moved to allow utilities to recoup investments in various ways. Douris (2017) reports that various utility companies in the state are developing charging stations for public use by larger electric vehicles, as well as installing and owning charging infrastructure (underground and at the point of connection) on commercial sites. Hybrid models are also being developed in some parts of the state, with for example Pacific Gas & Electric supporting upgrades to the grid infrastructure while the end user will be responsible for the on-site charging equipment. The state of Massachusetts allows utilities to fund and build the underground infrastructure for charging stations only, a “make ready” arrangement, a result of which is that one DNO in the state is spending $24million on a number of sites. This model is instructive if it could be employed by UK DNOs in regard to connections to commercial sites and fleet depots, not just public charging stations.

Europe

Other European countries have made greater progress towards EV transition than the UK, with Norway and the Netherlands having the strongest markets for electric vehicles (McKinsey, 2017), which is reflected in a seemingly more relaxed attitude towards the transition to electric vehicles as recorded by Bakker, Maat and van Wee (2014):

> “In general, the stakeholders do not seem overly concerned about either short-term returns on investments or long-term negative impacts. In this regard, the early phase of the transition can be understood as a relatively carefree phase. In order to continue the development of the emerging EV system and to keep it on the right track, however, for the foreseeable future, supportive policies will be necessary in order to provide a stable and reliable basis for further market expansion.”