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ELECTRIC VEHICLES FOR URBAN FOOD TRANSPORT

The case of fruit and vegetables deliveries in Paris

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ABSTRACT

Electric light commercial vehicles (LCVs) represent a new market with high potential sales in the European countries, due to the new restrictions for old diesel vehicles in European cities, e.g. Paris and London. Nevertheless the uptake of electric vans is still limited and only few logistics chains are renovating their diesel fleets with electric technology. In particular, actors within fresh food logistics chains, which circulate in urban areas to supply local shops and food outlets with perishable goods, appear to be hesitant.

This paper presents the ongoing work within the French project Corri-door, co-funded by the European Innovation & Networks Executive Agency. This study focused on the Fruit & Vegetables (F&V) temperature-controlled deliveries to non-corporate retailers. F&V supply chain is a highly complex and fragmented sector, comprised of many small and diverse stakeholders (retailers, wholesalers, service providers) reluctant to change and with limited investments resources. The aim of this paper is to investigate F&V “last mile” operations for independent retailers and hotels, restaurants and cafés (Ho.Re.Ca.), in order to identify technological obstacles to the adoption of electric vans. Based on PIPAME survey (2009) ad on national LCVs survey (2010), the article proposes an analysis on delivery schemes for the Paris metropolitan area, integrated with qualitative interviews with representatives of F&V sector operators and manufacturers. Although the delivery operations result to be suitable with the performance of electric vans, specific constraints, related to converted refrigerated vehicles and their reduced payload, represent relevant technological barriers.

1. INTRODUCTION

During the past ten years, diesel light commercial vehicles (LCVs) experienced significant gains in market share, accounting for 97% of total LCV sales in Europe (1), and 99% in France, the largest European market for LCVs (2). However, growing concerns about air pollution in urban areas and the impacts of diesel exhaust emissions (3) have drawn attention to the need to reduce the use of diesel-engine vehicles for urban freight transport (4). Indeed, these vehicles represent a major share of the air pollution generated from transportation in urban areas. Cleaner technologies, such as electric commercial vehicles (ECVs), have thus been identified as potential substitutes for diesel-engine commercial fleets in order to foster air and noise pollution reduction (5).

Looking at current ECV performance, vans and new format vehicles for urban freight transport (electrically-assisted cargo tricycles, minivans, etc.) represent a viable alternative for specific transport and supply chain operators. Notably, ECV solutions are recommended for operators whose round trips range from 100 km or shorter (6). Some logistics chains are better suited for adoption of ECVs, such as postal and parcels delivery providers, as demonstrated by electric van pilot projects at La Poste, DHL, FedEx, UPS and other postal operators (7).

According to our previous investigation (8), actors within fresh food logistics chains, which circulate in urban areas to supply local shops and food outlets with perishable goods, appear to be more hesitant towards changes and new technologies. More precisely, the target of this study centers on the Fruit & Vegetables (F&V) delivery system to non-corporate retailers, which is highly complex and fragmented sector, comprised of many small and diverse stakeholders (wholesalers, producers, retailers and service providers) reluctant to change and with limited investments resources (8). The aim of this paper is to investigate F&V "last mile" operations in the Paris metropolitan area, focusing on two receivers categories: (i) independent retailers; (ii) hotels, restaurants and cafés (Ho.Re.Ca.). The resulting analysis contributes to identify technological obstacles to the adoption of electric vans.

This paper is organized as follows. The next section presents a review of the literature. The third section introduces the methodology and data sources used in the research. The fourth section describes the F&V last mile patterns for independent food retailers and Ho.Re.Ca. operators. The fifth section highlights key constraints identified by sector operators and the final section presents conclusion.

2. INCREASING USE OF VANS IN EUROPEAN CITIES

In Europe, during the last two decades, two main trends have profoundly changed the urban freight transportation system: the downsizing (9) and the dieselization of freight vehicle fleets (10). In particular, diesel-powered LCVs, such as vans 3.5 tons or less, resulted to be strongly supported by various municipalities that implemented traffic limited zones implementing size-based truck restrictions (9) on one hand, and by national governments establish incentive programs, tax rebates and price controls on diesel engines, on the other hand.

Traditionally, LCVs have received little attention from transport researchers and policymakers alike, but they have increasingly become an important element of urban freight transport via goods delivery and the provision of a wide range of critical services (9). The impact of LCVs is greatest in European city centers where, in order to reduce emissions from road freight traffic, policymakers have increased access restrictions on heavy duty vehicles. The London Lorry Control Scheme, also known as the lorry ban, in 2004 (11) was one of the first programs of this kind. More recently, in January 2015, Paris announced a Low Emission Zone ("Zone à basse émission") in the inner city, targeting diesel vehicles. According to this initiative, the city of Paris will gradually ban old diesel vehicles (EURO 2 norm) beginning June 2016, with a goal to allow only Euro 5 and 6 by 2020 (12).

When compared to the extensive literature on constraint analysis for electric passenger vehicles, the prospects for commercial applications of electric LCVs remains an area in need of increased study. However, recent pilot projects have focused on the viability of using electric vans and trucks for last mile deliveries in conjunction with urban distribution centres in various European cities (13, 14). Projects co-funded by the European Commission, such as Elcidis (15), Enclose (6) and Frevue (16), have involved different groups of researchers and provided useful insights into the competitiveness and suitability of ECVs for urban freight operations, intended for policy planning purposes.

Most of these studies employed a general approach to city logistics operations. They focused on logistical relationships between major parcel delivery companies and non-perishable goods retailers. To the best of the authors' knowledge, there is no published research that assesses technical constraints related to the adoption of electric vans by perishable goods sector operators, as proposed in this paper for urban F&V deliveries in Paris, France.

3. METHODOLOGY

To assess the suitability of electric vans to serve as vehicles for urban F&V deliveries, we identified a set of logistics, technological and organizational variables that describe: i) the key features of F&V supply chain operations, ii) the patterns of use of the vehicles (average mileage, number of stops, etc.), including information about their LCV fleet. We developed an ad hoc methodology on the basis of the work of Morganti (8).

The main focus is on temperature-controlled deliveries, in particular deliveries for fresh fruit and vegetables, which have a short expiry date and which are bound by special preservation conditions, such as hygiene standards. Receivers are located in urban areas and are businesses classified in two food distribution systems:

(i) independent retailers, i.e. grocery stores, corner shops and specialty stores, épiceries and alimentation général in French;
(ii) hotel, restaurants and catering (Ho.Re.Ca.).

The specific target is on LCVs, vehicles designed for the carriage of goods and having a maximum mass (AGW for 'Authorised Gross Weight', or PTAC in French) not exceeding 3.5 tonnes, since they represent the large majority of F&V last mile deliveries (17). To explore sector delivery operations in the Paris metropolitan area, we selected relevant data from the investigation carried on by PIPAME in 2009 (17) concerning the F&V flows originated from the wholesale produce market of Paris, Rungis. As a complementary source, statistical results of national survey on the use of LCVs, made available by the French Ministry of Transport for the year 2010, are integrated in the analysis (18, 19). The investigation also included six qualitative face-to-face interviews with three representatives of French food final delivery providers and three automakers, carried out between September 2013 and December 2014, in order to explore the main technological constraints to electric vans' adoption and forthcoming vehicles improvements. The results of this analysis will be further verified once the complete results of the Paris Urban Freight Survey will be published (20).

4. ELECTRIC VANS FOR URBAN FREIGHT

4.1 The electric vans market

In 2012 just over 0.5% of the newly-registered vans in Europe (1.1 million) were pure electric vehicles (1), however, according with the automakers interviewed, this new market has near-term high potential sales in the European countries. As an evidence of the manufcturers' interest on electric van segment, new models have recently been released by Renault, Nissan, Peugeot, Mercedes and Iveco, and additional options exist for plug-in hybrid electric vehicles.

Despite the introduction in the European market of new electric vans, their uptake is still limited (21). On top of their limited driving range (a physical/operational barrier), several factors might hinder the introduction and acceptance of electric technology in the LCV fleet. The low consumer familiarity with the new technology (a non-cost barrier) and the upfront retail price of ECVs (a financial barrier) are certainly among the most important obstacles that partially explain their slow uptake (6). Other obstacles, such as the lack of fast charging infrastructure, which is still at an early stage of development in dense areas and depends on a wide range of private and public initiatives, is perceived as secondary threat to the interoperability and overall reliability of the electro-mobility system (22). Complementary information about the use of fast charging stations and their impact on LCV market in France are expected through the implementation of the project Corri-door, supplying the infrastructure across the country.

The improved but still limited choice of vehicles, as opposed to the seemingly infinite range of diesel models, can operate as another significant barrier. This is particularly true for the refrigerated vans segment, in fact various options are provided to fit diesel and gas-powered vehicles with refrigeration equipment, on the other hand, the offer of electric insulated, ventilated or refrigerated vans, requested to transport F&V, is very narrow. To the best of the author's knowledge, the fridge Goupil van (700 Kg payload, 6m3 volume) is one of the few models currently existing on the European market. Alternative options, such as technology to convert electric vans into electric fridge vans without high payload loss, appear relatively less developed.

4.2 The French market for LCVs

Annual sales of new LCVs in France had increased by 40% between 1980 and 1990. However, as a result of successive economic downturns, the market has recently fluctuated around levels well under the record-high 461,462 units of 2007: with 384,049 units sold in 2012, it was just 2.5% higher than the 373,986 units sold in 2009 (23). France yet remains the largest market for new LCVs in Europe, and one of the countries with the highest proportion of LCVs in new light-vehicle sales (around 15%-16%), just behind Norway and Portugal (23). In this scenario, diesel-powered vans represent up to 99% of total sales (23).

Table 1. Share of electric LCVs over new LCVs registration in France

Year	2012	2013	2014
Electric LCV registrations	1%	1.4%	0.9%

Source: 18

In 2009, a consortium of large corporate fleets, including La Poste, Electricité de France and Air France, committed to purchase an initial order of 50,000 electric vehicles to boost the market for electric vans (24). As a result, electric van sales rose by 42%, to 5.200 units over the period 2012-2013. However, after this first wave of sales market penetration declined by 13% in 2014 (23), accounting for 0.9% on new LCV registrations in France, as shown in Table 1. By December 2014, LCVs accounted for 34% of the 44.000 electric light-duty vehicles sold in France between 2010 and 2014 (23).

4.3 Main patterns of urban freight

Despite the phenomenal diversity characterizing urban freight transport (25), some basic logistics and organizational patterns (delivery frequency, stops per roundtrip, etc.) and technological features (type and engine of vehicles) can be identified to describe the complexity of the freight distribution system and, therefore, to assess potential suitability of electric commercial vehicles for daily operations. According to Routhier et al. (20), urban freight in European cities presents standard patterns, such as:

- 1 delivery / pickup each week, per job;
- 50% vans and 50% truck;
- 80% deliveries lasts less than 10 minutes, pick-ups average 30 minutes;
- 13 deliveries or pick-ups per round in average (19 for hire, 11 for own account).

With regards to vehicles features, urban freight vehicles can be quite old and their renewal is generally slower than for non-urban road freight traffic, because urban freight involves numerous competing small operators that cut costs as much as possible (25).

In France, freight transport accounts for 18 % of trips and 23% of kilometers traveled by LCVs. On a daily use, vans circulate mainly in urban areas for an average of 80 Km, lasting approximately 2:45 minutes. The annual mileage 19,300 km. Food transport accounts for a quarter of trips and miles of freight transport, and almost 40 % of tonne-kilometers performed (18).

5. LAST MILE DELIVERIES FOR F&V

The last food mile for independent retailers and food services is characterized by small-scale goods distribution. These receivers require frequent express deliveries (on average 3 times per week) of a limited number of parcels, within a narrow time-frame. Own account deliveries prevail in the F&V sector, i.e. 90% of deliveries are carried out by wholesalers, producers, retailers and food businesses owners. Only few delivery services are outsourced to third-party logistics providers, and some operations can rather be described as informal logistic activities, featuring private vehicles and last minute transactions (17).

As shown in Tables 2 and 3, the resulting F&V delivery schemes for independent retailers and Ho.Re.Ca. operators present similar patterns and eventually merge together, i.e. local producers deliver their own food products to restaurants and grocery stores. In both schemes, most of the deliveries are achieved by light commercial vehicles up to 3.5 tons, showing a limited degree of consolidation within the supply chain sector. The majority of vans leave the wholesale market with approximately 50% of their loading capacity, share that decreases to 25% if empty running on the return trip is taken into account. Most trips originate from the wholesale market of Rungis, located 7 km South of Paris, and receivers are located in the metropolitan area (17).

Logistics, technological and organizational practices to deliver F&V to independent retailers, épiceries, and the Ho.Re.Ca. outlets present wide similarities, although some varibles, such as peak hours and delivery's volume differ sufficiently. Delivery trips start from 05:00 onwards, usually till 14:00, with earlier peak hours for independent retailers than Ho.Re.Ca receivers. The large majority of vehicles used are vans under 3.5 tonnes, with refrigerated cargo area. Each van typically travelled approximately 19,300 km per year. Load units vary according to the type of products, although boxes are the most common units, and the quantity delivered range from one box to several. In total the drivers made 6 stops per trip. Delivery lasts on average less than 10 minutes (17, 18).

Table 2. F&V last mile deliveries for independent retailers

Macro-variables	Parameter	Details
Logistics variables	Frequency requested by receivers (average)	0.5 deliveries per day (week basis)
	Load unit	Mostly boxes, other: pallets or in rolls.
	Characteristics of deliveries	N. of deliveries /trip: 5 Average weight of total deliveries: 345 kg
Technological and organizational variables	Types of vehicle	95% of total deliveries made by diesel LCVs (up to 3.5 tonnes gross weight) 5.5% of diesel vans are euro 0, 1 (registered before 1997) 8.5% of diesel vans are euro 2 (registered before 2001)
	Delivery period	Deliveries are made in the morning: 5:00-14:00 Peak hour: 7:00-8:00
	Level of logistics optimization	Average (origin): 50% of loading capacity Average (round trip): 25% of loading capacity
	Types of carriers	90% own account, either wholesalers/producers and retailers
	Nodes in the supply chain	Rungis wholesale market 7km South of Paris Wholesalers' warehouses, freight platform, cross-dock facilities and. Most of the nodes are located within 50 km city inner center.

Source: our own elaboration on 17, 18

Table 3. F&V last mile deliveries for Ho.Re.Ca.

Macro-variables	Variables	Details
Logistics variables	Frequency requested by receivers (average)	1.8 delivery per day (week basis)
	Load units	Mostly boxes, other: pallets, rolls.
	Characteristics of deliveries	N. of deliveries /trip: 6 Average weight of total deliveries: 345 kg
Technological and organizational variables	Types of vehicle	95% of total deliveries made by diesel LCVs (up to 3.5 tonnes gross weight) 5.5% of diesel vans are euro 0, 1 (registered before 1997) 8.5% of diesel vans are euro 2 (registered before 2001)
	Delivery period	Deliveries are made in the morning: 5:00-14:00 Peak hour: 8:00-9:00am
	Level of logistics optimization	Average (origin): 50% of loading capacity Average (round trip): 25% of loading capacity
	Types of carriers	92% own account, either wholesalers/producers and retailers
	Nodes in the supply chain	Rungis wholesale market 7km South of Paris Wholesalers' warehouses, freight platform, cross-dock facilities and. Most of the nodes are located within 50 km city inner center.

Source: our own elaboration on 17,18

The results of this analysis show that F&V last mile deliveries for independent and Ho.Re.Ca. distribution systems, featuring small deliveries and short roundtrips limited to urban areas, are well-suited to ECVs. According to these data, battery range and loading capacity, crucial factors to increase operators' acceptance of electric vehicles, result to be compatible with the performance provided by the existing electric vans. However, it is worth to highlight that limited information about payload and volumes are provided by the available data. In order to filling the gap, qualitative interviews have been carried on and the perspectives of F&V operators and manufacturers have been gathered.

6. CONSTRAINTS OF F&V SECTOR

Technological constraints identified by the interviewed professionals focus on constraints to battery autonomy and payload/volume reduction. In particular they report specific constraints related to the converted vans, i.e. fridge vans:

- Driving range for electric vans equipped with refrigerator is more limited compared to not-converted electric vehicles.
- Adding a second battery will help to improve driving range, however the load capacity would result reduced as the payload, compared to diesel equivalent vehicles.
- The use of refrigerated boxes could represent a viable alternative only for a limited set of deliveries. Refrigerated boxes are not suitable for deliveries of pallets, roll and big boxes. Currently sectors operators do not own refrigerated boxes, thus this option represents an additional cost, with obstacles related to the transport unite' size.

More in general, the barriers on the adoption of electric LCVs existing for most of the urban logistics chains are heavier for fresh food supply chain operators, i.e. F&V final deliveries.

Traffic regulation and access restrictions put pressure on trucking companies and on-account transport actors to convert to light vehicles, especially on those with old diesel vehicles (Euro 0, 1, 2) that in the Paris metropolitan areas represent 14% of circulating LCVs (18).

7. CONCLUSION

Light commercial vehicles provide many advantages in terms of logistics and organizational performance, but the reduced load capacity generates a higher number of trips, and thus, has a negative impact on urban congestion and air quality, mostly because of the strong dieselization occurred in the last two decades. Electric vehicles are thus an alternative option to provide similar transport performance, without polluting emissions at the urban level.

Electric vans appear to be well-suit for different logistics chains, however technical constraints limit the adoption on the food last mile sector. With the existing technology, the logistic chain of F&V operators can adopt electric vans, however this additional costs should be compensated by an additional subsidy ad hoc for this use.

Policy decisions that consider the critical concerns of sector operators over the overall reliability of the electro-mobility system will bring better prospects of success for electric vehicles in LCV fleets.

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