Supporting Plug-in Electric Vehicle Adoption in Light-duty Fleets

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Claire Sugihara, Scott Hardman, Debapriya Chakraborty, Erik Figenbaum, George Beard, Virginie Boutueil, Nicolò Daina, Elisabeth Dütschke, Jae Hyun Lee, Nazir Refa, Benjamin Sovacool, Frances Sprei, Jake Whitehead, Brett Williams

Affiliations:
Claire Sugihara, University of California Davis, USA, ccsugihara@ucdavis.edu
Scott Hardman, University of California Davis, USA, shardman@ucdavis.edu
Debapriya Chakraborty, University of California Davis, USA, dchakraborty@ucdavis.edu
Erik Figenbaum, TOI (Institute of Transport Economics), Norway, Erik.Figenbaum@toi.no
George Beard, TRL, UK, gbeard@trl.co.uk
Virginie Boutueil, ENPC, France, virginie.boutueil@enpc.fr
Nicolò Daina, Imperial College London, UK, n.daina@imperial.ac.uk
Elisabeth Dütschke, Fraunhofer Institute for Systems and Innovation Research, Germany, elisabeth.duetschke@isi.fraunhofer.de
Jae Hyun Lee, Kyungpook National University, South Korea, giscience@knu.ac.kr
Nazir Rafa, Elaadnl, Netherlands, Nazir.Refa@elaad.nl
Benjamin Sovacool, University of Sussex, UK, B.Sovacool@sussex.ac.uk
Frances Sprei, Chalmers University of Technology, Sweden, fsprei@chalmers.se
Jake Whitehead, The University of Queensland, Australia, j.whitehead@uq.edu.au
Brett Williams, Center for Sustainable Energy, USA, brett.williams@energycenter.org

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Abstract

This paper discusses potential barriers to electric vehicle purchase in fleets and how these could be overcome by policymakers, fleets, and organizations with fleets. Fleets may face unique challenges to electrification and require different support than is provided to private consumers due to their variety of vehicle uses and applications. The paper is divided into discussions on purchase issues and those on operational issues. Purchase issues include ensuring plug-in electric vehicles (PEVs) are available across different vehicle types, creating educational campaigns for both decision-makers and fleet vehicle drivers, and tailoring incentives to the fleet context. Operational issues include factors such as creating post-purchase incentives, implementing low-emission zones and congestion charges, and facilitating utility support for fleet vehicle charging installations.

Introduction and Scope

In this paper we focus on the electrification of light-duty vehicles in fleets. For the purposes of this paper, light-duty vehicles refer to passenger cars, vans, and light-duty trucks, but does not include larger vehicles such as trucks, heavy-duty vehicles, large goods vehicles, or buses. Here, "fleets" and "fleet vehicles" refer to vehicles operating in fleets that are owned by public or private organizations and used by employees while conducting business for that organization. Such organizations include city fleets, county fleets, municipal fleets, utility fleets, delivery fleets, emergency vehicle fleets, electric utility fleets, fleets of private companies, and others. In some countries, the separation of private vehicles and fleet vehicles is blurred by 'company cars' which are vehicles provided to employees for business and personal use. We consider those vehicles to be out of scope of this report as purchase decisions are often made by the driver, not the fleet manager [1]. We also do not consider new mobility service fleets such as Uber and Lyft since vehicles in those fleets are often owned by the drivers.

Fleet vehicles are distinct from consumer-owned vehicles as they have a generally higher milage and faster turnover rate, leading to a disproportionate impact on emissions and energy consumption [2–4]. Fleet vehicles are often used within urban areas where criteria pollutants are more problematic. In some places, fleets constitute a substantial portion of vehicle sales [2,3]. This means the electrification of fleet vehicles can deliver substantial societal benefits. Furthermore, the uptake of electric vehicles by fleets has secondary benefits including increasing the local market for electric vehicles, developing a second-hand electric vehicle market, and potentially lowering vehicle prices through increased economies of scale [1,2,5].

Due to upcoming 100% zero emission vehicle sales goals and fleet vehicle purchase regulations, fleets in some regions will only be able to purchase PEVs by a certain date [6,7]. Many fleets have begun the process of fleet electrification, however, there are unique challenges that fleets face. These include behavioral issues such as difficulty in convincing fleet vehicle drivers to use and charge electric vehicles, lack of infrastructure and difficulties in installing chargers, lack of knowledge of electric vehicles on issues such as range [8] and vehicle maintenance [9], budgetary constraints which can include the requirement to purchase the lowest cost vehicles in a competitive bid process [10], organizational issues such as booking of vehicles and making sure that the vehicles are sufficiently charged prior to use, and a lack of vehicle availability in certain vehicle classes (e.g. light-duty pickup trucks in the USA, medium sized vehicles in Europe). The interaction between central fleet purchasers and the drivers of these vehicles is unique to fleets and has a strong influence on the types of vehicles that fleets are able to purchase [2,11].

Below we discuss the barriers and issues fleets face in purchasing PEVs and discuss how these could be overcome by policymakers, fleets, and other stakeholders. We broadly classify fleet electrification issues into two main categories: purchasing and operational.

Purchasing Issues

First, we discuss issues with PEV purchasing. This includes barriers that may prevent PEV purchase and potential strategies to overcome these barriers.

Vehicle model availability

Fleets contain many vehicle types including small cars, sedans, SUVs, vans, and pickup trucks. In some markets, such as the United States, trucks make up a substantial portion of fleet vehicles (87% of purchases in 2017). Without a diverse selection of PEV models, fleets will not be able to electrify. While PEVs are becoming widely available in the small car, sedan, and small SUV category, availability is moderate in the larger SUV, light truck, and van categories. In some regions, such as Europe, the selection of some vehicle types has increased over the past few years due to stricter limits for new car CO_2-emissions [12,13]. This resulted in greater electric vehicle model availability; however, these vehicles are still limited in many markets [14]. The pickup truck category has, until recently, lacked commercial PEV offerings in either Battery Electric Vehicle (BEV) or Plug-in Hybrid Electric Vehicle (PHEV) form. While manufacturers such as Rivian and Ford are introducing electric pickup truck models, these models have a significantly higher purchase cost and are not lower priced utilitarian trucks that fleets generally use. The limited availability of 4WD vehicles may, in some countries or areas with harsh winters and mountainous topography, also limit the adoption of BEVs.

The potential for incentives, education, and other measures to impact fleet electrification is directly impacted by vehicle model availability. Policymakers may have a role in requiring the sale of plug-in SUVs and trucks to encourage automakers to bring these vehicles to the market, similar to the role of the ZEV mandate in helping commercialize passenger PEVs [15]. Larger fleets may be able to send a signal to automakers that demand for electric vans and trucks exist by setting internal electric vehicle purchasing goals.

Range

In the consumer market, range is often a psychological barrier to BEV adoption since even short vehicle ranges are sufficient to meet most travel requirements. Fleets may have a better understanding of daily travel needs but may require longer driving ranges than consumers. Pfriem and Gauterin [16] examined the drive cycles of BEVs deployed in commercial fleets in France and Germany finding that BEVs travel shorter distances and durations than conventional vehicles in the fleet. A 2015 study conducted by FleetCarma examined the range and charging requirements needed to cover the duty cycle of fleet vehicles [17]. They found that when PEVs are selected to best match the existing operating characteristics of fleet vehicles, their electric range is generally sufficient for covering the duty cycle. In cases where a BEV is unable to meet these requirements, they recommend PHEVs. Since the publication of both of these reports, many longer range BEVs (i.e. more than 200 miles of range) have been introduced to the market.

The importance of range is shown by Globisch, Dütschke and Wietschel [9] who found that even after initial procurement, the mobility restrictions caused by limited range of BEVs can prevent fleets from purchasing subsequent BEVs. In some cases, the precieved range of the vehicle can inhibit their use even when the actual vehicle range is sufficient to cover the trip [10]. While these studies show range as a primary constraint, newer BEV models have longer range and thus meet more user needs. Figenbaum [8] found that 200 km range could make it possible for “craftsmen” to replace all vans (light commercial vehicles) in their fleet with battery electric vans. With increasing availability of longer-range vehicles, range may become less of an issue for fleets, though it is likely that some applications with high milage duty cycles may require PHEVs. Applications requiring PHEVs will require additional support to ensure that vehicles are charged, and electric range is maximized [18,19].

Educating & Training

Fleet decision-makers may be unaware of the benefits of procuring PEVs, vehicle attributes (such as range), and charging infrastructure installation [20]. Educating decision-makers has the potential to impact sales of thousands of vehicles in the case of large fleets. Education should focus on the benefits of PEVs to the fleet, the availability of PEVs, and practical concerns including vehicle charging and driving range, and the availability of grants and incentives. This should include information on how driving range of a PEV fits into the needs of the fleets, encouraging key decision-makers to trial PEVs in various applications, and teaching how fleet managers can educate users of the vehicles. In some regions, police fleets, which are sometimes considered the hardest to electrify, are experimenting with incorporating PEVs into emergency vehicle fleets (Figure 1) [10].

A key element of education is understanding the use of fleet vehicles. While some fleet decision-makers use in-vehicle telematics systems to gain a detailed understanding of vehicle utilization, including daily driving range, other fleets (often smaller ones) do not have this data. Without telematics it may be more difficult for fleet managers to identify vehicles that are easier or more appropriate to electrify. Telematics can act as an important educational tool that allow decision-makers to understand where PEVs can be incorporated into existing operations.

In addition to the operational feasibility of PEVs, education training on the financial benefits of PEVs is also critical to adoption. While some larger fleets have developed total cost of ownership (TCO) calculations tailored to their specific fleet, there are also many calculators developed by governments, industry associations, and other stakeholders [21]. These tools help educate fleets about the financial implications of switching to a PEV, which may help mitigate the barrier of higher purchase costs.

Driver education is another key component of fleet electrification. Fleet vehicle user studies have found that experience with using a PEV can increase driver acceptance [20,22], number of miles driven, and overall use of the vehicles [23]. Fleet managers should encourage drivers to use PEVs to increase vehicle acceptance and use. Educational campaigns on the benefits of the vehicles, as well as best practices for using them can help ensure that electric vehicles are utilized within the fleet, rather than having employees choose gasoline powered vehicles first [11]. These experiences also increase the likelihood of fleet drivers purchasing a PEV for their personal use, furthering the importance of fleet electrification. Driver resistance can pose a barrier for fleets who are influenced in their purchasing decisions by the users. Thus, by educating drivers about PEVs, fleet managers are better able to utilize them. Conversely, in some cases, the perceptions of fleet vehicle drivers have also been shown to be highly influential in fleet purchase decisions [2]. This increases the importance of including drivers in PEV education.

It is also important to ensure that manufacturers, leasing companies, and dealerships are informed about PEVs as they can influence what vehicles fleets procure [24]. Additionally, by educating these groups, they can work to further educate fleets on the benefits of electrification. This can be done by allowing fleets to trial a certain number of PEVs before deciding whether to fully integrate them into the fleet.

Figure 1: Fleets are trialing PEVs in various applications including as emergency response vehicles shown here in California (left) and Scotland (right) (source: the authors).

Purchase Incentives

Public fleets can be required to purchase vehicles with the lowest upfront cost that meet their needs, which creates a barrier to purchasing PEVs as they are typically more expensive than ICEVs. Additionally, fleet managers do not always use TCO calculations when deciding which vehicles to purchase [10] which means PEV operating costs will not overcome this issue. Adjusting lowest cost purchase requirements or including TCO into purchasing may allow electric vehicles to become more competitive, while saving money for the organization. In cases where this is not possible, utilizing incentives can reduce the purchase price for PEVs to equivalent, or even less than a comparable gasoline vehicle. This may make incentives that decrease the upfront costs of a vehicle more effective than incentives received at a later point in time [25], as the latter does not decrease the upfront cost which may prevent fleets from selecting that vehicle. Up-front incentives include purchase tax exemptions, point of sale rebates, feebate programs, and grants, while other rebates and annual tax credits are received at a later point in time [26].

A second issue is that in several countries, incentives are not applicable to all fleets. For example, in the United States, public fleets are unable to use the federal tax credit as they have no tax liability. They can utilize the credit if they lease vehicles as the incentive is used by the automaker to reduce lease costs, but most fleets purchase vehicles. Additionally, in Norway, BEV purchases are exempt from purchase and value added taxes (VAT), however, fleets do not pay VAT on any vehicle purchases (including ICEVs). Furthermore, in Germany private companies can benefit from the same purchase incentives as consumers, but public fleets (including municipal and city fleets) cannot access these. These situations are not unique to these countries, policymakers need to ensure that incentives apply to all fleet types, which will help achieve the highest possible electrification [27]. Incentives which allow fleets to secure funding in advance of vehicle purchase and allow for an increased number of rebates to be used at a given time may additionally increase adoption potentials.

In some countries, the purchase subsidies are adjusted based on the company size whereby small companies receive higher subsidies than larger companies. This allows for a fairer distribution of the total subsidy budget. In the Netherlands, the national government is applying this approach for vans and zero-emission trucks beginning in June 2022 [28].

Incentive design and administration must also include education and outreach as fleet managers are often unaware of the incentives available to them, lack the necessary time to keep track of incentives, and lack the knowledge of how to apply for incentives [10]. The incentives available to fleets need to be clearly publicized and the application process should be streamlined to remove barriers to applying [10]. Many fleet decision-makers are part of networks with decision-makers from other fleets. Encouraging and facilitating the sharing of practices and experiences (e.g. through workshops or seminars) with one another may help fleets understand how to incorporate electric vehicles. Additionally, streamlining the application and compliance process and providing assistance in applying can reduce administrative burden and increase the reach of these programs. In some instances, subsides may be restricted to exclude certain PEV types, such as PHEVs, or vehicles with a low electric range. These restrictions can prevent the adoption of PEVs by fleets whose duty cycle is currently unable to be met by a BEV.

Purchase Regulations

Fleet electric vehicle purchasing can be regulated at several different levels of governance. Local governments (e.g. cities, municipalities) and organizations with fleets can set rules for their own vehicle fleets, and state and national governments can set rules for the vehicles that fleets can purchase, or rules for what automakers can sell. Having simple, cohesive regulations allows fleets to clearly understand when vehicles need to be electrified. When set with sufficient advanced notice, these policies can allow fleets to incorporate PEVs during regular replacement cycles.

These regulations may be important for fleets partially due to requirements such as those to purchase vehicles with the lowest upfront cost and because the potential cost of ownership savings of electric vehicles is often not accounted for by fleet managers. To address this city, county, and state governments can introduce requirements for their fleets to procure PEVs to circumvent other purchase requirements. Several California cities including Oakland, San Jose, & Los Angeles, and states including Washington and Oregon have introduced such requirements [29–31].

Some U.S. states are requiring their own fleets to purchase a proportion of vehicles as electric, while others have introduced regulations that require vehicles to be low emission, alternative fuel, or zero emission vehicles (for example state agencies in Illinois must make 60% of total vehicle purchases as hybrid electric vehicles (HEVs) and 15% of purchases as BEVs by 2025). The State of California has introduced several regulations aimed at increasing electric vehicle use in fleets, including by 2024-25 50% of light-duty vehicle purchases in state-owned fleets must be zero emission electric vehicles [32]. At present, these regulations only apply to state-owned vehicle fleets. In the EU, the clean vehicle directive has specific targets for the share of PEVs to be procured among the vehicles purchased for use in public fleets. By 2026, between 17.6% and 38.5% of light-duty vehicles purchased by public authorities will be required to be zero emission vehicles [33]. This again only applies to publicly owned fleets, not private fleets.

Some national governments are setting goals for their own vehicle fleets. The Dutch Government, for example, has committed to only buying PEVs after 2028 [34]. California, Norway, and several other nations have goals of reaching 100% electric vehicle sales by 2025 (Norway), 2030 (Denmark, Ireland, United Kingdom), 2035 (California, Canada), and 2040 (Spain, France). After these dates, fleets will be required to purchase only PEVs for their fleets. The setting of sales targets for fleets in the years before these dates may help them prepare by gradually increasing PEV use in their fleets.

Environmental certification schemes, for example those that certify organizations as being sustainable, low energy, or ‘green’, can be expanded to include vehicle fleets. Schemes operating in Norway that require measures to reduce the environmental footprint of organization’s fleets have been found to drive electric van adoption [30].

A secondary benefit of these purchase requirements may be that these stakeholders send a signal to automakers that demand for PEVs exist in different vehicle categories, which may encourage automakers to introduce these to the market.

Operational Issues

Here we discuss issues with the integration and use of PEVs in fleets. This includes barriers that may prevent PEV use and potential strategies to increase PEV use and the benefits of PEV use to fleets.

Reoccurring incentives

In addition to financial purchase incentives, non-financial incentives can make PEVs more attractive for fleets to use. These include providing free or discounted parking or parking in preferential locations (including in loading or delivery areas), giving discounts or exemptions on tolls, and allowing PEVs to drive in carpool, bus, or transit lanes [35]. While these policies encourage PEV adoption, they have the potential to increase congestion. They are best suited for markets with low adoption rates and may need to be reevaluated once adoption rates increase.

Some cities have restrictions on the time of day in which vehicles can make deliveries. Giving electric vehicles greater freedom in which times they can make deliveries can be an incentive. Registration fee reductions, subsidies, and emissions-based taxes were seen as the most effective options in a study on Danish fleets [36].

Low and zero emissions zones and congestion charge schemes

Cities are restricting vehicle access to city centers using congestion charges, tolls, or low emissions zones. If these charges or tolls also apply to fleets, exceptions or cost reductions for fleet electric vehicles can incentivize their use over other vehicles. For example, the London congestion charge zone fee is £11.50 per day, which electric vehicles are exempt from. Assuming a fleet vehicle operates 5 days a week throughout the year, these fee exemptions can save fleets operating electric vehicles £2,990 (€3,532, US$3,894) per year. Some cities in Norway (Oslo, Bergen, Trondheim, Kristiansand) have introduced congestion charges on major roads leading to the city centers, alongside standing congestion regimes in Stockholm, Gothenburg, London, and Singapore. Some of these cities provide exemptions or rebates for BEVs. Low emission zones are also being introduced in many cities globally [37]. At present, many low emissions zones only restrict older polluting ICEVs from entering which does not encourage PEV adoption in fleets [38]. Restrictions to all light-duty ICEVs could be used to incentivize fleets (and consumers) to switch to PEVs. By announcing their plans to implement these zones with sufficient advanced notice, municipalities can help encourage companies to incorporate PEVs into their purchasing plans prior to implementation.

Infrastructure

Fleet vehicles typically either operate on a return to base model or drivers take the vehicles to their home residence at the end of each work shift. Vehicles that return to a fleet drivers' residence will require charging at these drivers' homes or need to use public charging stations. Fleet managers may need to develop reimbursement strategies and funding plans for home charger instalments and to cover charging costs both at home and in public. Reimbursements could be made with a fixed nightly rate or through telematics which record charging events. Policymakers should ensure grants are applicable to these situations and can used anonymized data collected under these programs to assist in infrastructure planning. As fleets begin to electrify, charging stations suited for additional fleet types (e.g. light-duty trucks and vans) will need to be placed in areas of high demand. This could include along highways and major traffic corridors where fleet vehicles frequently travel.

Return to base vehicles will require infrastructure at the fleet base, this may pose challenges if large numbers of vehicles need to be charged simultaneously. Some fleets are allocating PEV chargers on a per vehicle basis (Figure 2) where each vehicle has a charger, whereas others have fewer chargers that PEVs share. The latter will become easier to implement as longer range PEVs (i.e. more than 200 miles of range) enter vehicle fleets and with higher power chargers.

Past studies have shown that the installation and operation of charging infrastructure poses a major concern to fleets [11,39], particularly in regions where fleets do not typically own and maintain their own fueling infrastructure. In regions where fleets do have their own fueling stations (for example in the U.S.), installation, operation, and maintenance of charging infrastructure may be easier to implement, though it may still have challenges. This can include uncertainty about the monetary cost of charger installation, the potential rise in electricity costs, the investment in charging capacity required to maintain an operational fleet, lack of standardization in charging infrastructure and equipment, and the need for electricity grid upgrades [40].

Grants provided by policymakers can help fleets finance the development of charging infrastructure and grid upgrades. One example of this is the California Electric Vehicle Infrastructure Project (CALeVIP), which is operated by the California Energy Commission. The project provides rebates to cover costs of charging infrastructure equipment, installation costs, utility service orders, planning and engineering design costs, project signage, energy storage, networking agreements, and warranties for Level 2 and DC Fast Chargers [41,42].

With larger PEV fleets, charging many vehicles at the same time could put strain on the electric grid [43–45]. This may require fleets to upgrade existing electrical supply infrastructure. Some utilities are helping fleets with installation where they provide the equipment and install if for free with the caveat the fleet buys electricity from them. Utilities can also assist fleets in their electrification efforts by updating electricity tariff structures. In the U.S., rate plans for commercial organizations include demand charges which can have a significant impact on the monthly electricity bill of a fleet[1] [46]. Targeted commercial PEV charging rates, reduction in demand charges, and higher emphasis on time-of-use volumetric rates can help reduce the operating cost of PEVs for commercial fleets. Some utilities in California, like Pacific Gas & Electric and Southern California Edison, have proposed tiered rate plans that will allow commercial fleets to select plans based on charging needs. Encouraging solutions like smart charging [47] that allow use of price signals to align demand with grid conditions, and vehicle to grid integration as well as battery storage, may allow commercial fleets to further reduce the operating costs of PEVs

[1] The demand charge incurred by a customer is related to the peak power used during a monthly billing cycle. A demand charge is typically assessed for the highest average power over any 15-minute interval during the monthly billing cycle. This is charged in addition to what the utilities charge for the cumulative energy usage per month. Such charges can occur when PEVs are being recharged.

and avoid costly electrical upgrades [48]. Large fleets can minimize the need for grid upgrades by installing smart chargers, using time of use tariffs that can disperse charging demand over a longer period, or by distributing chargers in different fleet vehicle yards (if applicable). In fleets with multiple depots, charging stations can be located in areas with spare electric capacity to alleviate the need for electric grid upgrades.

Figure 2: 16 PEVs (including Ford Focus BEVs, Toyota Prius PHEVs, Chevrolet Volt PHEVs, and Chevrolet Bolt BEVs) parked in a California fleet home base, all with their own dedicated charger (source: the authors).

Summary

Light-duty fleets face unique challenges that require different support compared to private consumers. On purchasing issues, model availability is a limiting factor as the diversity of fleet use cases must be met with an equally diverse selection of vehicles. Electric vehicle purchase requirements, particularly those set by national and regional governments, may have two benefits, first they allow fleets to purchase electric vehicles and second, they may help in demonstrating to automakers that demand exists for electric vehicles in fleets, which may help increase vehicle model availability. As PEVs become available in increasing varieties, the role of educational campaigns will grow increasingly important. These should seek to promote the benefits of PEVs amongst both fleet vehicle decision-makers and drivers and promote the availability of incentives. Purchase incentives also need to be communicated and simplified. Point-of-sale incentives and increased funding may be effective as it removes the need to apply for incentives and can make PEVs align with requirements for fleets to purchase the lowest-cost vehicles.

Operational considerations include incentivizing the use of PEVs, the implementation of low-emission zones, and charging infrastructure. Reoccurring incentives help encourage the use of PEVs in fleets such as free or discounted parking, toll lane access, or preferential access to delivery and parking. Finally, support for the purchase and use of charging stations is essential for supporting fleet electrification efforts. Both utility and government support for charging station installation and lower electric rates can incentivize fleets to electrify.

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