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HOW CAN TAXES AND FEES ON RIDE-HAILING FLEETS STEER THEM TO ELECTRIFY?

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EXECUTIVE SUMMARY

The early transition to electric vehicles continues in many markets. Likewise, the use of ride-hailing services continues to greatly expand. However, only a limited number of vehicles used for ride-hailing—about 1%—are electric, which is less than the global electric vehicle sales share of new vehicles in 2018.

This paper analyzes the prospect of using strategically designed taxes and fees to steer ride-hailing fleets to electrify. We apply a total cost of operation metric for conventional, hybrid, and electric ride-hailing vehicles in cities in the United States and Europe. Based on this, we assess several different types of taxes and fees on ride-hailing vehicle use that could accelerate the electrification of ride-hailing fleets, and the appropriate timing for such programs. Our analysis leads us to the following three conclusions:

> **Government taxes and fee structures can make electric vehicles the most economically attractive technology for ride-hailing fleets.** Major markets with taxes or fees in place charge full-time ride-hailing drivers up to tens of thousands of dollars over a 5-year period. These programs can be designed to steer ride-hailing fleets to electrify. Taxes and fees on ride-hailing vehicles are increasingly common, but are not typically designed to promote cleaner cars. If fees are indexed to vehicle tailpipe emissions, a per-trip fee of $0.58 to $1.12 (equivalent to 5% to 9% of ride-hailing gross revenues or $0.07 to $0.14 per mile) is sufficient for electric vehicles to be economically superior to hybrid vehicles based on U.S. operating costs.

> **A well-designed ride-hailing fee program can help overcome the prevailing barrier of charging infrastructure.** Our analysis indicates that home and public fast charging are key to the economics of electric ride-hailing. Fees can be used to support home charging installation for ride-hailing drivers and the deployment of fast charging in optimal urban locations to reduce the opportunity costs from driver downtime while charging. Just 5% to 8% of fees collected from ride-hailing would be sufficient to create a self-sustaining charging infrastructure program.

> **As ride-hailing fleets transition to electric, taxes and fees will need to be adjusted over time.** For government programs to maintain similar revenues, while also funding broader city mobility goals, fee structures will need to evolve as more electric vehicles enter the fleet. Combustion vehicle fees will need to increase incrementally over time, and electric vehicle fees will need to be less than those imposed on combustion vehicles.

Taxes and fees can be a driving force behind the transition to electric vehicles in ride-hailing fleets and the market overall. While many cities actively discuss banning combustion vehicles, this paper offers a practical step to steer a large and fast-growing segment of urban vehicles toward zero emissions. Although this paper targets taxes and fees on ride-hailing vehicles, applying such policies more broadly to all vehicles could have greater effects. Emission-indexed charges applied fleetwide could support not just ride-hailing electrification, but also greater vehicle sharing and public transit usage, reduced congestion, and reduced parking needs.

INTRODUCTION

The reach and use of ride-hailing services have greatly expanded in major urban areas globally, and the trend is expected to continue. In U.S. cities with high ride-hailing usage, there are tens of thousands of drivers, more than 20% of urban residents use the services on a weekly basis, and ride-hailing trips rival local bus usage (Schaller Consulting, 2017, 2018; San Francisco County Transportation Authority [SFCTA], 2017a, 2018a). In Europe, ride-hailing typically is more regulated. Markets like the United Kingdom have experienced especially high growth and popularity, and ride-hailing already dwarfs the local taxi industry in several jurisdictions in terms of licensed vehicles (Department for Transport, 2018).

Ride-hailing fleets raise many questions related to their environmental and mobility impacts, including congestion and transit use, and electrification offers an opportunity to eliminate the vehicles' local emissions. As local and state governments seek measures to ensure environmental and social benefits, pricing ride-hailing services to include taxes, fees, and surcharges is emerging as a promising opportunity to limit externalities. Because the convergence of electric vehicles and ride-hailing vehicles has been limited (Slowik, Fedirko, & Lutsey, 2019), taxes and fees could offer the prospect of simultaneously managing ride-hailing externalities and accelerating their shift to electric.

This paper analyzes the economic opportunity for government taxes and fees to steer ride-hailing fleets toward electric. A key question of this research is whether these programs can tip the economic value proposition of ride-hailing in favor of electric vehicles and make a compelling business case. In our analytical approach, we treat taxes and fees as if they are borne by ride-hailing drivers. In practice, these costs may be paid by companies or passed along to customers. Fundamentally we believe the impact of our presumption that fees are incurred by drivers is the same as if fees flowed down to customers in a highly competitive market. The taxes and fees can be integrated into a company's own pricing algorithms and reflected in the price of service for its customers, thus providing economic motivation to electrify and avoid fees.

Building on our previous work (Pavlenko, Slowik, & Lutsey, 2019), we use a 5-year total cost of operation (TCO) metric for conventional, hybrid, and electric ride-hailing vehicles in cities in the United States and Europe. Our approach incorporates electricity and fuel costs, maintenance, taxes, and opportunity costs for public charging of electric vehicles, as well as 2020–2025 vehicle technology improvements and driver access to charging infrastructure. Based on this analysis, we assess improved government programs that levy taxes, fees, or surcharges that help mitigate ride-hailing fleets' externalities and accelerate their electrification. In particular, this work seeks to identify the key principles for effective policy to encourage ride-hailing companies and their drivers to adopt electric vehicles.

BACKGROUND ON LEVYING TAXES AND FEES ON RIDE-HAIILNG

Wide-ranging government regulations that levy taxes or fees on ride-hailing fleets are emerging. Figure 1 summarizes the major frameworks. Some governments apply authorization fees, which may require ride-hailing companies to acquire an annual permit or drivers to acquire an annual license for operating their privately-owned cars. Fees on ride-hailing vehicle operation can also be charged, such as per-trip fees, per-mile fees, or percentage fees based on revenues. In some areas, ride-hailing vehicles pay to access city infrastructure, including per-day, per-entrance, or per-hour fees to drive in predefined urban areas such as the city center.

Example tax and fee frameworks levied on ride-hailing

Authorizing fees	Operating fees	Accessing fees
‣ Permit fees ‣ License fees	‣ Per-trip fees ‣ Per-mile fees ‣ Percentage-based fees	‣ Per-day fees ‣ Per-entrance/exit fees ‣ Time-dependent fees

Figure 1. Summary of example frameworks of fees levied on ride-hailing fleets.

This section summarizes several existing and proposed regulations in the United States and Europe in 2019, including information on the tax or fee details and regulatory authorities.

UNITED STATES

Regulatory authority over ride-hailing services is fragmented, and existing rules vary widely. Forty-eight states had some ride-hailing regulation in place as of 2017 to address issues including legal authority, safety, insurance, and fares (Texas A&M Transportation Institute, n.d.). Many cities also are interested in implementing policy to govern ride-hailing in an effort to improve safety, accessibility, and data transparency, or minimize its externalities such as congestion and pollution. For example, upon evaluating ride-hailing and other mobility services in the area, the San Francisco County Transportation Authority recommends the city adopt road pricing schemes to manage congestion and curb access (SFCTA, 2018b).

Several state and local governments levy some sort of tax or fee on ride-hailing to mitigate local impacts. Table 1 summarizes several existing regulations. Governments are charting somewhat different paths in levying taxes and fees on ride-hailing operations: Some apply a per-trip fee on all trips, some assess a percentage-based fee based on trip fares or company revenues, and others impose permitting and licensing fees for ride-hailing companies or their drivers. For example, the City of Portland, Oregon, assesses a $0.50 per-ride fee on all trips, and Hawaii collects 4% of each fare. New Orleans, Louisiana, applies a $0.50 per-trip fee for all trips originating in Orleans Parish and also requires companies to have annual permits worth $15,000. In other examples, San Francisco International Airport collects $3.80 per-ride for all pickups and drop-offs, and Washington, D.C., applies a 6% tax on all trips originating in the district.

Table 1. Summary of example regulations levying taxes or fees on ride-hailing in the U.S.

	Market	Regulatory authority	Tax and fee details
STATE	**Alabama**	Public Service Commission	1% of gross trip fare for all rides originating in the state, collected quarterly (Legiscan, 2018).
STATE	**California**	Public Utilities Commission	0.33% of revenue. Company $1,000 initial permit fee, $100 permit renewal fee. $0.10 per-ride wheelchair accessibility fee (CPUC, 2013, 2019a, 2019b).
STATE	**Connecticut**	Department of Transportation	$0.25 per ride originating in the state, collected quarterly (Connecticut General Assembly, 2017). Company $5,000 annual fee (CDOT, 2018).
STATE	**Hawaii**	Department of Taxation	4% of each fare (Hawaii Department of Taxation, 2018).
STATE	**Maryland**	Public Utilities Commission	Maryland allows counties and municipalities to impose per-trip fees, up to $0.25 (Comptroller of Maryland, 2015)
STATE	**Massachusetts**	Department of Public Utilities	$0.20 per ride, with partial revenue proportionately distributed to municipality of origin (Commonwealth of Massachusetts, 2018)
STATE	**Nevada**	Public Utilities Commission	3% of total fare. $200 fee for annual business license required for each driver. (Nevada Legislative Council, 2015)
STATE	**New York**	Department of Motor Vehicles	4% of gross trip fare assessed on all trips originating outside of NYC (New York State Department of Taxation and Finance, 2018). 2.5% “Black Car Fund” surcharge on all trips statewide.
STATE	**Rhode Island**	Public Utilities Commission	A 7% sales and use tax is applied to ride-hailing company operations (Rhode Island Department of Revenue, 2016).
STATE	**South Carolina**	Public Service Commission	1% of gross trip fare collected on all trips originating in the state (South Carolina General Assembly, 2015).
CITY	**Chicago**	Business Affairs and Consumer Protection	$0.62 per trip, with additional $0.10 per ride for all non-wheelchair-accessible vehicles. $10,000 annual license fee per company. (City of Chicago, n.d.)
CITY	**New Orleans**	Department of Safety & Permits	$0.50 per trip originating in Orleans Parish. $15,000 annual permit fee per company. (City of New Orleans, 2018)
CITY	**New York City**	New York City Taxi & Limousine Commission	8.875% sales tax per trip (City of New York Office of the Mayor, 2016). $2.75 surcharge for trips south of 96th Street in Manhattan, $0.75 for pooled trips (New York State, 2018). $550 application for vehicle 2-year license (NYC TLC, n.d.).
CITY	**Philadelphia**	Pennsylvania Public Utility Commission	1.4% of gross receipts for rides originating in Philadelphia issued to city. $50,000 application fee per company paid to state. (Pennsylvania General Assembly, 2015)
CITY	**Portland**	Portland Bureau of Transportation	$0.50 per-ride fee (City of Portland, 2018a, 2018b)
CITY	**San Francisco**	SFO Airport Commission	$3.80 per-ride for pickups and drop-offs at San Francisco International Airport (SFCTA, 2017b).
CITY	**Seattle**	King County Records and Licensing Services	Per-ride fee of $0.14 or $0.35 for rides originating in Seattle or King County, respectively. Additional $0.10 per-ride wheelchair accessibility surcharge (King County, n.d.).
CITY	**Washington, D.C.**	Department of For-Hire Vehicles	6% of gross receipts for trips originating in D.C. (District of Columbia, 2018).

Notes: Based on San Francisco County Transportation Authority (2017b) and Kim & Puentes (2018). Regulatory tax and fee details shown in table are simplified.

The revenues generated from taxes and fees serve multiple purposes. Revenues often support administrative and enforcement costs associated with their regulation. In other cases, revenues go toward filling needs created by ride-hailing operations. Some states, such as Connecticut and Hawaii, deposit proceeds into the general transportation budgets, which then go toward supporting projects such as local roadway improvement. Other governments use fee revenues to support local transit systems (e.g., Washington, D.C.), improve mobility options for passengers with disabilities (e.g., California; Chicago, Illinois), or assist the taxi industry (e.g., Massachusetts). Research conducted by the Eno Center for Transportation summarizes the disposition of funds from ride-hailing taxes and fees in the United States (Kim & Puentes, 2018).

Some governments are exploring how program design can influence ride-hailing company and driver behavior to meet a variety of objectives. In Chicago, the per-trip fee is reduced by 50% for trips that begin or end in a designated underserved area. Chicago also imposes an additional $0.10 fee on all trips in vehicles that are not wheelchair accessible. In New York, ride-hailing trips are subject to a $2.75 surcharge for trips south of 96th Street in Manhattan; pooled trips are partially exempt and pay $0.75. Providing exemptions from such fees incentivizes ride-hailing companies and their drivers to operate in underserved areas, adopt wheelchair accessible vehicles, and increase pooling.

Taxes and fees also can be designed to encourage reducing ride-hailing vehicles' environmental externalities. Just as Chicago's fee structure steers ride-hailing companies toward servicing underserved communities and wheelchair users, taxes and fees also could be designed to promote electric vehicles. For example, policymakers in Massachusetts could exempt electric vehicles from the $0.20 per-ride fee, the District of Columbia could exempt electric vehicles from the 6% tax, and New Orleans could exempt electric vehicles from the $0.50 per-trip fee and reduce annual permit fees for companies with a high number of electric vehicles in local service. Fees applied to ride-hailing vehicles could be indexed based on vehicle emission levels and thereby financially motivate companies and their drivers to adopt less-polluting vehicles. In theory, all existing and future policies levying taxes and fees on ride-hailing could be designed to prioritize zero-emission vehicles over their combustion counterparts.

Table 2 summarizes how five of the existing regulations shown in Table 1 could be adapted to encourage the adoption of electric vehicles. Specifically, these programs could fully or partially exempt electric vehicles from the various taxation and fee structures. For context, this approach is under consideration in Delhi, India, where policymakers have proposed waiving a ride-hailing fee for trips in electric vehicles as outlined in the Delhi Draft Electric Vehicle Policy (Delhi Transport Department, 2018). Policymakers also could increase fees placed on combustion vehicles as another strategy to promote electric vehicles. Later in this paper we analyze how adapting these regulations might impact the economics and timing of cost-effectively transitioning ride-hailing to electric vehicles in these markets.

Table 2. Approaches to adapt government tax and fee structures to incentivize electric vehicles.

Market	Existing regulatory design	Potential regulatory adaptations to encourage electric vehicles
California	• 0.33% of revenues fee	• Electric vehicles exempt from revenue-based fee
Chicago, Illinois	• $0.62 fee per trip • $10,000 annual license fee per company	• Trips in electric vehicles exempt from fees • Companies are partially exempt from annual license fee based on fleet electric share
New York City, New York	• 8.875% sales tax per trip • $2.75 surcharge for trips south of 96th St. Manhattan, $0.75 for pooled trips. • $550 application for vehicle 2-year license	• Electric vehicles exempt from sales tax • Electric vehicles exempt from Manhattan-based surcharges • Electric vehicles exempt from licensing application fee
Portland, Oregon	• $0.50 per-ride fee	• Exempt rides in electric vehicles
San Francisco Airport	• $3.80 per-ride for pickups and drop-offs	• Exempt electric vehicles from airport fee

EUROPE

Ride-hailing companies have faced greater challenges entering European markets than in the United States. The lack of national regulatory frameworks for new mobility services such as ride-hailing has been one of the main barriers. Court decisions at European Union (EU) and national levels led to companies like Uber being subject to greater regulation, more like taxi companies, and experiencing lower growth in Europe than in the United States (European Commission, 2016; Court of Justice of the European Union, 2017, 2018).

Ride-hailing regulatory approaches are fragmented in the European Union. Ride-hailing services generally must comply with national safety, service, and pricing standards as well as licensing rules. Most EU Member States have not yet incorporated new mobility services such as ride-hailing in their legal framework (Organisation for Economic Co-operation and Development, 2018). Estonia was the first country to legalize ride-hailing by amending its Public Transport Act (Riigi Teataja, 2016). Lithuania, Finland, and Portugal also have legalized intermediate platforms (Republic of Lithuania, 2016; Finnish Government, 2018; Republic of Portugal, 2018).

Some jurisdictions have implemented taxes, fees, or surcharges for ride-hailing services. Table 3 provides an overview of selected regulations. These can include fixed daily fees, per-entrance/exit fees, or time-dependent charges for driving in, through, or out of restricted urban areas as applied in Gothenburg, London, Milan, Stockholm, or Valletta. In London, daily fees for entering the Congestion Charge Zone and the Ultra Low Emission Zone (ULEZ) can be as much as £24.00 ($34.30). The standard daily rate for entering Milan's congestion and Low Emission Zone (LEZ) is €5.00 ($5.60). Stockholm's congestion tax applies per-trip in or out the congestion zone up to a maximum daily charge of 105 Swedish kronas (SEK) ($11.30); in Gothenburg the equivalent rate is 60 SEK ($6.50). Malta's capital city, Valletta, applies a time-dependent fee for entering the congestion zone. Airport drop-off or pickup surcharges are applied in cities such as Berlin, Bucharest, and Edinburgh and range for the selected cities from $0.56 to $5.20.

Table 3. Summary of example regulations levying taxes or fees on ride-hailing in Europe.

Market		Regulatory authority	Tax and fee details
Germany	Berlin	Senate of Berlin	Surcharge of €0.50 ($0.56) for a trip starting from Berlin Tegel Airport (Senate of Berlin, 2019)
Italy	Milan	Municipality of Milan	Standard daily rate of €5.00 ($5.60) to access the congestion charging area and LEZ (Municipality of Milan, 2019)
Malta	Valletta	Government of Malta	A per-hour fee applied to access the zone during operating hours. Maximum daily fee of €6.52 ($7.40) (Controlled Vehicular Access, 2019)
Romania	Bucharest	Henri Coandă International Airport	3.00 Romanian Leu (RON) ($0.70) pickup surcharge added to airport fares (Uber, 2019a)
Sweden	Gothenburg	Swedish Transport Agency	A tax applied when vehicles enter/exit the congestion charging zone that varies in value based on time of day. Maximum per-day fee of SEK 60 ($6.50) (Swedish Transport Agency, n.d.)
	Stockholm	Swedish Transport Agency	A tax applied when vehicles enter/exit the congestion charging zone that varies in value based on time of day. Maximum per-day fee of 105 SEK ($11.30) (Swedish Transport Agency, n.d.)
United Kingdom	Edinburgh	Edinburgh Airport	£2.00 ($2.60) drop-off or £4.00 ($5.20) pickup surcharge added to airport fares (Uber, 2019b)
	London	Transport for London (TfL)	Standard charge of £11.50 ($15.00) for entering London's Congestion Charge Zone plus £12.50 ($16.30) for entering the ULEZ (TfL, 2019a; 2019b; 2019c; City of London, 2019)

Notes: Regulatory tax and fee details shown in table are simplified. For conversion of various currencies, we adopt currency exchange rates from April 2019.

The revenues generated serve different purposes. In the case of London, revenues are invested in transport infrastructure, public transport, or sustainable transport options (TfL, 2018a). In Edinburgh, revenues are used to combat congestion and finance new road infrastructure to the airport (Edinburgh Airport Limited, 2018). In Milan, revenues gained are partly used to strengthen and promote alternative modes of transportation (Municipality of Milan, 2018). In terms of access regulations, charges generally apply to all passenger cars without differentiating between private or shared and hired vehicles. In addition, with exceptions like London, Milan, or Valletta, these charges usually do not include any preferences or exemptions for electric vehicles. In the following section, we explore how modification of these programs could pave the way for electric ride-hailing.

ANALYSIS OF TAXES AND FEES LEVIED ON RIDE-HAILING

In this section we assess how modified government regulations that levy taxes or fees on ride-hailing fleets could make a compelling business case for electric ride-hailing. We analyze three reference vehicle technologies: conventional gasoline, hybrid electric, and electric with 250 miles of electric range. Shorter-range (i.e., 150- and 200-mile) electric vehicles are excluded, as they are the least cost-effective technology for full-time ride-hailing drivers (Pavlenko, Slowik, & Lutsey, 2019). We analyze shifting upfront and operating costs of electric vehicles relative to conventional and hybrid vehicles from 2020 to 2025, factoring in regional variation, shifts in fuel costs, and vehicle and battery technology improvements. For energy costs, we use local level data on typical petroleum, residential electricity, and public fast charging electricity prices in the various markets. We exclude government and industry purchase incentives for electric vehicles in this analysis (e.g., the U.S. $7,500 federal income tax credit, the UK £3,500 plug-in car grant, California's $2,500 state rebate, Uber's London-specific grant worth up to £4,500), because the opportunity for modified fee structures to create a compelling business case for electric ride-hailing is a key question of this research.

We separately analyze several markets in the United States and Europe, focusing the core of our analysis on two illustrative cases: Chicago and London. We do not conduct detailed assessments on what the various taxation and fee concepts mean for shared ride-hailing, but we qualitatively discuss the potential implications in the discussion below. In this section, a key assumption is that drivers *do not* have access to home charging and are entirely reliant on public DC fast charging. Based on our analysis, regular access to home charging can lower total electric vehicle operating costs by about 27% in 2020 due to lower energy and opportunity costs than public rapid charging; this is illustrated in the next section, which addresses designing taxation and fee policies.

To analyze taxes and fees that are based on a percentage of revenue, we use data from Uber's website that provides market-specific fare estimates (e.g., see Uber, 2019c). We use a weighted average of UberX and UberPOOL fare structures to assess typical revenues (and thus the percentage-based fees) in different markets for typical full-time ride-hailing drivers working 280 days per year. For taxes and fees that are trip-based, we use data from Schaller Consulting (2018) on typical ride-hailing trip distance and deadheading (i.e., non-fare generating miles) in selected cities, and use average values when city-specific data are not available.

Access-based fees often are pegged to specific geographies or apply on entering specific zones or regions. Detailed data on individual driver behavior are not available, so we use the best available data and research literature on typical ride-hailing vehicle behavior to estimate the frequency with which vehicles are subject to fees and we develop additional cases to test this sensitivity. In the case of London's Congestion Charge Zone and ULEZ, we use data from the City of London on the typical number of taxi and private hire vehicle entrances into the zone (City of London, 2018; TfL, 2018a). For New York City's $2.75 surcharge that applies to ride-hailing trips south of 96th Street in Manhattan, we use data from Schaller Consulting (2017) on the percentage of trips originating in the Manhattan core. To analyze fees incurred from ride-hailing trips to or from airports, we estimate the frequency of airport trips based on emerging data from Circella, Matson, Alemi, and Handy (2019).

There is uncertainty with regard to how taxes and fees are levied and how they are borne by the ride-hailing companies, their drivers, or their passengers. In our total cost of operation analysis of ride-hailing vehicles, we incorporate the cost of fees, which suggests that fees are directly incurred by drivers. In practice, fees may be paid by companies or passed along to their customers. Because of lack of data, we do not speculate on whether the companies pay fees or whether they are passed along to their customers. Based on market dynamics and strong competition among the ride-hailing companies to offer lower-cost service (e.g., Krisher and Liedtke, 2019; McArdle, 2019), we assume that any fees, whether levied on the companies, drivers, or their passengers, motivate companies and their drivers alike to adopt cleaner vehicles to avoid fees. We presume that, in a highly competitive market, the impact of fees that are incurred by drivers is the same as if fees flowed down to customers. Differences in taxes and fees can be integrated within ride-hailing companies' app-based variable pricing algorithms and reflected in the price of service for their customers, thus providing economic motivation to electrify and avoid fees. In a highly competitive market where one company avoids fees by electrifying and one does not, the company that electrifies can reflect lower fees in its product pricing by offering lower cost services. These long term macro effects can provide significant economic motivation to electrify, whether fees are directly borne by companies, drivers, or passengers initially. Companies can integrate government fee structures into their own financial planning and product pricing in various ways. For example, they could use third-party or subsidiary financial organizations to support a future fleet of electric vehicles with proactive procurement and vehicle purchasing guidance practices to help overcome model availability and upfront cost barriers for their drivers.

UNITED STATES

Our vehicle costs and efficiency match the specifications outlined in Lutsey and Nicholas (2019), which is based on the sales-weighted technical attributes from U.S. market model year 2016 data, the latest complete dataset for car price, rated engine power, efficiency, and size (National Highway Traffic Safety Administration, 2018). Representative models in the car segment include the Ford Fusion, Honda Accord, and Nissan Altima. For electric vehicles, we assume drivers do not have access to home charging and are entirely reliant on public rapid charging. Data on the distribution of ride-hailing drivers and their annual mileage are not available. We use a flat assumption of 40,000 miles per year to analyze typical full-time drivers who likely represent a disproportionately high amount of the total miles traveled on ride-hailing platforms and who would be most affected by electrification.

The City of Chicago assesses a $0.62 fee for all ride-hailing trips. Figure 2 illustrates the 5-year total cost of operation (TCO) for full-time ride-hailing drivers in Chicago in 2020. We analyze a 49 mile-per-gallon (mpg) hybrid, a 31-mpg gasoline vehicle, and three electric vehicle cases (full fees, half fees, and fee exempt). Also shown is the associated average cost per mile (black line, right axis). As shown, electric vehicles with fees have the highest TCO at $0.46 per mile. When electric vehicles pay half fees, the TCO is reduced to $0.43 per mile. When exempt from fees, electric vehicles' TCO is $0.40 per mile, slightly higher than the $0.38 per-mile cost of the conventional vehicle with fees. As shown, hybrids have the lowest per-mile costs at $0.34.

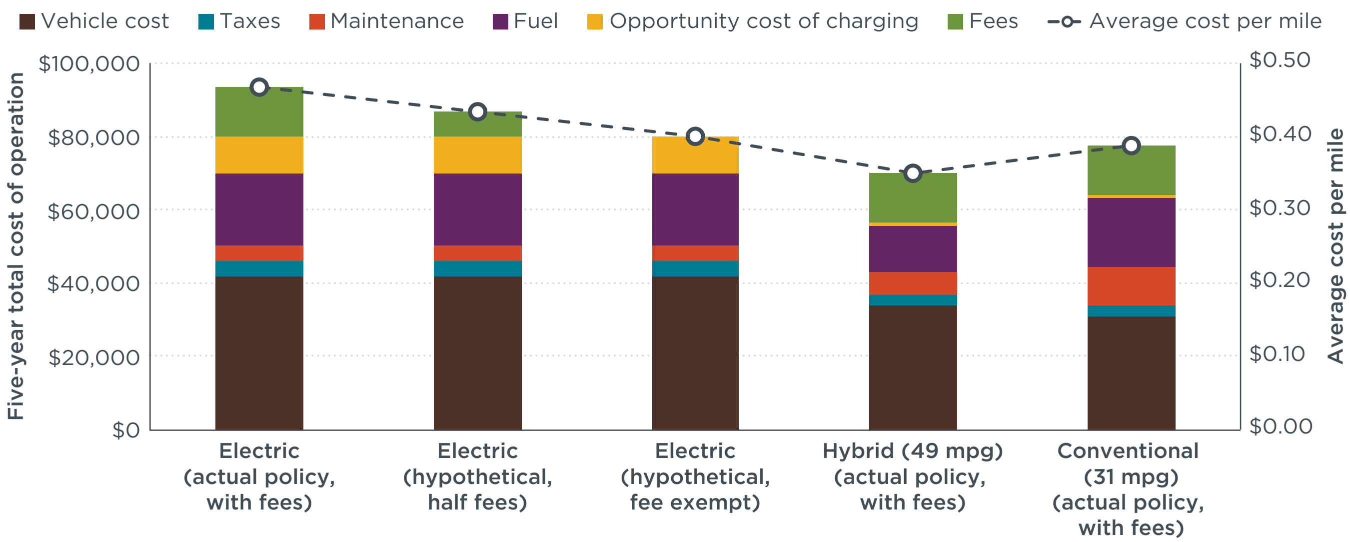

Figure 2. Comparison of 5-year TCO across vehicle technologies for full-time ride-hailing drivers in Chicago in 2020.

The cost of Chicago's $0.62 per-trip fees, shown in green, amounts to more than $13,000 over five years for typical full-time ride-hailing drivers. When electric vehicles are fee exempt, the TCO is reduced by that amount. Applying fees only on polluting vehicles gives impetus to electric vehicles and improves their value proposition. Compared to the full fees, exempting electric vehicles from the fee reduces the average cost per mile for electric vehicles by about 15%. When electric vehicles are exempt from fees, they are about 14% more expensive on a per-mile basis than comparable hybrids and are near-parity with conventional models.

Although not shown here, we also analyzed how Chicago's fee structure might affect the TCO for electric vehicle drivers who have regular access to lower-cost overnight charging. When home charging is a regular option, electric vehicles can become the most cost-effective technology. When exempt from fees, electric vehicles with home charging have the lowest per-mile costs at $0.31.

In addition to per-trip fees, Chicago requires ride-hailing companies to hold an annual license worth $10,000 per company each year. Informal reporting of city estimates indicates there are approximately 67,000 Uber and Lyft cars combined in Chicago (Channick, 2018), meaning the annual license fee amounts to less than $1 per vehicle per year. Thus, reducing the annual $10,000 company license fee based on the share of electric vehicles in their fleet provides significantly less economic motivation for companies and their drivers to adopt electric vehicles compared to the per-trip fee scenario analyzed in Figure 2.

We also analyzed the change in average cost per mile for full-time ride-hailing drivers without home charging in Chicago from 2020 to 2025 based on the 5-year TCO. From 2020 to 2025, hybrid and conventional vehicle efficiency is assumed to increase by about 1% and 2% per year, respectively, yet the total cost of driving hybrid and conventional vehicles increases by about 2% and 3%, respectively, as a result of increasing fuel prices and additional vehicle technologies required to meet the prevailing emission standards. Through 2025, the per-mile cost of electric vehicles declines by about 25% largely due to battery price decreases and reductions in the opportunity cost of charging from faster charging speeds. We find exempting electric ride-hailing vehicles from Chicago's per-ride fee greatly accelerates the time frame when electric vehicles become cost competitive with hybrids. If electric and combustion vehicles pay the same fees, electric vehicles reach TCO parity with hybrids after 2025. Fully exempting electric vehicles makes them the most cost-effective technology in ride-hailing applications around 2023. Half-exempting electric vehicles means electric vehicles reach cost parity with hybrids around 2024–2025.

The Chicago case demonstrates that exempting electric vehicles from ride-hailing fees can have a large economic effect on the TCO of electric ride-hailing. As identified in Table 1 and Table 2, there are numerous government policies that levy taxes or fees on ride-hailing trips in the United States, and their details vary. In the following paragraphs we introduce four additional regulations and assess how hypothetically exempting electric vehicles from their fees impacts the TCO and business case of adopting electric vehicles.

California. The California Public Utilities Commission (CPUC) collects an annual fee of 0.33% of ride-hailing company revenues. Data on companywide revenue are not available. We use local level data from Uber's website for the greater Los Angeles area to assess how the CPUC fees impact ride-hailing TCO on an individual vehicle basis (Uber, 2019c). We use a weighted average of UberX and UberPOOL fare structures to assess typical revenues (and thus the percentage-based fees) for typical full-time ride-hailing drivers driving 40,000 miles per year and working 280 days per year. From this, we find that a typical full-time ride-hailing driver over a 5-year period would generate about $250,000 in gross revenue. Thus, the CPUC 0.33% assessment amounts to about $800 over a 5-year period. Although not assessed here, the CPUC also began collecting a $0.10 per-ride wheelchair accessibility fee on July 1, 2019.

New York City. New York City levies multiple taxes and fees on ride-hailing vehicles and drivers. Drivers must submit a $550 application every two years for vehicle licensing. Ride-hailing trips are also subject to a sales tax rate of 8.875%. In addition, non-pooled trips south of 96th Street in Manhattan are assessed a $2.75 surcharge whereas pooled trips have a reduced rate of $0.75. To estimate the value of each of these fees, we use fare data from the Uber website and assume 56% of trips originate in the Manhattan core and 20% of rides are pooled, based on data by Schaller Consulting (2017, 2018). For a typical full-time ride-hailing driver in New York City, the fees amount to more than $50,000 over a 5-year period. Exempting electric vehicles from fees would provide a strong economic motivation for companies and their drivers to adopt electric vehicles.

Portland. The city of Portland assesses a $0.50 per-ride fee for all ride-hailing vehicle trips in its jurisdiction. We evaluate the 5-year value of fees based on average ride-hailing trip distance and share of deadheading miles identified by Schaller Consulting (2018). For a typical full-time ride-hailing driver who drives 40,000 miles a year in Portland, the fees amount to about $10,000 over a 5-year period.

San Francisco International Airport. San Francisco International Airport applies a fee of $3.80 per ride for all pickups and drop-offs on the premises. In 2016, the airport collected nearly $22 million in fees from more than 5.7 million ride-hailing trips (SCFTA, 2017b). Data on the share of ride-hailing trips to or from the airport were not available. We assume that 18% of trips made by a typical full-time ride-hailing driver in the San Francisco area are to or from the airport, based on data from Circella, Matson, Alemi, and Handy (2019), and find airport fees amount to about $19,000 per vehicle over a 5-year period. Of course, some drivers may make many more, while others far fewer, trips to or from the airport.

Figure 3 illustrates the impact of the four fee structures summarized above on ride-hailing vehicles' 5-year TCO, based on the underlying data and assumptions previously outlined. For the four markets (California, New York City, Portland, San Francisco airport), the 2020 TCO is shown for four vehicle types: 31-mpg conventional, 49-mpg hybrid, electric including fees, and a hypothetical case where electric vehicles are exempt from fees.

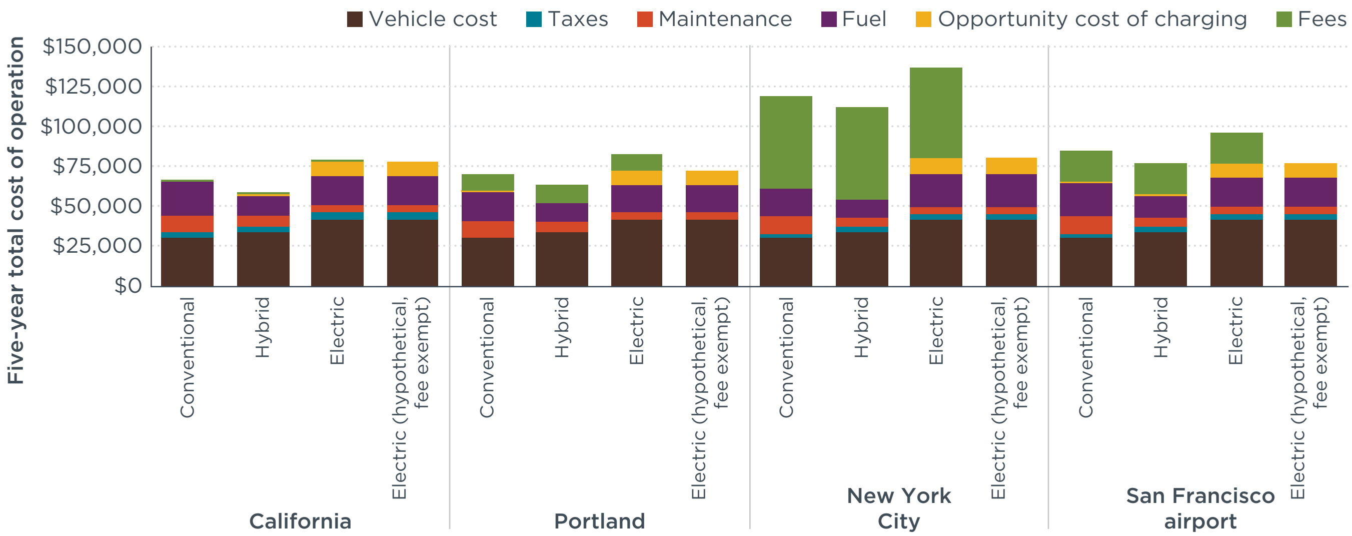

Figure 3. Five-year TCO for full-time ride-hailing drivers in four markets with four vehicle types: conventional, hybrid, electric (with fees), and electric (fee exempt).

As shown, applying fees to ride-hailing vehicles has a substantial impact on the total cost of operation in some markets. New York City stands out as a market that levies relatively greater taxes and fees on ride-hailing, which amount to over $50,000 and greatly increase the TCO. Airport fees at the San Francisco airport amount to about $19,000 for ride-hail drivers in the San Francisco area. Fees in Portland amount to about $10,000 over a 5-year period for full-time ride-hailing drivers. In California, the CPUC 0.33% fee is less than $1,000 over the 5-year period, barely visible on the left-side of the chart. For context, fees in Chicago amount to about $13,000 over a 5-year period (Figure 2). Overall, we find that if electric ride-hailing vehicles were exempt from fees, electric vehicles could become the most cost-effective technology in 2020 in the markets where strong fees are in place (e.g., New York City), even under the most expensive case where electric vehicle drivers are entirely reliant on public fast charging (i.e., no home charging access). When home charging is regularly available, electric ride-hailing vehicles can reach cost parity with hybrids much more quickly.

The analysis illustrates that the taxes and fees levied on ride-hailing in the United States vary in fee value, type, and complexity. In markets like New York City and San Francisco airport fees largely depend on the share of driver trips conducted in a particular geography or location, such as in the urban core or on airport premises. Our analysis is based on the limited best available ride-hailing travel behavior and operational data. Of course, some drivers may take many more, while others far fewer, trips to locations that are subject to taxes or fees, therefore impacting the individual TCO in a different way.

EUROPE

Many European markets have introduced access regulations, and some are applying fees, surcharges, and/or penalty charges for entering, driving into, or exiting these zones. Few cities to date are using these policies to accelerate electric private hire and ride-hailing vehicles. London is a good example where preferential access regulations for electric private hire vehicles—including ride-hailing services—have been phased in, making for a unique case study to analyze how such rules already are incentivizing electrification. We do not analyze black cabs, which are subject to their own unique set of regulations.

Ride-hailing drivers in London pay for entering the inner-city Congestion Charge Zone and, if their vehicle does not comply with strict emission standards, the ULEZ. The Congestion Charge Zone requires drivers to pay a daily one-time fee of £11.50 ($15.00) during charging hours (Monday through Friday, 7 a.m. to 6 p.m.). A 100% discount applies to vehicles that meet Euro 6 standards (petrol and diesel), emit no more than 75 grams of carbon dioxide per kilometer (g CO_2/km) (about 47 g CO_2/mile), and have a minimum 20 miles of zero-emission-capable range. Starting October 2021, only purely electric vehicles will qualify for a 100% discount. This discount is scheduled to be withdrawn in December 2025 (TfL, 2018b, 2019a, 2019b).

London's ULEZ covers the same area as the Congestion Charge Zone, but will expand to 18 times the size in October 2021. Driving in the ULEZ is charged with £12.50 ($16.30) per day, and applies in addition to the Congestion Charge. The ULEZ charge runs 24 hours a day, 7 days a week, throughout the year. Vehicles that do not need to pay this charge are gasoline cars that meet the Euro 4 standard and diesel cars that meet the Euro 6 standard. The Mayor of London's Transport Strategy also includes a policy to introduce a Zero Emission Zone in the center of the city from 2025 (Mayor of London, 2018).

Our analysis of London builds on our previous work (Wappelhorst, Mock, & Yang, 2018). Some key inputs and assumptions differ from the U.S. case to better reflect the landscape of the United Kingdom and London. We hold similar technical assumptions for a standard conventional, hybrid, and electric vehicle the size of a Volkswagen Golf, which is a more representative passenger car for the United Kingdom and slightly smaller compared to the U.S. analysis. We apply similar vehicle technology cost and efficiency rate differences for electric, hybrid, and combustion vehicles as done for the United States. For the conventional car (36 mpg, 6.5 liter/100 km) and hybrid car (58 mpg, 4.1 liter/100 km) we reflect real-world fuel consumption. Taxes include 20% value added tax (VAT) on car purchase, excise duty on registration, and regularly payable ownership tax. We avoid speculations on future tax rates as data are not available. For fuel and electricity costs, we project data based on the Department for Business, Energy and Industrial Strategy of the United Kingdom (2018) and Eurostat (2018). Our analysis of fees includes the reduced daily Congestion Charge of $13.70 if using Auto Pay (TfL, 2018b) and $16.30 for entering and driving in the ULEZ.

We analyze private hire vehicle drivers who regularly enter the Congestion Charge Zone and ULEZ. The typical full-time private hire vehicle drivers are assumed to drive 30,000 miles per year, reflecting the general trend of decreased annual mileage in Europe compared to the United States. These ride-hailing drivers drive 280 days per year in our analysis, based on studies indicating cab drivers in England work a maximum of 5.5 days per week (Department for Transport, 2018). As above, we assume drivers are entirely reliant on public charging, which is to says there is no home charging. London drivers with regular access to home charging would see substantially lower TCO by as much as 18% in 2020. In the absence of detailed local level data, we apply similar assumptions from our U.S. analysis, including the same maintenance and opportunity cost input data.

Figure 4 plots the 5-year TCO for full-time private hire vehicle drivers in London in 2020 assuming the ownership of newly purchased electric, hybrid, and conventional gasoline vehicles. The TCO includes data on vehicle cost, taxes, maintenance, fuel, and opportunity cost of charging, as well as fees for entering London's regulated access areas. Under current policy, Euro 6 gasoline cars meet the ULEZ standard, which means the hybrid and conventional vehicle pay only the Congestion Charge and not the ULEZ fee. We also assess a hypothetical case, assuming that only ultralow emission vehicles (ULEVs) with emissions of 75 g CO_2/km or less are exempt from paying the daily ULEZ charge starting in 2020. For context, we can expect future steps to move toward zero emissions as outlined in the London Mayor's Transport Strategy (Mayor of London, 2018). Our analysis is specifically investigating private hire vehicle drivers who regularly enter the congestion zone. Emerging data indicate that there are as many as 18,000 unique daily private hire vehicle entries into the zone (TfL, 2018b).

Figure 4 shows that based on our assumptions under current policy, the average cost per mile for the hybrid model is the lowest ($0.44 per mile). The electric car generates slightly higher cost per mile at $0.47. The driver of the conventional car bears the highest cost, $0.50 per mile. The 5-year cost disadvantage for the electric ride-hailing driver compared to the driver of a hybrid car under current policy is almost $0.03 per mile. In actual policy, the fees shown in green add up to more than $8,600 for the hybrid and conventional car in 5 years, which reflect only the Congestion Charge as all vehicles meet the emission standards defined for the ULEZ. Assuming changes in the ULEZ emission limits such that only ULEVs with emissions of 75 g CO_2/km or less are exempt from charges, 5-year fees for the hybrid and conventional car increase to about $26,000. Under this hypothetical policy, the per-mile cost benefit of the electric vehicle versus the hybrid car is $0.09 per mile ($0.47 vs. $0.56 per mile, respectively).

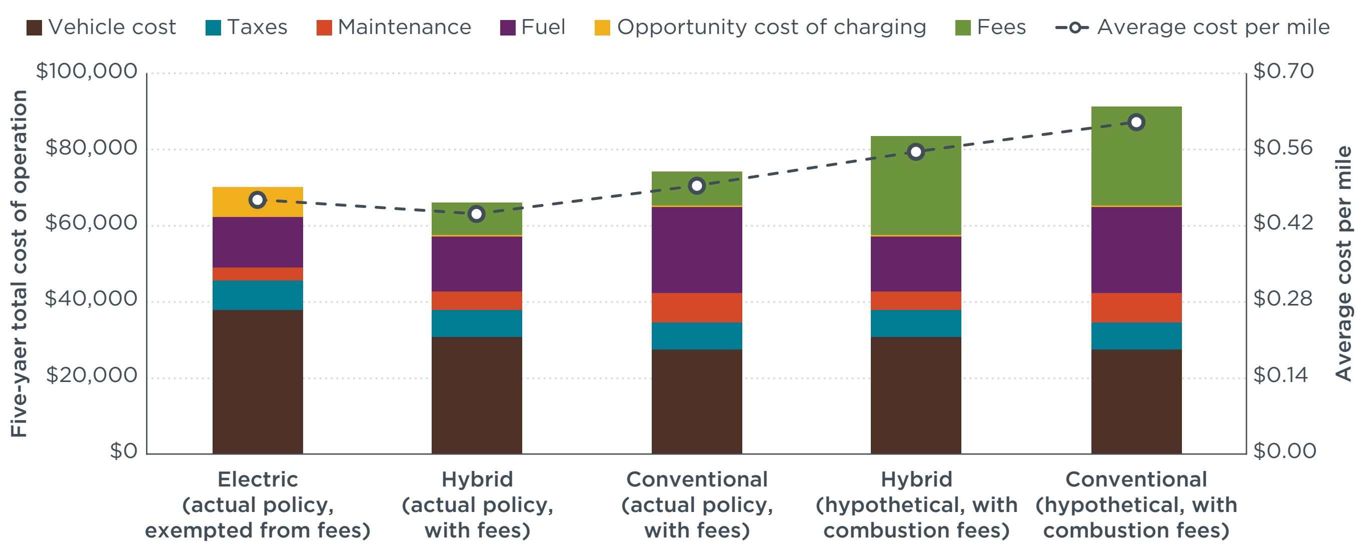

Figure 4. Comparison of 5-year TCO across vehicle technologies for full-time ride-hailing drivers in London in 2020.

Under current policy, the electric car has the second-highest 5-year TCO of about $70,000. The TCO of a hybrid and conventional car is about $66,000 and $74,000, respectively. Fees play an important role in the 5-year TCO under current policy, however only reflecting the Congestion Charge. These fees for the hybrid and conventional car add up to about $1,700 per year on the basis of the assumptions made for our London case. In contrast, yearly fees would add up to $5,200 ($26,000 in 5 years) for non-ultralow emission compliant vehicles where the fees for entering the ULEZ would apply.

With hypothetical fees for hybrid and conventional ride-hailing cars entering London's ULEZ in addition to the Congestion Charge, electric vehicles benefit from significant 5-year cost advantages. Whereas in actual policy the 5-year TCO for the electric vehicle is $4,000 higher than for the hybrid car, tighter emission standards for entering London's ULEZ would reverse this effect significantly to a 5-year cost benefit for electric vehicles from more than $13,000 compared to the hybrid to $21,000 compared to the conventional car. Under this scenario, there would be a greater stimulus for operators and drivers to opt for electrified vehicles.

Our analysis assumes that after the expansion of London's ULEZ, ride-hailing drivers enter the zone about 250 days each year, or 90% of their 280 working days. Because there is considerable variation in the annual number of entrances that ride-hailing drivers make into restricted zones, we also assessed how variations in annual entrances influence the TCO comparison. Table 4 outlines our sensitivities on annual entrances into the zones, split into "low," "central," and "high" case scenarios. As shown, the number of annual entrances in the ULEZ increases in 2021 in line with the zone's 18-fold geographic expansion in late 2021. Our Congestion Charge Zone assumptions remain constant through 2025 because there are no announced plans for expansion. For context, the fees shown in Figure 4 are based on the central case scenario outlined in Table 4.

Table 4. Annual percentage of working days that full-time ride-hailing drivers in London enter the Congestion Charge Zone and ULEZ from 2020 to 2024.

	Congestion Charge Zone annual entrances			Ultra Low Emission Zone annual entrances		
Year	**Low**	**Central**	**High**	**Low**	**Central**	**High**
2020	25%	50%	75%	65%	75%	85%
2021	25%	50%	75%	70%	80%	90%
2022	25%	50%	75%	80%	90%	100%
2023	25%	50%	75%	80%	90%	100%
2024	25%	50%	75%	80%	90%	100%

Figure 5 plots the 2020 five-year TCO for electric and hybrid vehicles assuming that only electric vehicles are exempt from the daily ULEZ charge. To show the impacts of fewer and greater numbers of annual entries, we assess the hybrid TCO under the low, central, and high cases outlined in Table 4. The figure shows how fees scale with more annual entrances. Even hybrid vehicle drivers who enter the zone infrequently have a cost disadvantage over the electric. The hybrid generates 5-year per-mile cost ranging between $0.51 (low case) and $0.58 (high case), significantly above the electric vehicle under current policy ($0.47 per mile). Access fees for the hybrid range from almost $18,600 (low case) to about $29,500 (high case) over a 5-year period.

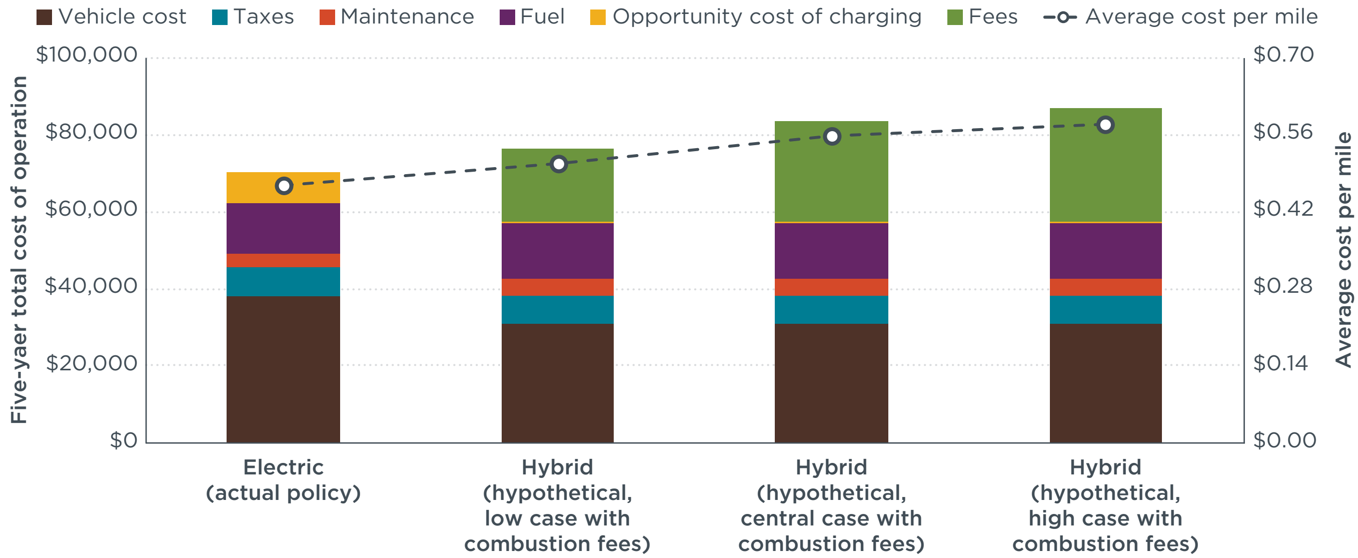

Figure 5. 2020 five-year TCO for full-time ride-hailing drivers in London with electric vehicles and hybrid vehicles under three operating behavior scenarios.

Figure 5 clearly shows how the relative cost advantage of electric vehicles increases when drivers enter the Congestion Charge Zone and ULEZ more frequently. From this, we find that access-based policies like London's per-day fee can be more economically significant when zones have broader geographic coverage. In our hypothetical case where we assume that per-day fees apply to all combustion vehicles, which is to say that ULEZ emission limits tighten to exempt only ULEVs, the TCO gap for electric vehicles scales up significantly after the expansion of the ULEZ across inner London to cover 40% of the population.

DESIGNING RIDE-HAILING TAXATION AND FEE POLICIES

As assessed above, taxes and fees can have a large impact on ride-hailing financials. The Chicago case demonstrates that a $0.62 per-trip fee amounts to more than $13,000 per vehicle over a 5-year period for a typical full-time driver in 2020. Drivers in London who frequently enter the Congestion Charge Zone can pay about $8,600 over this same time period. In contrast, California collecting 0.33% of company revenues amounts to less than $1,000 per vehicle. In this section, we introduce a hypothetical ride-hailing fee system with consistent average revenue per vehicle that would steer ride-hailing fleets to transition to electric vehicles in the 2025 time frame.

COST PARITY

As identified above, there is significant variation in the valuation of exempting electric ride-hailing vehicles from existing fee structures, ranging from about $1,000 to tens of thousands of dollars. In this section, we explore the level of combustion vehicle fees that results in TCO cost parity between electric and hybrid vehicles.

Figure 6 illustrates the 5-year TCO for electric and hybrid vehicles in the United States based on different combustion vehicle per-trip fee values in 2020. We analyze electric vehicles under three home charging scenarios: drivers with regular access to home charging (i.e., drivers with home charging 100% of nights), drivers with occasional access to home charging (home charging is available 50% of nights), and drivers who use only public DC fast charging (0% home charging use). If drivers rely on regular access to home charging (100%), they would see substantially lower operating costs, by as much as 27% from the 0% home charging scenario in 2020. Electric vehicles are exempt from fees, so the TCO remains flat despite a shifting combustion fee. In contrast, the hybrid TCO increases by several thousand dollars as the fee increases from $0 to more than $1 per trip. The green line shows how the hybrid has a TCO of about $55,000 when the per-trip fee is $0, increasing to about $80,000 when the fee is $1.20.

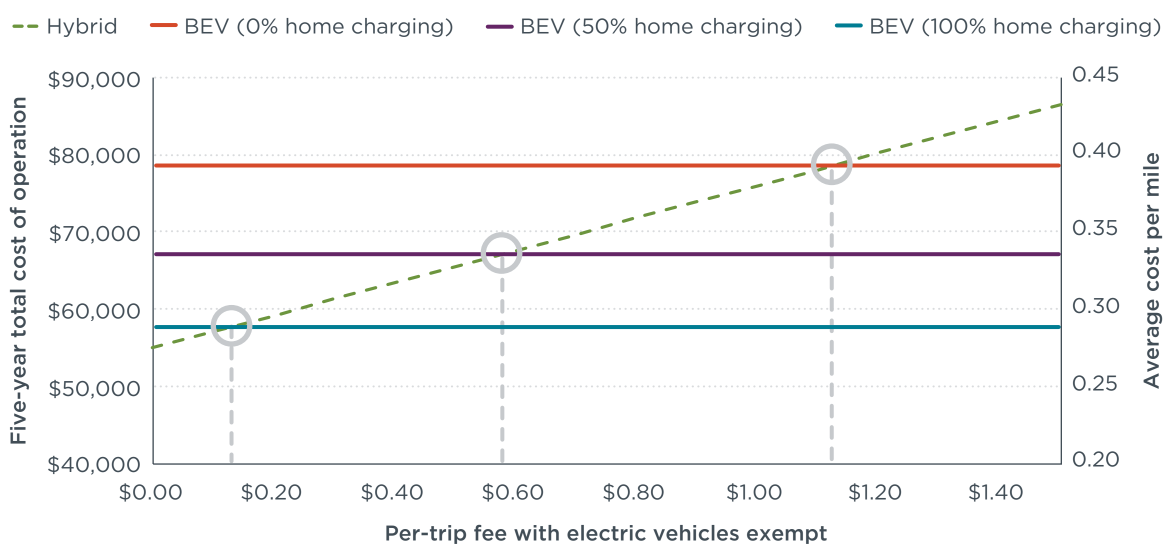

Figure 6. Average U.S. 2020 ride-hailing TCO under different per-trip fees for hybrid and electric vehicles with 0%, 50%, and 100% home charging.

Figure 6 also shows how greater reliance on fast charging impacts the combustion vehicle per-trip fee breakeven point, when electric vehicles reach cost parity with hybrids. As shown, a combustion vehicle per-trip fee of $0.16 is sufficient for electric vehicles with daily access to home charging (blue line) to be cost competitive with hybrids in 2020. In the 50% home charging scenario (purple line), a per-trip fee of $0.58 is the cost-parity point. Drivers who only charge at DC fast stations (red line) have a much higher TCO—here, a $1.12 per-trip fee on combustion vehicles results in cost parity in 2020.

From this analysis, we find that, even under the most expensive 0% home charging circumstance, a non-electric per-trip fee of $1.12 is enough to fundamentally change the TCO between electric and hybrid alternatives, tipping the value proposition in favor of the electric vehicle. This could happen in several ways. For example, governments could apply a $1.12 fee to all ride-hailing trips and fully exempt electric vehicles. Alternatively, governments could set higher fees and apply partial exemptions to electric vehicles: New York City, for example, could maintain the current $2.75 per-trip surcharge and partially exempt electric vehicles so that their fees are $1.63. Of course, exempting electric vehicles from fees that are higher than $1.12 would provide stronger incentives. Increasing the combustion vehicle fee by $0.13—to $1.25 per trip—would generate a $2,500 financial incentive for a typical full-time ride-hailing driver under the 0% home charging scenario. At the same time, combustion vehicle fees at roughly half this level ($0.58) would be sufficient for electric vehicles to reach cost parity in situations where electric ride-hailing drivers have semi-frequent (50%) or regular (100%) access to home charging.

We also analyzed alternative frameworks to understand how percentage-based fees on gross revenue might tip the value proposition in favor of electric vehicles in 2020. Figure 7 illustrates the 5-year TCO for electric and hybrid vehicles based on different combustion vehicle percentage-based fees on gross revenue. A key factor, of course, is typical per-vehicle gross receipts, which we identified to be greater than $250,000 over a 5-year period for full-time drivers. As above, electric vehicles are exempt, so the TCO remains flat despite a shifting combustion vehicle fee. In contrast, the hybrid TCO increases from about $55,000 to about $80,000 as the fee increases from 0% to about 11%.

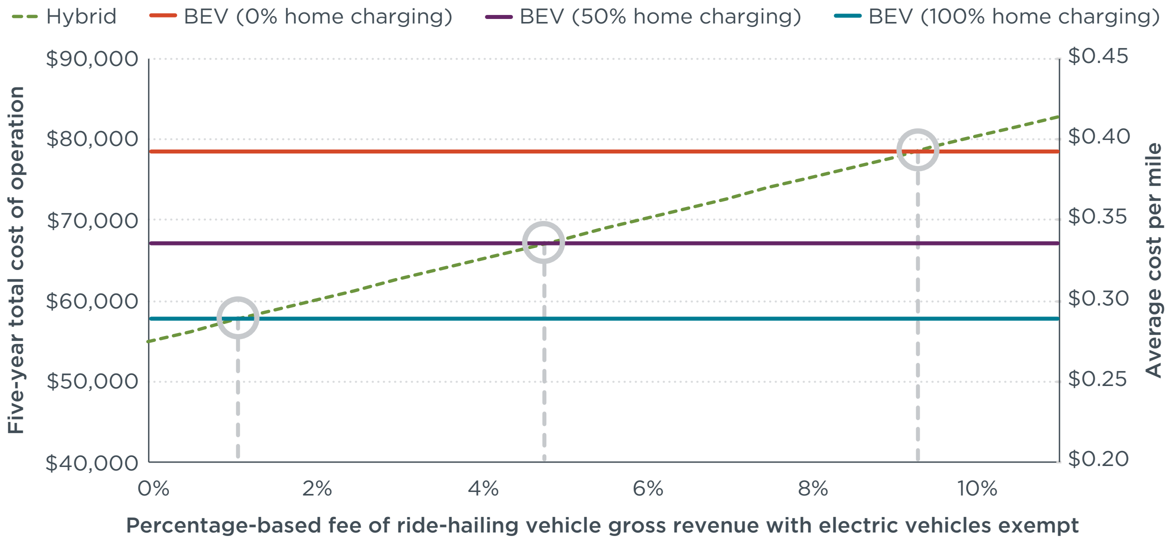

Figure 7. Average U.S. 2020 ride-hailing TCO under different gross revenue percentage-based fees for hybrid and electric vehicles with 0%, 50%, and 100% home charging.

The figure shows how a combustion vehicle percentage-based fee on revenue of about 1.5% is sufficient for electric vehicles with daily access to home charging (blue line) to be cost competitive with hybrids in 2020. In the 50% home charging scenario (purple line), we find that a percentage-based fee of about 5% is the cost parity point. Under the most expensive 0% home charging scenario (red line), a combustion percentage-based fee on revenue of about 9% is enough for electric vehicles to reach cost parity with hybrid alternatives. For this to happen, governments could apply a 9% fee to all ride-hailing trips and fully exempt electric vehicles. We also find that combustion vehicle percentage-based fees at roughly half this level would be sufficient for electric vehicles to reach cost parity in situations where drivers have semi-frequent (50%) or regular (100%) access to home charging. For context, markets like Washington, D.C., and Hawaii charge 6% and 4%, respectively, of gross revenues. In San Francisco, policymakers are preparing to introduce a 3.25% fee (Sze & Olney, 2019).

We also determined the cost parity points between electric and hybrid alternatives for different regulatory models. For per-mile fees, we find that a combustion vehicle per-mile fee of $0.14 is enough for electric vehicles to reach cost parity with hybrids under the most expensive 0% home charging scenario. About half that value ($0.07 per mile) is sufficient for electric vehicles to reach parity when drivers have semi-frequent (50%) access to home charging. For per-day access fees, we assume that drivers enter the zone 210 days per year (75% of working days), and find that a combustion vehicle per-day fee of $26 is enough for electric vehicles to reach cost parity with hybrids under the most expensive 0% home charging scenario. About half that value ($13 per day) is sufficient for electric vehicles to reach parity when drivers have semi-frequent (50%) access to home charging.

REVENUE NEUTRALITY

As introduced in the second section, the revenues generated by taxes and fees have multiple purposes, including supporting regulatory administrative and enforcement costs, local infrastructure improvement projects, and local taxi and transit operations. For these programs to be a viable option to pave the way for electric vehicle adoption, it is important that they remain revenue neutral. By revenue neutrality, we mean that for a given number of ride-hailing vehicles, the total government revenue remains constant even as the fee-exempt electric vehicle share increases. This allows the fees to continue to support other programs over time.

Figure 8 shows a hypothetical revenue-neutral per-trip fee scenario to transition a local ride-hailing fleet to electric vehicles by 2027. As shown, the electric vehicle fleet share (blue line, left axis) increases from 5% in 2020 to 100% in 2027 whereas the non-electric vehicle share falls from 95% to 0% over this period. A hypothetical combustion vehicle per-trip fee out to 2024 is also shown (hashed grey line, right axis), which begins around $1.12 (consistent with our 0% home charging scenario in Figure 6) and increases over time as a greater share of the fleet transitions to electric.

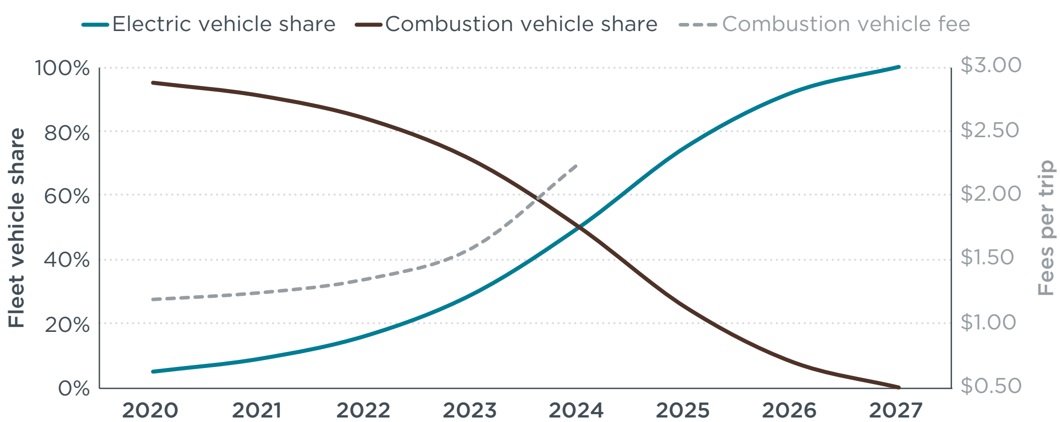

Figure 8. Hypothetical ride-hailing electric and combustion vehicle share and value of fees to remain revenue neutral from 2020 to 2027.

Figure 8 illustrates how fees are steadily increased over time to keep the program revenue neutral as more fee-exempt electric vehicles enter the fleet. As a greater share of ride-hailing fleets transition to electric, fewer vehicles will pay into the program. This figure demonstrates that only when electric vehicles reach a 20% share of ride-hailing vehicles, around 2022–2023 in this scenario, would the combustion vehicle fee need to significantly increase to make up for the lost revenue from the electric vehicle exemption. From this we can infer that it would make sense to transition from a full fee exemption for electric vehicles to a partial exemption in the 2023–2026 period. This roughly matches the policy path set forth in London, where electric vehicles are no longer exempt from the Congestion Charge beginning in December 2025 (TfL, 2019a; 2019b). For context, Uber's goals are to electrify 50% of its London fleet (which was approximately 40,000 vehicles in 2017) by the end of 2021 and 100% by 2025 (Uber, 2018).

We also explored a percentage-based fee scenario to assess how fees on combustion vehicles might need to adapt during the transition to electric vehicles. Previously we identified a percentage-based fee of about 5% to about 9% of ride-hailing gross revenue is sufficient for electric vehicles to reach cost parity with hybrid counterparts under the 50% and 0% home charging scenarios, respectively. Similar to the per-trip model, we find that as the fleet transitions toward 50% electric share, percentage-based fees will need to gradually increase to remain revenue neutral until approximately doubling to about 10% to 18% in 2024. Beyond 2023, electric vehicles will need to begin paying fees.

FUNDING A FAST CHARGING NETWORK

Public charging infrastructure, and DC fast charging in particular, is critical to facilitating electric ride-hailing. In this section, we explore the opportunity for government taxes and fees on ride-hailing to pave the way for infrastructure funding. We conduct an illustrative analysis of a hypothetical ride-hailing fleet of 10,000 full-time drivers who transition to electric vehicles by 2027, none of which have home charging (i.e., 0% home charging). Of course, some cities have many more, while others far fewer, ride-hailing vehicles on local roads. For context, this is roughly double the number of ride-hailing vehicles on a typical day in San Francisco. Chicago estimates that there are about 67,000 ride-hailing drivers in the area. In London, there are approximately 21,000 black cabs and 87,000 private hire vehicles (Slowik, Fedirko, & Lutsey, 2019).

We evaluate three scenarios for how DC fast charging station utilization impacts the overall charging infrastructure needs. We assess three utilization scenarios: where chargers are in use for 4 hours, 6 hours, and 8 hours per day. These represent dedicated charging facilities, likely where there are clear business relationships between charging providers, ride-hailing companies, and drivers to help optimize the placement and use of the infrastructure. There is early evidence of some DC fast charging stations that have utilization this high. Table 5 summarizes the public DC fast charging infrastructure needs under a 4-, 6-, and 8-hour utilization scenario.

Table 5. Public DCFC infrastructure needs for a 250-mile BEV fleet entirely reliant on public fast charging under a 4-hour, 6-hour, and 8-hour DCFC utilization scenario.

Year	Number of combustion vehicles	Number of battery electric vehicles	Electric vehicle share	Cumulative number of DC fast charge points		
				4 hours	6 hours	8 hours
2020	9,500	500	5%	54	36	27
2021	9,100	900	9%	92	61	46
2022	8,380	1,620	16%	157	104	78
2023	7,084	2,916	29%	267	178	133
2024	5,000	5,000	50%	434	290	217
2025	2,500	7,500	75%	620	413	310
2026	800	9,200	92%	760	507	380
2027	0	10,000	100%	827	551	413

The table shows that with greater utilization, fewer total charge points are needed. We find that the number of DC fast charge points needed to support a fleet of 10,000 ride-hailing vehicles in 2027 ranges from 827 (4-hour scenario) to 413 (8-hour scenario). Several points help provide context to the values in Table 5. In 2018, many metropolitan areas including Atlanta, Chicago, Sacramento, San Jose, Seattle, and Washington, D.C., had about 200 to 275 DC fast charge points in place, whereas leading areas including Los Angeles, New York, Riverside, and San Francisco each had between 350 and 675 fast charge points. This suggests that the additional infrastructure needed to support a fleet of several thousand electric ride-hailing vehicles by 2027 is relatively modest compared to infrastructure growth through 2018.

The data in Table 5 reflect that the ratio of electric vehicles to DC fast charge points gradually increases over time. Under the central 6-hour utilization scenario, for example, the ratio of electric vehicles to DC fast charge points increases from 14 in 2020 to 18 in 2027. This is a result of technological charging advancements on the vehicle and charger side, as well as the trend toward faster chargers from 50 kW to 150 kW. For context, these are about 6 to 12 times less than the battery electric vehicle to DCFC ratios in high-uptake U.S. markets in 2018 (Slowik & Lutsey, 2019).

The installation and hardware costs of DC fast charging infrastructure vary widely (Nicholas & Hall, 2018), but some representative data and cost estimates can be used to estimate what it might cost to pay for the infrastructure needed to support the hypothetical electric ride-hailing fleet outlined above. Based on Nicholas and Hall (2018) we use average costs of about $38,000 for 50 kW chargers and $98,000 for 150 kW chargers starting in 2018, and assume reduced fast charging hardware costs at 10% per year for 150 kW chargers and 1% per year for 50 kW chargers through 2027. We assume installation cost reductions of 1% per year for all fast charging stations through 2027. These hardware and installation cost reductions are based on industry maturation, increased competition, and the shift to more charge points per site.

We estimate the funding needed for a DC fast charging infrastructure network for 10,000 local ride-hailing vehicles from 2020 to 2027 to be about $22 million, $29 million, and $44 million under the 8-hour, 6-hour, and 4-hour utilization scenarios, respectively. To provide some context to these costs, San Francisco's proposed tax on ride-hailing trips—3.25% for single-occupant and 1.5% for shared trips—is expected to raise up to $35 million annually (Brinklow, 2019).

Many governments have limited budgets, and the business case for deploying DC fast charging infrastructure remains a challenge in many 2019 markets. Given the strong need for DC fast charging infrastructure development to support electric ride-hailing, we explored the impacts of funding about 550 DC fast charge points (6-hour utilization scenario) on overall ride-hailing fee revenue collected by the government. We begin with a $1.12 per-trip fee on combustion vehicles, as identified in the 0% home charging scenario in Figure 6, and assume that electric vehicles begin paying fees in 2024. We then assess how a hypothetical increase in fees could provide the revenue to pay for the needed infrastructure. We find that a marginal per-trip fee increase of about $0.09 is sufficient to pay for the $29 million in DC fast charging infrastructure costs from 2020 through 2027. From this illustrative cost analysis, an additional per-trip fee of $0.09 for all ride-hailing drivers (i.e., $1.21 instead of $1.12 per trip) would be sufficient to fund the DC fast charging infrastructure. We note that this does not include operating and maintenance cost for the charging, which we assume that electricity sales would be sufficient to cover. On a percentage basis, we find that if 5% to 8% of fees collected from ride-hailing companies during the 2020–2027 transition period were dedicated to DC fast charging, this would be sufficient to cover the required urban fast charging infrastructure.

SUMMARY OF GUIDELINES FOR DESIGNING RIDE-HAILING TAXATION AND FEE STRUCTURES

Based on the above analysis, several basic guidelines can help pave the way for the transition of ride-hailing fleets toward electric vehicles. Although few governments have done so, an overarching conclusion is that taxes and fees can be used to promote cleaner vehicles by implementing differentiated rates based on vehicle pollution levels. Developing emissions-indexed regulations can be a powerful tool to reduce emissions by greatly accelerating the effective cost parity point between electric and combustion vehicles.

Key questions relate to how ride-hailing taxes and fees need to adapt over time, the importance of data reporting, and the fee levels necessary to effectively spur the fleet toward electrification. Regarding adapting the fees over time, from 2020 to 2025 the level of ride-hailing fees would need to be reassessed and incrementally adjusted. This is important to ensure consistent average revenue per vehicle, as a greater share of the fleet becomes electric. Importantly, although this study was focused on adapting taxes and fees to promote electrification, these programs can similarly be used to promote greater occupancy and more shared rides. New York City is an early example; for shared trips, the per-trip fee is reduced from $2.75 to $0.75.

Any policy that provides lower fees or fee exemptions to ride-hailing companies or their drivers who are adopting electric vehicles could be enhanced by implementing data reporting requirements and verification. Policymakers could set eligibility limits so that companies can only receive the benefits of differentiated fees for electric vehicles if they fully demonstrate their commitment to equitable access, increased trip sharing, and reporting of deadheading miles. Some of these opportunities are beginning to emerge in especially forward-thinking U.S. markets like Chicago and Seattle where additional fees are added to ride-hailing trips that are in non-wheelchair accessible vehicles. Similarly, registered wheelchair accessible ride-hailing vehicles in London are exempt from ULEZ requirements and charges. Establishing data reporting requirements ensures that cities learn and are better able to adapt if and when unplanned patterns emerge. The data also can be immensely important for the city in planning its future policies, including those related to parking, pickup and drop-off zones, zoning for charging infrastructure, and codes for buildings and parking structures.

Table 6 summarizes the range of fees for electric vehicles to achieve parity with combustion vehicles for several major regulatory frameworks. The frameworks of per-trip, percentage-based, per-mile, and per-day accessibility charges are shown, as these are measures in place or under consideration in various markets globally. As with the analysis above, we assume that fees apply only to combustion vehicles, and we assess the value of fees that would lead to electric vehicles reaching cost parity with hybrid alternatives in 2020. The middle column shows the range of fee value to reach cost parity, under the U.S. average case for electric ride-hail drivers who have semi-regular (i.e., 50%) access to home overnight charging (low value) to having no (0%) access to home charging (high value). The high values appear to be more representative of real-world practices, where most drivers are highly reliant on a public DC fast charging network. The middle column provides a relative comparison for the comparable fee values under different frameworks for electric ride-hailing vehicle cost parity. In the right-side column of Table 6, several considerations are provided including how different combustion vehicle fees might impact shared ride-hailing.

Table 6. Sample fee frameworks and key considerations to promote electric vehicles.

Framework to levy fees on combustion vehicles	Fee value for electric vehicles to achieve cost parity	Key considerations
Per-trip	$0.58 to $1.12	• Simple, transparent, relatively easy verification • Applies relatively higher fees to lower-cost shared trips • Applies relatively lower fees to higher-cost single-occupant trips
Percentage-based	4.8% to 9.3%	• Simple, transparent, relatively easy verification • Applies relatively higher fees to higher-cost single-occupant trips • Applies relatively lower fees to lower-cost shared trips
Per-mile	$0.07 to $0.14	• Could apply to miles travelled without a passenger while using app to discourage zero-occupant travel • More difficult enforcement and verification • Applies relatively higher fees to single-occupant trips • Applies relatively lower fees to shared trips
Per-day to enter zone	$13 to $26	• Simple and transparent • Greater motivation with broader geographic coverage • Applies relatively lower fees to shared trips • Applies relatively higher fees to single-occupant trips • Can apply to private cars and shift behavior toward sharing

Governments that are considering levying fees or taxes on ride-hailing will face several considerations concerning program type and design. Our analysis finds that each of these models can be used to financially encourage companies and their drivers to adopt cleaner cars. Other considerations remain critical in the decision-making process, such as how fees can simultaneously ensure equitable mobility or promote more shared trips among users. Per-trip fees, for example, may not be effective at promoting sharing; per-trip fees apply higher relative fees to lower-cost UberPOOL and Lyft Line options, where three unique passengers may book separate trips and thus pay three fees for the same ride. To avoid this, New York City's program is designed to encourage shared trips through lower fees ($0.75 vs. $2.75). Percentage-based fees on revenues apply higher fees for more expensive single-occupant trips and thus may send market signals for passengers to opt for more shared trips. These models would more strongly promote shared trips by applying differentiated fees for shared trips, such as the proposal under consideration in San Francisco (1.5% vs. 3.25%).

Per-mile fees could also encourage sharing by spreading the costs across multiple riders. Such programs could be enhanced by shifting to a per-passenger-mile metric to more strongly incentivize higher occupancy and discourage zero-occupant travel. Per-day fees for entering specific zones apply relatively lower fees for shared trips by allocating costs across more riders, whereas single-occupant passengers would pay relatively higher fees. With broader geographic coverage across urban areas, per-day access fees increase in power and influence. London's approach to implement a Congestion Charge Zone and a ULEZ is unique compared to the other approaches assessed here in that London's rules apply to both ride-hailing as well as privately-owned vehicles. As a result, the policy creates strong motivation for cleaner cars across all transportation modes while also giving impetus to shared modes.

CONCLUSIONS

Electric vehicle growth and the use of ride-hailing services have largely remained separate trends: electric ride-hailing has been relatively limited. This work analyzes the opportunity for government taxes and fees to address ride-hailing fleets' environmental externalities by steering companies and their drivers to accelerate adoption of electric vehicles. Our analysis leads to the following three conclusions.

Government taxes and fee structures can make electric vehicles the most economically attractive technology for ride-hailing fleets. Emissions-indexed taxes and fees are powerful tools for reducing emissions and would be especially effective for ride-hailing vehicles. This would work by applying higher fees for higher-polluting combustion vehicles, shifting the electric vehicle operating cost parity point forward, tipping the value proposition for ride-hailing companies and drivers to choose electric vehicles.

Typical full-time ride-hailing drivers are charged from several thousand to tens of thousands of dollars in fees over a 5-year period, which could effectively be designed to steer ride-hailing fleets toward electrification. If fees were indexed to vehicle emissions, a per-trip ride-hailing fee of $0.58 to $1.12 is sufficient for the total cost of operation of electric vehicles to be lower than hybrid vehicles in the United States. For other markets starting from different existing types of fees, or with other locally preferred policies, similar zero-emission vehicle preferences can be established. Based on our analysis, applying fees of about 5% to 9% of ride-hailing gross revenue in jurisdictions with percentage-based fees, $0.07 to $0.14 on a per-mile basis, and $13 to $26 on a per-day accessibility charge is sufficient for electric vehicles to reach cost parity with comparable hybrids.

A well-designed ride-hailing fee program can help overcome the prevailing barrier of charging infrastructure. The availability of charging infrastructure is a critical component to the transition to electric ride-hailing. Home charging is where vehicles are idle for the longest portion of time, offers the lowest-cost electricity, and results in a lower demand for more public DC fast charging. Addressing gaps in home charging availability is a much broader issue involving how quickly home charging can become readily available where many ride-hailing drivers reside, including at multiunit dwellings or nearby curbs. Hypothetically, grants or tax incentives could be made to support the installation of home charging for ride-hailing drivers, but these ideally would be linked to drivers owning electric vehicles rather than shorter-term rentals or leases.

There is still a very strong case for electric ride-hailing where home charging is limited if sufficient and well-placed DC fast charging is provided. DC fast charging in key urban areas can reduce the opportunity costs from downtime during daily ride-hailing operation. This analysis finds that if 5% to 8% of fees collected from ride-hailing companies during the 2020–2027 transition period were dedicated to DC fast charging, this would be sufficient to cover the required urban fast charging. This would amount to a $0.09 per trip (on top of a $0.58 to $1.12 per-trip fee) or a 0.7% fee (on top of a 5% to 9% revenue-based fee) to support the basic charging infrastructure need. Such a direct funding mechanism ensures the ride-hailing infrastructure fund is self-sustaining.

Any dedicated charging infrastructure could be cost-shared between the government collecting the fee, ride-hailing companies, and charging providers, who could also coordinate to ensure optimal charging placement. Furthermore, because this could be one of the DC fast charging applications with the highest utilization (due to explicit coordination between vehicle and charging growth), public funding may not be as critical as hundreds of electric ride-hailing vehicles enter the fleet. In addition to public expenditures from fee collection, policymakers can support electrification through parking codes, preferential zoning to streamline charging installations in key locations, and nonfinancial perks such as prioritized electric vehicle-only loading zones in cities and at airports.

As ride-hailing fleets transition to electric, taxes and fees will need to be adjusted over time. The fees collected as a result of government regulatory measures are likely to be distributed to several programs and divisions to accomplish local mobility goals. This makes it critical for any modified fee structure to maintain similar revenues as more electric vehicles enter the fleet. In our analysis of how the structure of taxes and fees might support the transition of ride-hailing fleets to electric vehicles, we find that the value of fees placed on combustion vehicles will need to incrementally increase over time. However, we find that only when electric vehicles reach a 20% share of ride-hailing vehicles, perhaps around 2022–2023 based on our analysis, would the combustion vehicle fee begin to significantly increase to make up for the lost revenue from the electric vehicle exemption. As a result, our analysis suggests a transition from a full exemption for electric vehicles to emissions-indexed fees (i.e., still less than combustion vehicles, but not zero) would likely fall in the 2023–2026 period.

The policies in place in London provide a clear example for how cities can act on the key findings from this paper to transition to cleaner vehicles. London's policies are making it so drivers of polluting vehicles that do not meet emissions standards face steep daily fees. These policies are making it cost effective to adopt cleaner cars, and hybrids are the most economically attractive technology in 2020. For electric vehicles to reach cost parity with hybrids sooner, London's Ultra Low Emission Zone could shift to an emissions-indexed scheme, where only zero-emission vehicles are fully exempt. Doing so would align well with the Mayor of London's Transport Strategy to implement a Zero Emission Zone by 2025. In addition, from 2020 through 2022, new private hire vehicles licensed for the first time must be zero-emission capable, and, starting 2023, all ride-hailing vehicles of any age will need to do so when licensed for the first time. London is also directly supporting the deployment of charging infrastructure to ensure electric vehicles' commercial service is not disrupted, and plug-in hybrid vehicles are predominantly powered by electricity. The policy path set forth in London, where electric vehicles are no longer exempt from the Congestion Charge beginning in 2025, also aligns with our analysis on the underlying economics. London also, as a condition for its financial and charging infrastructure support, is collecting the driver and charging behavior data so it can continue to learn from and improve its policy and infrastructure. Although U.S. cities have not employed the same policy structure, their emerging fees on ride-hailing vehicles provide important potential building blocks for such policies to be more comprehensive in the years ahead.

Integrating government taxes and fees is one of many considerations that ride-hailing companies take into account in their own financial planning and product pricing, and the barriers of electric vehicle model availability, charging infrastructure, upfront costs, and driver awareness and understanding are all challenging to overcome. Ideally the implementation of government programs to levy fees on ride-hailing would provide sufficient timing and foresight for companies to appropriately plan and integrate future regulations into their operations. This approach is demonstrated in London.

Using tax and fee structures to incentivize electrification can be a driving force behind the transition to electric vehicles in ride-hailing fleets and beyond. While many cities actively discuss banning combustion vehicles, this paper offers a practical step toward steering a large and fast-growing segment of city vehicles toward zero emissions. Although this paper examines taxes and fees on ride-hailing, the most effective such policies would be more broadly applied to all vehicles, as is the case in London and a handful of other European cities. When emission-indexed fees apply to all vehicles, the policy supports not just the ride-hailing technology choice, but also positively supports greater sharing of vehicles, greater use of public transit, reduced congestion and reduced parking needs. As a result, higher usage of fewer vehicles, including strategic use of ride-hailing vehicles, could become an increasingly important tool for cities to meet their broader sustainability goals.

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