Guide to electrifying ride-hailing vehicles for cities

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Technology improvements and commitments by ride-hailing operators and governments alike indicate that ride-hailing fleets are poised to shift to electric vehicles (EVs). This shift could result in outsized climate and public health benefits due to the high number of kilometers driven by these vehicles. Electrifying ride-hailing fleets can also help to steer the broader transition to electric vehicles by increasing public awareness of EVs and spurring the deployment of an efficient charging network. Major cities where these fleets are concentrated can play a role in making this transition faster and maximizing the benefits for drivers, the public, and the climate.

This paper is designed to aid cities in accelerating the electrification of ride-hailing fleets to reduce their environmental impacts; it does not assess the complex advantages and drawbacks of ride-hailing platforms more broadly. To guide governments’ financial policies and investments, it investigates two key uncertainties around electric ride-hailing vehicles: the total cost of ownership compared to hybrid and combustion engine vehicles, and the charging infrastructure needed for an electric ride-hailing fleet. The paper also catalogs government and industry programs to transition this sector to electric, including incentives, mandates, infrastructure, and driver education. Finally, it concludes with recommendations to help cities to encourage the transition to electric ride-hailing fleets, including engaging with public and private stakeholders, conducting data-collection and analysis, and navigating legal frameworks. While this paper primarily focuses on Europe, where commitments to electrification are strongest, the process will be useful for cities in all markets at different stages of the transition to electric.

Introduction

The introduction of ride-hailing has been a disruptive force in urban transportation. Ride-hailing platforms, which may be categorized in some markets as transportation network companies (TNCs) or private-hire vehicle (PHV) operators, generally describe...
companies that match passengers with drivers of vehicles for hire via mobile apps or websites. Unlike taxis, which can be both hailed and pre-booked, the drivers of these platforms are only allowed to pick up pre-arranged bookings. Additionally, payment is made through the app rather than directly with the driver. The popularity of such services has increased dramatically since the launch of the first major ride-hailing company, Uber, in 2010.

Figure 1 illustrates the ridership for taxis (brown bars) and ride-hailing platforms (blue bars) in selected years from 2000 to 2018. The combined annual taxi and ride-hailing ridership has increased by 230% between 2012 and 2018 in the United States; however, all of the growth has come from TNCs.1 Ride-hailing fleets have grown in vast numbers at the same time as the taxi industry has shrunk, and by 2018, ride-hailing platforms accounted for seven times as many trips as taxis.

The ride-hailing industry has grown in other markets as well: Figure 2 shows the number of licensed taxi drivers, licensed private-hire drivers (including ride-hailing, chauffeur services, shuttles, etc.), and more specifically, the number of Uber drivers in London between 2009 and 2020.2 Although the number of Uber drivers operating in London has increased significantly, surpassing the number of taxi drivers in 2016, the number of taxi drivers has declined only slightly from 2011 to 2020.

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Figure 2. Evolution of the number of taxis, PHVs, and Uber drivers since 2009 in London.

One company—Uber—controls over 60% of the ride-hailing market in Europe and over 65% in the United States. Other major players in the ride-hailing market include Lyft, which represents almost all of the non-Uber trips in the United States, Free Now (which recently merged with competitor Kapten) with 20% of the European market, and Bolt with 10% of the European market. Uber has grown from $500 million in global net revenue in 2014 to more than $13 billion in 2019, an annual growth rate of more than 500%. Other companies are experiencing similarly rapid growth; Bolt was the third fastest growing European company in 2018 and saw its revenue grow from about €500,000 in 2015 to almost €80 million in 2018.

The rapid growth in these services has had numerous impacts on cities, triggering protests, lawsuits, and regulations. Among these impacts are environmental damage resulting from increased vehicle kilometers traveled and congestion. The emissions from these fleets are substantial: Uber vehicles emitted 335,000 tons of carbon dioxide (CO₂) in London in 2017, for example. This has contributed to a 23% increase in emissions from the taxi and PHV sectors in the UK from 2012 to 2017, even as the number of taxis has declined. Research from California indicates that ride-hailing trips in 2018, about 1% of which were powered by electricity, had 50% greater CO₂ emissions per passenger mile travelled and 7% lower passenger occupancy compared to the statewide passenger vehicle fleet average. A major factor in these emissions is the 39% share of miles travelled by ride-hailing vehicles with zero passengers. Research in the United States indicates that ride-hailing can draw people away from more environmentally friendly public transportation and that ride-hailing trips emitted 69% more CO₂ than the trips

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6 Le Petit and Earl, “Europe’s Giant ‘taxi’ Company: Is Uber Part of the Problem or the Solution?”

they displace. 8 However, ride-hailing vehicles tend to be relatively efficient, with an average fuel economy rating of 39.7 miles per gallon (mpg) versus 26.7 mpg for the light passenger vehicle fleet at large.

Electric vehicles have the potential to significantly reduce the life-cycle greenhouse gas and air pollutant emissions from light passenger vehicles and can be especially impactful in ride-hailing applications due to the greater annual driving distances. Replacing a combustion engine ride-hailing vehicle with a battery electric vehicle (BEV) in Europe can save 85 tons of CO₂ over the vehicle’s lifetime, compared with 30 tons when replacing a private passenger car. 9 A study focused on California found that substituting an internal combustion engine (ICE) vehicle used for ride-hailing with a BEV would save 40 kg CO₂ per day, with lifetime CO₂ savings three times that of substituting an ICE private car with a BEV. 10

A related category of services is ride-sharing services, represented by companies like CleverShuttle, MOIA, or Berlkönig in Germany. These services are specifically designed to facilitate pooled rides using larger vehicles. Ride-sharing services are well-positioned to complement public transit (Berlkönig is operated by Berlin’s transit authority and CleverShuttle is financed by the German national railway), and there is evidence that these services encourage greater use of public transit and detract from car usage. 11 These services are also pushing quickly toward electrification; for example, the fleet of CleverShuttle is 100% electric as of the end of 2020. However, because these services face different regulations and represent a lower share of vehicle-kilometers traveled (VKT) compared to ride-hailing services, we do not explicitly analyze or discuss ride-sharing companies in this report.

Regulatory status of ride-hailing services

Ride-hailing services are regulated differently around the world. These regulations are continuously evolving to address concerns about safety, environmental damage, or employment impacts. The specific regulatory framework in place in each market inform the approaches that governments may take to steer ride-hailing fleets toward electric.

The private hire vehicle industry in Europe faces regulations at the European Union, national, and local level; these regulations are generally stricter than those faced in the United States. At the European Union level, the European Court of Justice ruled in 2017 that Uber is a transportation and not an internet service company, thus requiring Uber to hire only licensed drivers; meet requirements related to health, safety, minimum wages, and drivers’ background checks; and follow each member country’s transportation regulations. However, the legal framework remains unsettled. In December 2020, the European Court of Justice ruled in favor of the Romanian Start Taxi app against the city of Bucharest, stating that this app is an internet rather than a transportation service.

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because the app puts passengers directly in touch with taxi drivers and does not provide a crucial part of the transport.\textsuperscript{12} The decision was hailed as a victory by ride-hailing services seeking changes in regulations.\textsuperscript{13}

National governments may impose additional requirements on ride-hailing platforms and their drivers. For example, in France, courts established that Uber drivers are employees rather than self-employed, requiring the platform to pay more taxes and provide additional benefits to its drivers such as sick leave and paid time off; similar obligations may follow for other operators.\textsuperscript{14} Additional regulations imposed on ride-hailing operations at the national level in Europe and North America are summarized in Table A1 of the Appendix.

Regulatory responsibilities for ride-hailing services are often further delegated to cities or local authorities. The Spanish government has delegated licensing and regulation to Spain’s 19 Autonomous Communities. Similarly, in Portugal, municipalities are empowered with all regulatory authority except licensing of operators, which is dealt with at the national level. London also has its own legislation governing taxis and private hire services, administered by Transport for London (TfL). Some cities and countries have implemented time restrictions on the booking of a private hire vehicle in an attempt to address competition with taxis. For example, Catalonia in Spain implemented a mandatory 15-minute period between a booking and the trip commencing.\textsuperscript{15}

Illustrating the complex and often contentious status of ride-hailing in Europe, Figure 3 displays legal battles between Uber, the largest ride-hailing operator, and different major European countries. This includes lawsuits which have been filed against Uber by national governments (orange hashes) and opposing lawsuits filed by Uber against national governments (blue hashes). The map also indicates in which countries Uber operates in any form as of January 2021 (outlined in blue), or where Uber is absent (outlined in black). Finally, the map shows the countries in which UberPop has been banned (outlined in red). UberPop is an Uber platform which allows any driver to provide rides with their own car without the need to be a professional taxi driver, similar to how UberX operates in the United States. In the countries where UberPop is banned, Uber may operate other services under different regulations, typically requiring more training or licensing.

\textsuperscript{12} Star Taxi App SRL v Unitatea Administrativ Teritorială Municipiul București - Case C-62/19 (European Court of Justice, December 2020).


Lawsuits filed against Uber allege that it operates an illegal taxi service, does not provide minimum benefits to its employees, or is an unfair competitor to taxi operators. Uber has also filed complaints with the European Commission claiming that some national laws present unfair legal obstacles to its business as they favor regular taxi services. Similar legal battles have also played out at the city level. In London, Uber was denied license renewal by the London transportation authority several times for failing to meet strict standards to protect passengers. In 2020, Uber won a lawsuit filed against the city and is allowed to operate again in London.

This patchwork of regulations surrounding the ride-hailing industry indicates the challenges and opportunities of pushing the sector towards electric vehicles. Because of the distributed authorities, governments at all levels have opportunities to implement favorable policies; however, creating comprehensive strategies will require collaboration among many stakeholders with different interests. In cases where limits on ride-hailing exist, such as vehicle or mileage caps, these could potentially be relaxed or modified for electric vehicles to create a strong incentive for fleets to shift to electric. Where ride-hailing is considered equivalent to taxis or is more formally regulated, governments may have more leverage to create phase-out targets, taxes, and fees. These policy options will be discussed in following sections.

Figure 3. Map showing lawsuits filed by and against Uber and legal status of UberPop in part of Europe.
Progress toward ride-hailing electrification

Through 2020, electric vehicle uptake within ride-hailing fleets has grown slowly, but data on the electric share of ride-hailing vehicles are sparse. In France, about 10% of vehicles on the Uber platform, which controls more than 70% of the ride-hailing market, are electric, split between 6% BEV electric and 4% plug-in hybrid (PHEV). The second and third largest platforms, Free Now and Bolt, are both comprised of about 2% BEVs, although 18% of Bolt’s fleet are PHEVs. In London, an estimated 3% of the private hire vehicle fleet has already been electrified (including BEVs and PHEVs). In California in 2018, 1.5% of vehicles serving in ride-hailing fleets were electric (BEV or PHEV) and 0.8% of ride-hailing vehicle-miles traveled were powered by electricity.

Government phase-out requirements for fleets. While European cities and countries are increasingly setting targets for new internal combustion engine vehicle sales, few governments have set explicit targets for converting their ride-hailing fleets to electric. One exception is London, where newly licensed private hire vehicles must be zero emission capable (minimum 10 miles electric range, emit no more than 50 g CO₂/km–75 g CO₂/km, and have a Euro 6 emission standard) beginning in 2021; this requirement took effect in 2020 for vehicles less than 18 months old. France has required that, by 2020, 10% of PHV and taxi fleets be low emission, emitting no more than 60 g CO₂/km (effectively limited to electric and plug-in hybrid vehicles). Shenzhen, China required ride-hailing fleets to be 100% electric by the end of 2020.

Governments are implementing other regulations to phase electric vehicles into ride-hailing fleets. In New York City, only battery electric vehicles may be registered on ride-hailing platforms after July 2019, although wheelchair-accessible vehicles are exempt. While combustion vehicles cannot receive a new license, those licensed prior to July 2019 may continue to operate. The cities of Guangzhou, Zhengzhou, Wuhan, and Xi’an in China will also only allow electric vehicles to be newly registered on ride-hailing platforms starting in 2021; because ride-hailing vehicles must be no more than 8 years old, this will lead to a complete conversion to electric by 2028. The California Air Resources Board is developing a Clean Miles Standard, which will set requirements for the percentage of miles driven in zero-emission vehicles and require an incremental decrease in the emissions per passenger-mile of trips hosted on each ride-hailing platform.

City governments have more commonly set electrification requirements for taxi fleets, over which they have more clear regulatory authority; such policies could serve as examples of how to regulate ride-hailing fleets. In Amsterdam, all taxis will have

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to be emission-free by 2025; in Oslo, the target year for full electrification is 2023, 
and in Bergen, 2024. Several cities in China have adopted more ambitious targets. 
Shenzhen completed electrification of its taxi fleet in 2020, Hangzhou will require full 
electrification of taxis in 2021, and Beijing and Guangzhou are set to follow in 2022.

**Low- and zero-emissions zones and combustion vehicle phase-outs.** Cities are 
increasingly regulating the vehicles (including ride-hailing fleets) that may drive in the 
city to reduce air pollution and emissions. Low-emission zones (LEZs), or areas of cities 
where vehicles that exceed specific emissions limits are restricted or charged a fee, have 
become increasingly popular in Europe in response to diesel air pollution; through late 
2019, over 250 cities have enacted low-emission zones. These zones vary in design 
and stringency, but most commonly limit older diesel-powered cars and trucks. Well-
designed LEZs have been effective in reducing nitrous oxides and black carbon. Because 
ride-hailing vehicles tend to be newer, with higher emissions standards, European LEZs 
in their current form may not significantly impact ride-hailing drivers.

Beyond LEZs, some cities are now working to fully phase out combustion vehicles, 
including those in high-mileage fleets. This includes creating zero-emission zones 
(ZEZs), or areas of the city where no combustion-powered vehicles will be allowed. 
As of early 2021, 35 cities, primarily in Europe and the Americas, have signed C40’s 
Green and Healthy Streets Declaration, pledging that a major area of the city will be 
zero-emissions no later than 2030. Oxford in the United Kingdom and Bergen, Norway 
plan to implement ZEZs as soon as 2021. London plans to create a central ZEZ in 2025 
and currently has two small ZEZs in place in the City of London and Hackney since 
the beginning of 2020. Other cities have set later target dates for the full phase-out 
of combustion vehicles, including Oslo in 2024; Amsterdam, Paris, and Rome in 2030; 
and Brussels in 2035. These policies could present a strong incentive for ride-hailing 
companies to accelerate electrification in order to continue providing rides in central 
ZEZ areas and cities more broadly.

**Operator electrification commitments.** Ride-hailing companies have made bold 
announcements regarding future electrification targets. Uber has made several 
electrification commitments in its 2020 “Spark!” report. Specifically, it has pledged to 
electrify 50% of its rides collectively across Amsterdam, Berlin, Brussels, Lisbon, London, 
Madrid, and Paris, and 100% of its rides in London by 2025. Uber has stated it will 
commit to become fully electric in any European city within 5 years of electric vehicles 
becoming cost-effective for ride-hailing. Uber has also committed to being a fully 
electric platform in Canada, Europe, and the U.S. by 2030 and globally in 2040.

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25 Hall, Cui, Bernard, Li, and Lutsey, “Electric Vehicle Capitals: Cities Aim for All-Electric Mobility.”
26 Jens Müller and Yoann Le Petit, “Low-Emission Zones Are a Success - but They Must Now Move to Zero-
Emission Mobility” (Transport & Environment, September 2019), https://www.transportenvironment.org/sites/
healthy-streets.
Announcements across Europe” (Washington, D.C.: International Council on Clean Transportation, May 10, 
29 Matthew Richardson, Santosh Rao Danda, Giles Wilkes, Jamie Graves, and Reece Decastro, “SPARK!
Partnering to Electrify in Europe” (Uber, September 8, 2020), https://www.uber.com/us/en/about/reports/
spark-partnering-to-electrify-europe.
The company has published strategies at the national (France and Portugal) and city (London) levels to reach its electrification goals. These strategies include a plan to phase out diesel and internal combustion engine vehicles, a financial plan to fund drivers’ transition to electric vehicles, and partnerships with charging infrastructure operators. In France, diesel vehicles will no longer be added to the platform starting in 2022, all diesel vehicles will be removed from the platform by 2024, 50% of vehicles on the platform will be electric by 2025, and 100% will be electric vehicles by 2030. These targets align with the Paris region’s decision to ban all combustion engine vehicles, including hybrids and PHEVs, from its roads starting in 2030. In Portugal, as of July 2020, Uber is only accepting electric cars for new registrations on the platform.

Uber’s announcements followed a commitment made by Lyft in June 2020 to make 100% of its rides electric by 2030. In Europe, Free Now has pledged to electrify 50% of its fleet by 2025 and 100% of its fleet by 2030. Free Now also claims to have the largest share of electric vehicles of any ride-hailing fleet in London and other major European cities. Bolt, the third-largest European operator, has also promised to become entirely environmentally sustainable by 2030.

The gap between ride-hailing companies’ stated ambitions to decarbonize and the observed low rates of electric vehicle uptake, along with the growing numbers of kilometers travelled by the combustion engine-powered ride-hailing fleet, indicates a role for stronger government oversight and support to make this sector more environmentally sustainable.

Financial outlook for electric vehicles in ride-hailing fleets

The use of electric vehicles for ride-hailing currently poses a financial challenge compared to gasoline and diesel ICE vehicles and hybrid vehicles due to the higher upfront purchase cost, the time lost charging, and the high cost of public charging. The prices of electric vehicles continue to decline and are expected to reach price parity with comparable conventional alternatives in the mid-2020s. In order to accelerate the transition before this point, purchase incentives, tax reductions, or other benefits are needed to shift the economic calculus. These incentives and their application are described in this section.

Programs to improve the financial outlook of electric ride-hailing vehicles

The financial proposition for the use of electric vehicles in ride-hailing applications depends on many factors; consequently, there are numerous opportunities to make electric vehicles more cost-effective. These include differentiated ride-hailing taxes and fees, congestion charge discounts or exemptions, electricity discounts, and vehicle incentives and tax reductions.

Per-trip, per-mile, and per-day ride-hailing taxes, fees, and credits. A number of local governments, particularly in the United States, have implemented taxes or per-trip fees on ride-hailing activities in order to mitigate congestion and fund transportation infrastructure. If electric ride-hailing vehicles are exempt or receive discounted rates, this would create an incentive for drivers to transition to electric. In late 2020, San Francisco approved the first ride-hailing tax with discounted rates for zero-emission vehicles: 3.25% for combustion vehicles and 1.5% for electric vehicles or shared rides. Many other U.S. cities and states have adopted taxes and fees that are not differentiated by vehicle type, such as a 6% tax in Washington, D.C., a $0.50 per ride fee in Portland, OR, and per-trip fees ranging from $0.55 to $8.00 in Chicago which depend on whether the ride is shared, where the ride starts and ends, and the time of day.\(^{37}\)

Fees on ride-hailing can also be integrated into a ride-hailing platform’s pricing scheme and used to fund electric vehicle programs. Starting in 2019, a clean air fee of 15p ($0.20) per mile, paid by the customer, is applied to all rides (including electric) with Uber originating in London. The money raised goes to a fund to help Uber drivers upgrade to an electric vehicle. Similarly, starting in January 2021 through the end of 2023, Uber will increase the price of rides by 3 cents per kilometer for every ride in France, except for Uber Green, and Uber France will match this fee with an additional 3 cents. This £0.06 per km is applied to a fund to assist Uber drivers with the transition to electric and can be redeemed when purchasing an electric vehicle from one of Uber’s partners. In addition to this mileage fee, Uber France gives a €1 credit per ride, with a maximum of €4,000, for all 100% electric vehicles registered on the French platform before the end of December 2021. As another example, Free Now pays U.K. drivers a £10.50 bonus each day they use an electric or plug-in hybrid car.

Congestion charges. Congestion charging involves charging fees for vehicles to enter particular areas of a city, sometimes during certain hours. These charges are designed to reduce congestion and its associated environmental and economic impacts; they may also create significant revenue for a city. Electric vehicles may be exempt from congestion charges or face lower fees, which can be a powerful incentive for prospective purchasers. London levies a congestion charge of £11.50 (temporarily raised to £15 during the coronavirus pandemic) on cars entering an area of central London, usually from 7:00 am to 6:00pm, though temporarily until 10:00 pm. Fees are currently waived for vehicles emitting less than 75 grams of CO\(_2\) per kilometer, which includes all BEVs and most PHEVs, through the city’s Cleaner Vehicle Discount (CVD). Beginning in October 2021, only zero-emission vehicles will be eligible and by 2025, the CVD will be withdrawn to ensure that the congestion continues to be controlled. Electric vehicles are also exempted from congestion charges in Milan and receive a significant discount in Oslo.

Because congestion charges are often applied in central business districts where a large share of ride-hailing trips occur, an exemption for electric vehicles could be an important

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tool for reducing the cost of electric ride-hailing vehicles. Multiple analyses have identified London’s congestion charge and electric vehicle exemption as a best practice for making electric vehicles cost-effective for ride-hailing.38

**Discounted public charging programs.** Electricity is the largest operational cost of ride-hailing with an electric vehicle and charging at DC fast charging stations away from home can often approach the per-mile cost of driving a gasoline vehicle. Ride-hailing fleets represent a consistent source of charging demand and may be complementary to private cars in terms of peak charging times. Ride-hailing operators, charging operators, utilities, and governments may create preferential lower-cost charging programs to ensure additional demand. For example, Uber partnered with EVgo, the largest DC fast charging operator in the United States, to offer less expensive charging. Uber drivers are eligible for discounts up to 25% on per-minute charges with no monthly or session fees and extended session limits.39 In Europe, Uber has agreements with Power Dot and EDF in France and BP in the UK to ensure exclusive access to charging hubs. In Portland, Oregon, the utility Portland General Electric provides free public charging to Lyft drivers.

**Vehicle purchase subsidies, taxes and fees.** Vehicle purchase incentives offered for private and company cars also benefit ride-hailing drivers and may be able to fully recover the total cost of ownership difference between electric and conventional vehicles. In 2020, most countries in Europe offered bonus payments, tax benefits, or a combination.40 These policies are most commonly implemented at a national level, but some subnational governments such as states and provinces offer additional financial incentives. In some jurisdictions, taxes benefit from additional local or national fiscal incentives. The UK Office for Zero Emission Vehicles (OZEV) and TfL gives taxi drivers up to £7,500 for the purchase of a new electric vehicle and provides funding for the development of taxi-dedicated charging infrastructure. As of early 2021, there are no local or national financial incentives offered by governments exclusively to ride-hailing vehicles.

Another incentive to lower the cost, or obviate the need to own a vehicle, are partnerships with auto manufacturers. Uber Green in Berlin, which offers rides only in BEVs or fuel cell vehicles, is a partnership between Volkswagen and Uber in order to provide Uber partner taxi and car-rental companies with electric vehicles.41 This partnership is mutually beneficial since it also helps Volkswagen provide enough electric vehicles to the market in order to avoid paying penalties related to tighter European Union fleet-average emission standards.

**Impact of incentives on total cost of ownership**

This section explores the financial outlook for electric vehicles in ride-hailing service in London, Berlin, and Madrid. The cost of ownership of three vehicle options over the 2021–2026 period are compared: an all-electric BEV, a gasoline hybrid, and a gasoline ICE vehicle. The analysis compares BEVs with low-cost overnight charging available (either public or private) and with overnight charging not available. Electric vehicles

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38 Richardson, Danda, Wilkes, Graves, and Decastro, “SPARK! Partnering to Electrify in Europe”; Slowik, Wappelhorst, and Lutsey, How Can Taxes and Fees on Ride-Hailing Fleets Steer Them to Electrify?


with overnight charging are assumed to get 90% of their energy overnight at public or private locations and the remaining 10% at public DC fast chargers, while electric vehicles without home charging are assumed to get 100% of their energy at public DC fast chargers.

The BEV is assumed to have a range of 400 kilometers (km) (249 miles); this range is more appropriate for ride-hailing than lower range vehicles as it reduces the time and opportunity cost of public charging. The efficiency of the BEV is 0.183 kilowatt-hours per kilometer, the hybrid is 4.6 liters per 100 km, and the efficiency of the ICE is 5.3 liters per 100 km, corresponding to efficiency among similar size vehicles in Europe in 2021.

The prices of vehicles used in this analysis, as well as the cost of maintenance, leverage a previous study with prices adjusted for 2021 and checked for consistency with available vehicle prices. We assume that all vehicles are driven 50,000 km annually.

The key inputs for the total cost of ownership analysis for London, Berlin, and Madrid are summarized in Table 1. This includes incentives and tax policies that affect the initial price of the vehicles, with upfront and annual registration taxes and fees designed to favor low emission vehicles. For London’s congestion charge zone, we assume that ride-hailing drivers enter the congestion zone on 50% of working days.

Table 1. Summary of key inputs for total cost of ownership analysis in London, Berlin, and Madrid.

<table>
<thead>
<tr>
<th>Input</th>
<th>London</th>
<th>Berlin</th>
<th>Madrid</th>
</tr>
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<tbody>
<tr>
<td>Purchase incentive</td>
<td>£3,000 (£2,635)</td>
<td>€6,000</td>
<td>€4,000</td>
</tr>
<tr>
<td><strong>Tax benefits for BEVs</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Exempt from car purchase tax and annual taxes</td>
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<tr>
<td>Exempt from first year ownership tax</td>
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<tr>
<td>Exempt from purchase tax, 75% reduction in annual taxes</td>
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<td></td>
</tr>
<tr>
<td>Congestion zone discounts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exempt from £15/day congestion charge</td>
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<td></td>
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<tr>
<td>Petrol price</td>
<td>£1.23/liter (£1.40/liter)</td>
<td>€1.41/liter</td>
<td>€1.34/liter</td>
</tr>
<tr>
<td>Home electricity price*</td>
<td>£0.18/kWh (£0.20/kWh)</td>
<td>€0.29/kWh</td>
<td>€0.18/kWh</td>
</tr>
<tr>
<td>DC fast charging price (Ionity network)*</td>
<td>£0.27/kWh (£0.30/kWh)</td>
<td>€0.32/kWh</td>
<td>€0.32/kWh</td>
</tr>
</tbody>
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The analysis also includes the opportunity cost of fueling, or the time spent charging or refueling with gasoline that could otherwise be spent driving and earning revenue. The methodology is fully described in a previous paper. The value of the time spent charging is adjusted by city using the relative fare differences based on the Uber trip


**Slowik, Wappelhorst, and Lutsey, How Can Taxes and Fees on Ride-Hailing Fleets Steer Them to Electrify?


**ACEA, “Overview - Electric Vehicles.”

**Slowik, Wappelhorst, and Lutsey, How Can Taxes and Fees on Ride-Hailing Fleets Steer Them to Electrify?

**Pavlenko, Slowik, and Lutsey, When Does Electrifying Shared Mobility Make Economic Sense?
cost calculator, assuming an average trip length of 10 km. Berlin shows the highest differentiation in price at 140% of the price of a similar trip in London.

**Total cost of ownership results**

Figure 4 summarizes the costs to operate each of these vehicles as a ride-hailing driver, including the taxes and subsidies available in each city. The left axis represents the cumulative costs over a five-year period. The purchase incentive for electric vehicles is shown below the x axis in light brown and lowers the initial vehicle cost. The remaining components above the x axis represent the cost over five years of operation: purchase price, taxes, energy (fuel or electricity), maintenance, the opportunity cost of charging, and congestion fees (for London). The right axis shows the cost per kilometer driven over the vehicle’s life. There are two costs per kilometer represented. The gray circles are the costs per kilometer including all current purchase incentives, favorable tax policies, and the congestion zone exemption fee in London for electric vehicles. The orange dots represent the hypothetical unsubsidized cost per kilometer if all vehicles received the same tax and fee treatment as the ICE vehicle; this unsubsidized counterfactual allows for the comparison of different policies to create cost parity. The cost per kilometer for the ICE is identical for the subsidized and unsubsidized cases.

**Figure 4.** Comparison of 5-year TCO across vehicle technologies for full-time ride-hailing drivers in three cities in 2021 with current incentives and exemptions included.

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The analysis clearly illustrates that access to overnight charging is a key driver of cost savings for electric vehicles in ride-hailing. As shown by the gray circles in the figure, if home charging is available, electric vehicles have the lowest cost per kilometer in 2021, with savings ranging from 7% in Berlin to 10% in Madrid compared to a hybrid. Even without accounting for financial subsidies or tax benefits for electric vehicles, as indicated by the orange dots, the electric vehicles with overnight charging still compete well with hybrids and ICE vehicles in London and Madrid but face higher costs in Berlin due to high home energy prices. Access to overnight charging can save drivers between €1,700 and €2,100 annually compared to relying solely on DC fast charging.

If overnight charging is not available, electric vehicles may be more or less costly than combustion vehicles depending on policy measures. In London, the electric vehicle exemption from the £15.00/day (€16.50/day) congestion charge alone makes electric vehicles more economical to operate, assuming that a ride-hail vehicle enters the congestion zone on 50% of days. However, except for London, electric vehicles without home charging are currently the highest cost option for ride-hailing. The opportunity cost of charging and the high price of retail DC fast charging together make electric vehicles more costly to operate for ride-hailing compared to a gasoline hybrid. Without any subsidies, electric vehicles purchased in 2021 with no home charging would be the most expensive option in each city, facing a hypothetical 5-year cost deficit of £7,000 (€8,000) in London and €11,500 in Berlin.

**Opportunities to create a financial advantage for electric vehicles**

As shown in Figure 4, electric vehicles are the least costly option if affordable overnight charging is available; strategies to expand home charging access are described in a later section. Table 2 summarizes other opportunities to equalize the total cost of ownership for electric cars in ride-hailing applications. For each action, the table provides the value of the incentive which would create total cost of ownership parity for an electric ride-hailing vehicle purchased in 2021 without home charging versus a gasoline hybrid for each of the 3 cities in the analysis above. These values assume that no other incentives are in place. In practice, some incentives are already in place: yellow text indicates that an incentive is available at a lesser value than is needed to create TCO parity, and green text indicates that an incentive is in place at the full recommended value. Next, it identifies the stakeholders which may be responsible for administering the program. Finally, the table provides an example of how the incentive has been implemented as of 2021.
Table 2. Summary of incentive options for electric vehicles to reach cost parity with hybrids for ride-hailing electrification in 2021.

<table>
<thead>
<tr>
<th>Incentive type</th>
<th>Incentive value to enable TCO parity for electric ride-hail vehicle*</th>
<th>Implementing stakeholder(s)</th>
<th>Real-world example of implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone charge (Congestion / low emission) with electric vehicles exempt</td>
<td>€13 per day</td>
<td>€18</td>
<td>€15</td>
</tr>
<tr>
<td>Per-trip tax/fee with electric vehicles exemptb</td>
<td>€0.47 - per trip (4% per trip)</td>
<td>€0.67 - per trip (4% per trip)</td>
<td>€0.56 - per trip (4% per trip)</td>
</tr>
<tr>
<td>Per-kilometer fee with electric vehicles exemptc</td>
<td>€0.05 per km</td>
<td>€0.07</td>
<td>€0.06</td>
</tr>
<tr>
<td>Low-cost DC fast charger electricity</td>
<td>€0.10 per kWh</td>
<td>€0.03 per kWh</td>
<td>€0.08 per kWh</td>
</tr>
</tbody>
</table>

* 5-year TCO parity for an electric vehicle with no overnight charging compared to a hybrid in major European markets, assuming no other incentives are available. Incentives marked green are already fully in place; incentives marked yellow are in place at a lower value.

b Average trip length is 10 km

c Excludes 30% deadhead miles

Although there is variation from city to city, the range of potential subsidies in Table 2 is generally applicable in most markets in Europe. The variables most important to the differences are energy costs used to determine the per-mile savings from an electric vehicle and labor costs used to determine opportunity cost.

Cost parity can also be achieved by combining multiple incentives of lower value. Figure 5 provides a hypothetical illustration of how this approach could be used to achieve 5-year TCO parity between a BEV without overnight charging and a hybrid vehicle in ride-hailing service in Madrid. The figure shows the impact of the existing purchase tax exemption and upfront financial incentive in Madrid (solid green bars). One path to achieving TCO parity could be to implement two hypothetical new policies (hashed bars): a 20% discount on DC fast charging electricity rates (a reduction from €0.32/kWh to €0.27/kWh) and a central city congestion charge of €5/day from which electric vehicles would be exempt (assuming that ride-hail drivers enter the zone on 50% of working days). Under this scenario, conventional internal combustion engine vehicles would be the most expensive with a 5-year total cost of €54,860. Conversely, a BEV with overnight charging would be the least expensive option, with a 5-year total cost of €43,696.
Figure 5. Illustration of how existing and hypothetical policies can enable TCO parity for BEVs with no home charging for in ride-hailing in Madrid.

Financial comparisons for electric ride-hailing in the United States

While each of the cost components discussed above are different in the United States compared to Europe, other research has found a similar overall picture: electric ride-hailing vehicles purchased today are cost-competitive with gasoline-powered alternatives with home charging but face a cost penalty if they rely solely on public DC fast charging.

A 2019 ICCT study assessed the total cost of ownership for conventional, hybrid, and electric vehicles in eight U.S. cities. It found that even without purchase incentives, BEVs will be the most economical solution for ride-hailing around 2025 depending on the annual mileage driven. This study also highlighted the importance of overnight charging access by showing that a large reliance on public fast charging increases operating costs by about 25%.

A follow-up analysis focused on the United States recommends per-trip fees on combustion vehicles of $0.55–$1.15 or taxes of 4.5%–9% to reach TCO parity between BEVs without home charging and hybrid vehicles. As electric vehicles continue to decline in cost, these incentives could be tapered; by the late 2020s, electric vehicles will likely have the lowest TCO for ride-hailing applications without subsidies. Even now, if home charging is available, electric vehicles are near parity with hybrid vehicles due to low electricity cost, low maintenance cost, and high gasoline prices.

A separate TCO analysis for 15 U.S. metropolitan areas from 2021 reached similar findings, concluding that full time ride-hailing EV drivers fully dependent on public fast charging are 3%–27% more expensive to operate than ICE vehicles, and will not reach

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50 Pavlenko, Slowik, and Lutsey, *When Does Electrifying Shared Mobility Make Economic Sense?*

cost parity with conventional vehicles before the end of the decade without subsidies.\textsuperscript{52} The high energy costs and opportunity costs of DC fast charging are the primary challenges to electrifying the sector. Providing low-cost overnight charging is a top priority for encouraging electrification. The study also finds that a 25% discount on DC fast charging could enable TCO parity by 2025 for those without home charging.

**Providing charging infrastructure for electric ride-hailing vehicles**

The analysis above describes the important influence of both home charging and DC fast charging in making electric vehicles attractive for ride-hailing. The following analysis details how much charging is needed to support the transition. Ride-hailing drivers are less likely to have overnight charging than other drivers as they are more likely to live in multi-unit dwellings and in neighborhoods with underdeveloped public charging.\textsuperscript{53} The central assumption in this analysis is that 20% of ride-hailing drivers have access to private or curbside overnight charging and 80% rely exclusively on DC fast charging. Although other types of charging such as normal workplace or public charging could also be used, these types of charging are not analyzed here as they are considered too slow for mid-shift charging.

Ride-hail vehicles are assumed to charge at public DC fast chargers (> 43 kW) when possible. Given the limitations of the public charging network, additional dedicated DC fast chargers may be needed to achieve ride-hailing electrification targets. The methodology of how many ride-hail vehicles a public charger can support is detailed in another report on North American charging needs.\textsuperscript{54} Assumptions have been changed to adapt to the European context and are shown in Table 3.

<table>
<thead>
<tr>
<th>Table 3. Assumptions for ride hail vehicle infrastructure analysis.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parameter</strong></td>
</tr>
<tr>
<td>Annual mileage for ride hailing</td>
</tr>
<tr>
<td>Charging power in 2021</td>
</tr>
<tr>
<td>Charging power in 2025</td>
</tr>
<tr>
<td>Share of drivers with home charging</td>
</tr>
<tr>
<td>Percent of energy from fast charging when there is no home charging</td>
</tr>
<tr>
<td>Percent of energy from fast charging when home charging is available</td>
</tr>
</tbody>
</table>

In 2021, the average power of DC fast charging is assumed to be 45kW. Chargers are often rated for faster speed, but factors such as temperature, charger power sharing, and vehicle power limits are assumed to reduce the actual speed from a charger’s maximum speed. By 2025, the average charging power experienced across the fleet is assumed to rise to 80kW as charger and vehicle technology improves.

While private vehicle owners often charge after work around 6pm, ride-hail drivers avoid charging during this time period since this is the most popular time for pick-ups. Instead,

\textsuperscript{52} Ross McLane, EJ Klock-McCook, Shenshen Li, and John Schroeder, “Racing to Accelerate Electric Vehicle Adoption: Decarbonizing Transportation with Ridehailing” (Rocky Mountain Institute, January 2021), https://rmi.org/insight/accelerating-the-electric-vehicle-transition/.

\textsuperscript{53} Richardson et al., “SPARK! Partnering to Electrify in Europe.”

ride-hail drivers with no home charging often fast charge late at night after they’ve finished for the day.\textsuperscript{55} These patterns and opportunities to facilitate complimentary usage are further described in a related study.\textsuperscript{56}

Table 4 illustrates DC fast charging infrastructure needs for ride-hailing in 2021 and 2025 for public and dedicated ride-hail chargers. For public stations, the analysis considers three utilization thresholds corresponding to different tolerance levels for crowding at chargers. The numbers of chargers are shown in terms of how many ride-hail drivers can be supported per public charger. In 2021, utilization of stations by the general public is relatively low compared to 2025, allowing more capacity for ride-hail drivers to be served. For example, in the low utilization scenario in 2021, seven ride-hail drivers can be served per charger. The number of drivers supported in 2025 increases modestly, with higher charging speeds partially counteracted by greater charging demand from the public. If dedicated chargers are used, there is no overcrowding concerns with the general public, so only the high utilization threshold (8 hours per day) is used.

Table 4. Number of ride-hail drivers supported per DC fast charger with different utilization thresholds assuming 20% access to home charging.

<table>
<thead>
<tr>
<th>Utilization threshold</th>
<th>Shared public charger</th>
<th>Dedicated ride-hail charger</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low (4 hours public and ride-hailing combined)</td>
<td>Central (6 hours public and ride-hailing combined)</td>
</tr>
<tr>
<td>Ride-hail drivers supported per DC fast charger in 2021</td>
<td>7</td>
<td>11</td>
</tr>
<tr>
<td>Ride-hail drivers supported per DC fast charger in 2025</td>
<td>9</td>
<td>16</td>
</tr>
</tbody>
</table>

Case study of ride-hailing vehicle charging needs in the London metropolitan region

Applying the usage ratios identified above to the London metropolitan region (including Greater London as well as suburban areas where many drivers live) enables an estimate of the number of ride-hail drivers supported by the current and future charging network. Table 5 estimates the number of drivers supported for each scenario given the current number of DC fast chargers in 2021 and projected charging network growth in 2025.\textsuperscript{57} This assumes that 20% of drivers have access to home charging, while 80% rely exclusively on DC fast charging. For example, for the central utilization scenario in 2021, 798 (the number of DC fast chargers in the region) is multiplied by 11 drivers per charger (from Table 4) to get 8,778 electric ride-hail drivers served. The anticipated public charging infrastructure growth through 2025 in the London region to support private electric vehicles is sufficient to support the electrification of approximately 50% of the Uber fleet, or 20% of the entire PHV fleet.

\textsuperscript{55} Jenn, “Emissions Benefits of Electric Vehicles in Uber and Lyft Ride-Hailing Services.”

\textsuperscript{56} Nicholas, Slowik, and Lutsey, Charging Infrastructure Requirements to Support Electric Ride-Hailing in U.S. Cities.

Table 5. Ride-hail drivers in the London metropolitan region supported on public DC fast charging.

<table>
<thead>
<tr>
<th></th>
<th>Estimated public DC fast chargers</th>
<th>Ride-hail drivers served (20% have overnight charging)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low utilization threshold</td>
<td>Central utilization threshold</td>
</tr>
<tr>
<td>London 2021</td>
<td>798</td>
<td>5,500</td>
</tr>
<tr>
<td>London 2025</td>
<td>1,381</td>
<td>12,400</td>
</tr>
</tbody>
</table>

The number of DC fast chargers required to serve the ride-hailing fleet is directly dependent on the access to overnight charging. Figure 6 shows the number of additional DC fast chargers needed beyond expected network expansion to support the entire ride-hail fleet in London by 2025 as a function of the share of drivers with overnight charging. The figure shows two scenarios: ride-hailing drivers supported by dedicated chargers (blue line) or an expanded public network (brown line). The estimated overnight charging availability in 2025, which could serve about 20% of drivers, is indicated by the dashed line. At this level of overnight charging availability, either 1,000 additional publicly accessible chargers or 550 additional dedicated chargers would be needed by 2025.

Figure 6. Ride-hail drivers supported by the current 2021 and projected 2025 London metropolitan region DC fast charger network as a function of overnight charging availability.

The figure illustrates the tradeoff between overnight charging, either private home or shared on-street, and DC fast charging. The relationship is not linear, as those who gain a home charger still occasionally use DC fast charging to complete long driving sessions. The number of public chargers needed would be greater than dedicated stations, as shared public stations see lower utilization to avoid potential conflicts. If at least 80% of ride-hail drivers had access to overnight charging, anticipated network growth through 2025 to support private drivers could also support the entire fleet of ride-hail drivers. Coupled with the finding that overnight charging improves the business case for electric ride-hailing, this relationship indicates that, when possible, overnight charging should be prioritized to minimize infrastructure costs and reduce operational expenses.
Programs to increase charging access for ride-hailing drivers

As with financial incentives, ride-hailing operators, governments, and other companies can help to ease the infrastructure challenge for ride-hailing drivers. Specific strategies are detailed below.

Discounts on home charging stations for ride-hailing drivers. The cheapest and most convenient charging option for electric vehicle drivers is public or home AC overnight charging. Stable overnight charging enables not only lower rates, but also can negate the need to charge before or after a driving shift, allowing them more time to accept rides. To address this gap, ride-hailing operators may partner with charging operators, utilities, cities, and local and national governments to install public residential chargers at or near drivers’ home and provide discounted home charging solutions. In the United States, Uber drivers receive $125 discounts on home chargers from Enel X, and General Motors and Uber have partnered to provide discounted home charging equipment. Uber France partnered with IZI by EDF to offer their drivers a discounted price for home charging and access to the IZIVIA charging station network, which includes AC normal and DC fast chargers.

Government subsidies for home charging stations. As of 2020, there are no dedicated government programs to provide charging specifically for ride-hailing drivers, but there are many programs to promote greater access to charging more broadly. The United Kingdom provides £500 for purchasing a home charger as part of their electric vehicle home charge grant. Some cities provide subsidies specifically for taxis, such as Paris, where the city will cover half of the expenses up to €4,000 for installing a home charger in a multi-unit dwelling. After comparing the costs of public and private charging, Oslo created a program to install charging in multi-unit housing cooperatives particularly in lower-income areas. This program financed over 16,000 chargers in 2018 alone.

Curbside residential charging stations. Many cities are concentrating on building out public curbside charging stations in residential areas to serve those without off-street parking; this is identified as a high priority for Uber to enable its drivers to transition to electric. The streamlined, demand-driven curbside charging program in Amsterdam may be especially suited for installing the large numbers of chargers needed in the neighborhoods where ride-hailing drivers live. In cities like Stockholm, which use a planning-oriented approach to site chargers, ride-hailing companies may be able to contribute data to ensure that their drivers’ needs are served. Finally, some cities such as Los Angeles and London are prioritizing installing chargers in underserved neighborhoods, where electric vehicle ownership lags in the early market but where ride-hailing drivers are more likely to live. Analyses in London indicate a spatial mismatch between PHV driver homes and early public charging deployments.

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60 Richardson, Danda, Wilkes, Graves, and Decastro, “SPARK! Partnering to Electrify in Europe.”
highlighting the need to consider the neighborhoods where chargers are installed rather than only pursuing city-wide targets.63

**Strategies and policies to electrify ride-hailing**

Electrifying ride-hailing fleets requires a similar supportive ecosystem as for the broader transition to electric, including policies designed to promote affordability, awareness, and convenience. However, there are additional policy considerations and opportunities for ride-hailing fleets, indicating the need for separate strategies developed in coordination with ride-hailing operators and other stakeholders.

In addition to financial incentives, governments and other stakeholders can implement many other supportive policies to entice ride-hailing drivers to switch to electric vehicles. Some policies are specific to private-hire vehicles and high-mileage fleets such as taxis, while others may benefit all electric vehicle drivers but are particularly relevant for ride-hailing. Based on practices in leading jurisdictions, some opportunities include:

» **Awareness campaigns.** Many city, regional, and national governments have created consumer education programs for electric vehicles, but these have mostly been targeted toward private drivers or commercial fleets. Ride-hailing drivers may have unique questions and concerns around electric vehicles' capabilities which could be addressed in targeted awareness programs. For example, cities could arrange electric fleet demonstration and trials such as the one run by Nottingham City Council.64 Ride hailing operators could organize events such as the “Green Summit” organized by Uber France to answer drivers’ questions on the switch to an electric vehicle.65 These campaigns could be co-organized with ride-hailing operators to demonstrate a unified commitment to electrification.

» **Priority queuing and parking.** Amsterdam grants free parking for taxis at all charging points and provides priority queuing to “green” taxis at some locations, like the central train station.66 Other cities offer free or discounted parking or priority for parking permits to electric vehicle drivers.

» **Access to priority or express lanes.** A number of governments in Europe (e.g., Oslo), North America (e.g., California and New York), and China (e.g., Guangzhou and Liuzhou) offer electric vehicles access to priority or express lanes.67 For ride-hailing applications, this privilege could attract additional customers or enable the companies to charge higher rates (which could be passed along to drivers) based on the opportunity to save time. These perks can be scaled back or restricted as electric vehicle uptake grows and bus and carpool lanes become congested; in California, for example, electric vehicles now receive access to carpool lanes for 3-4 years after registration.

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67 Hall, Cui, Bernard, Li, and Lutsey, *Electric Vehicle Capitals: Cities Aim for All-Electric Mobility.*
Figure 7 summarizes five key steps for cities, ride-hailing operators, and other stakeholders to take in order to create a comprehensive ride-hailing electrification program. As indicated by the arrow, the ideal strategy is an iterative process that is refined as the market develops: feedback and new data collected at each stage should be used to adjust policies and strategies at regular intervals.

1. Gather data
   Collect data on:
   - Ride-hailing travel profiles, vehicle types
   - Charging access and behavior (home and public, time of day, speed)

2. Set zero-emissions targets
   - Calculate fleet decarbonization timeline consistent with transport emission targets
   - Set intermediate date requiring newly registered vehicles be zero-emissions

3. Set conditions to ensure electric is cost-effective
   - Upfront vehicle incentives
   - Daily (congestion charge) or per-mile fees for combustion vehicles
   - Favorable electricity tariffs

4. Increase charging infrastructure access
   - Prioritize affordable overnight charging (private or curbside) where possible
   - Locate ultra-fast charging hubs along corridors of high demand, near amenities

5. Engage drivers and other stakeholders
   - Create focus groups of drivers to identify challenges and test solutions
   - Partner with ride-hailing platforms and charging operators to share costs and organize education campaigns

Figure 7. Key steps for city governments to electrify ride-hailing

Along with this suggested strategy, this guide indicates several recommendations and findings for cities seeking to electrify ride-hailing fleets.

*Ride-hailing operators have set ambitious timelines for electrification which complement or surpass city and national goals.* Cities are at the forefront of the transition to electric vehicles and clean transport globally. However, few cities have created policies specifically targeting electrification of ride-hailing fleets, sometimes due to the contentious regulatory and legal environment in which these fleets operate. At the same time, leading ride-hailing operators like Uber, Lyft, Bolt, and Free Now have set ambitious targets to electrify their operations, as soon as 2025 in some cities. These commitments set a pace of electrification far faster than the private vehicle market in most cities and can potentially have outsized climate and air quality benefits. Cities can help to ensure these targets are met by adopting comprehensive strategies in coordination with stakeholders such as ride-hailing operators, drivers, charging providers, and utilities. This would ideally include binding electrification targets that match operator timelines, schemes to make electric vehicles less costly to operate than combustion vehicles, and infrastructure build out for overnight and mid-shift charging.

*Affordable charging and emissions-based fees can make electric vehicles cost-effective for ride-hailing in the near future.* Electric vehicles are well-suited to ride-hailing applications because of their low per-mile operating costs. In most European and North American markets, electric vehicles are cost-competitive with conventional hybrids to
use in ride-hailing applications if affordable overnight charging is available but are 15%-20% more costly if drivers rely on public DC fast charging. This price difference can be overcome through ongoing operational benefits; for example, our analysis indicates that electric vehicles may be the most cost-effective option for ride-hailing in 2021 in London based on their exemption from the £15/day congestion charge and national purchase subsidies. Cities and ride-hailing operators have many options to bridge this cost gap, including per-mile or per-trip fees on combustion vehicles, differentiated congestion pricing, upfront purchase incentives or tax discounts, and providing more affordable charging options.

*Convenient charging at home and at destinations will be a crucial enabler of electrification.* As with the broader market, convenient, affordable charging infrastructure is a key enabler of mainstream electric vehicle adoption for ride-hailing drivers. Overnight home charging in particular is critical to making electrification cost-effective, yet ride-hailing drivers are less likely to have access to home charging than other electric vehicle drivers. This suggests a need to prioritize programs that provide overnight charging in private garages, at multi-unit dwellings, and curbside in residential areas. Additional DC fast charging will also likely be needed of about 1 public charger for every 16 vehicles or 1 ride-hailing-only charger for every 45 vehicles, but this need can be mitigated with more overnight charging. Data on ride-hailing trips and driver residences will be important in determining the number and ideal location for new chargers. The steady demand from the ride-hailing sector may also help to improve utilization and profitability of public chargers, attracting further investment.
Appendix

National regulations on ride-hailing services

Table A1 shows the legal status of private hire vehicles in countries in Europe and North America according to three metrics. First, it states whether private-hire vehicles are limited in number, or “quantitative restrictions.” Second, it lists whether each country regulates taxis and private-hire vehicles together in a one-tier system, or whether they are separate categories in a two-tier system. Finally, it specifies whether there is a “return to garage” rule requiring drivers to return to a home base between every ride. In practice, this rule can often be avoided by scheduling another trip while one is in progress.

Table A1. Summary of regulations imposed on ride-hailing services in selected European and North American countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Quantitative restrictions</th>
<th>Tier system</th>
<th>Return to garage rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>No</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Belgium</td>
<td>Only in Brussel Capital Region</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>No regulation</td>
<td>No regulation</td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>No</td>
<td>Two-tier</td>
<td>No</td>
</tr>
<tr>
<td>Cyprus</td>
<td>No</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>Yes</td>
<td>One-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Estonia</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Finland</td>
<td>N/A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>No</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Germany</td>
<td>No</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Greece</td>
<td>No, but only travel agencies and car rental are allowed to perform the service</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Hungary</td>
<td>Only as ancillary service for hotel, travel agencies, event organization</td>
<td>One-tier</td>
<td>Only activities included in the contract are allowed</td>
</tr>
<tr>
<td>Ireland</td>
<td>No, but currently only wheelchair accessible hackney licenses are issued</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Italy</td>
<td>Depends on the municipality</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Latvia</td>
<td>No</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>No</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Luxembourg</td>
<td>No</td>
<td>One-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Malta</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>No</td>
<td>One-tier</td>
<td>No</td>
</tr>
<tr>
<td>Poland</td>
<td>No</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Portugal</td>
<td>Yes</td>
<td>One-tier</td>
<td>Only when the service is performed by rental cars</td>
</tr>
<tr>
<td>Romania</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>N/A</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>N/A</td>
<td>One-tier</td>
<td>Yes, a contract is necessary between the carrier and the passenger</td>
</tr>
<tr>
<td>Spain</td>
<td>Yes, 1 PHV licensed every 30 taxis.</td>
<td>Two-tier</td>
<td>Yes</td>
</tr>
<tr>
<td>Sweden</td>
<td>N/A</td>
<td>One-tier</td>
<td>N.A.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>No</td>
<td>Two-tier (except Northern Ireland)</td>
<td>Some jurisdictions</td>
</tr>
<tr>
<td>United States</td>
<td>No (except in limited cities)</td>
<td>Two-tier</td>
<td>No</td>
</tr>
</tbody>
</table>

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