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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

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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.

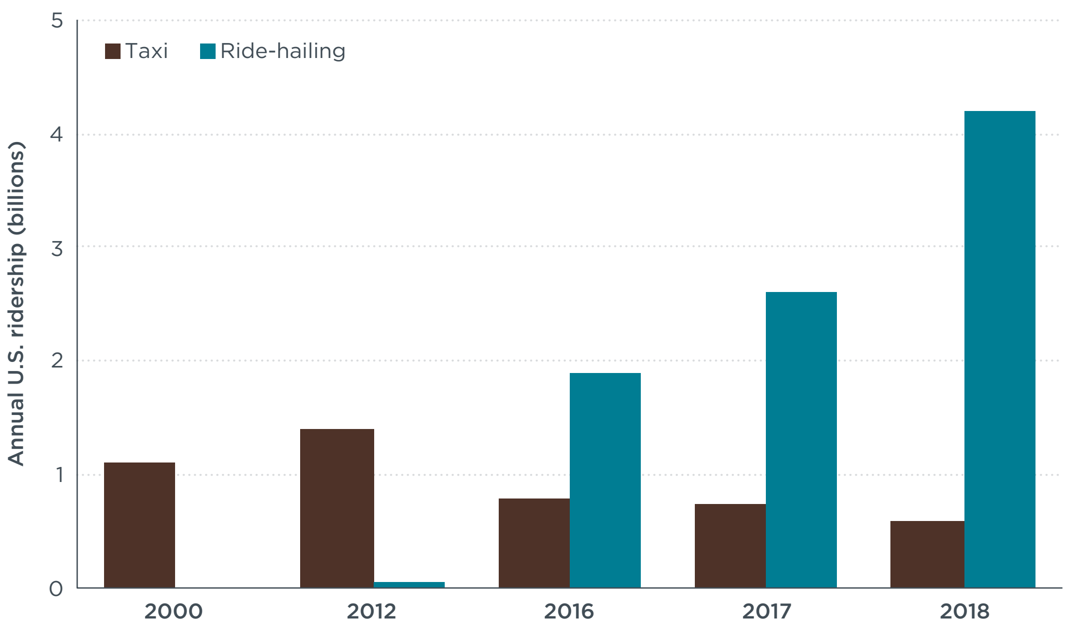

Figure 1. Annual U.S. ridership in billions for taxis and ride-hailing networks between 1990 and 2018.

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.

1 Bruce Schaller, "The New Automobility: Lyft, Uber and the Future of American Cities" (Schaller Consulting, July 25, 2018), http://www.schallerconsult.com/rideservices/automobility.pdf.

2 Transport for London, "Licensing Information," accessed August 4, 2020, https://www.tfl.gov.uk/info-for/taxis-and-private-hire/licensing/licensing-information; Yoann Le Petit and Thomas Earl, "Europe's Giant 'taxi' Company: Is Uber Part of the Problem or the Solution?" (Transport & Environment, November 2019), https://www.transportenvironment.org/sites/te/files/publications/T%26E_Europe%20s%20giant%20taxi%20company%20is%20Uber%20part%20of%20the%20problem%20or%20the%20solut...%20%281%29.pdf.

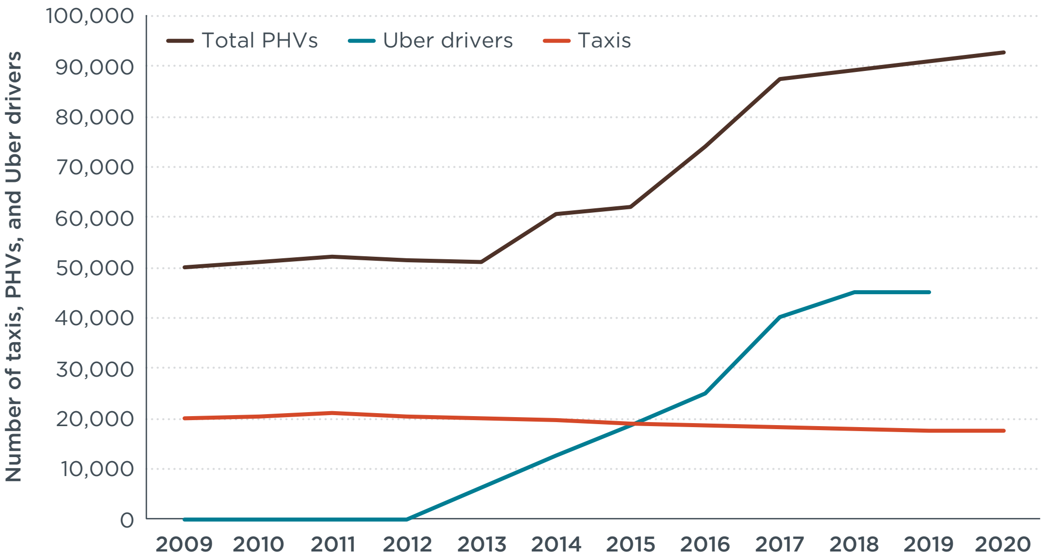

Figure 2. Evolution of the number of taxis, PHVs, and Uber drivers since 2009 in London.

One company—Uber—controls over 60% of the ride-hailing market in Europe and over 65% in the United States.[3] 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%.[4] 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.[5]

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 (CO_2) in London in 2017, for example.[6] 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 CO_2 emissions per passenger mile travelled and 7% lower passenger occupancy compared to the statewide passenger vehicle fleet average.[7] 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 CO_2 than the trips

3 Business of Apps. "Ride Hailing Taxi App Market [Sector Profile]," November 10, 2020. https://www.businessofapps.com/data/ride-hailing-app-market/.

4 "Uber Announces Results for Fourth Quarter and Full Year 2019," Uber Technologies, Inc., February 6, 2020, https://investor.uber.com/news-events/news/press-release-details/2020/Uber-Announces-Results-for-Fourth-Quarter-and-Full-Year-2019/.

5 "FT 1000: The Fourth Annual List of Europe's Fastest-Growing Companies," *Financial Times*, Accessed November 29, 2020. https://www.ft.com/content/691390ca-53d9-11ea-90ad-25e377c0ee1f.

6 Le Petit and Earl, "Europe's Giant 'taxi' Company: Is Uber Part of the Problem or the Solution?"

7 California Air Resources Board, "SB 1014 Clean Miles Standard 2018 Base-Year Emissions Inventory Report" (December 2019), https://ww2.arb.ca.gov/resources/documents/2018-base-year-emissions-inventory-report. California Air Resources Board.

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 CO_2 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 CO_2 per day, with lifetime CO_2 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

8 Don Anair, Jeremy Martin, Maria Cecilia Pinto de Moura, and Joshua Goldman, "Ride-Hailing's Climate Risks: Steering a Growing Industry toward a Clean Transportation Future" (Union of Concerned Scientists, February 25, 2020), https://www.ucsusa.org/resources/ride-hailing-climate-risks.

9 Yoann Le Petit and Lucien Mathieu, "Why Uber Should Go Electric" (Transport & Environment, June 2020), https://www.transportenvironment.org/publications/why-uber-should-go-electric.

10 Alan Jenn, "Emissions Benefits of Electric Vehicles in Uber and Lyft Ride-Hailing Services," *Nature Energy* 5 (June 29, 2020): 520–25, https://doi.org/10.1038/s41560-020-0632-7.

11 Andreas Knie and Lisa Ruhrort, "Ride-Pooling-Dienste und ihre Bedeutung für den Verkehr. Nachfragemuster und Nutzungsmotive am Beispiel von "CleverShuttle" (Ride-pooling services and their significance for transportation demand patterns and usage motivations based on the example of "CleverShuttle")" (Wissenschaftszentrum Berlin für Sozialforschung, April 2020), https://bibliothek.wzb.eu/pdf/2020/iii20-601.pdf.

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

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

13 Melissa Heikkilä, "EU Court Ruling Delivers Win for Uber, Ride-Hailing Apps," *Politico*, December 3, 2020, https://www.politico.eu/article/uber-europe-court-ruling-delivers-win-ride-hailing-apps/.

14 "Arrêt N°374 Du 4 Mars 2020 (19-13.316), Cour de Cassation, Chambre Sociale, Cour de Cassation," Accessed November 29, 2020, https://www.courdecassation.fr/jurisprudence_2/chambre_sociale_576/374_4_44522.html.

15 Matthew Niblett, "When Regulation Goes Wrong: Ride Hailing in Spain," *Inline Insights* (blog), Inline Policy, accessed November 29, 2020, https://www.inlinepolicy.com/blog/when-regulation-goes-wrong-ride-hailing-in-spain.

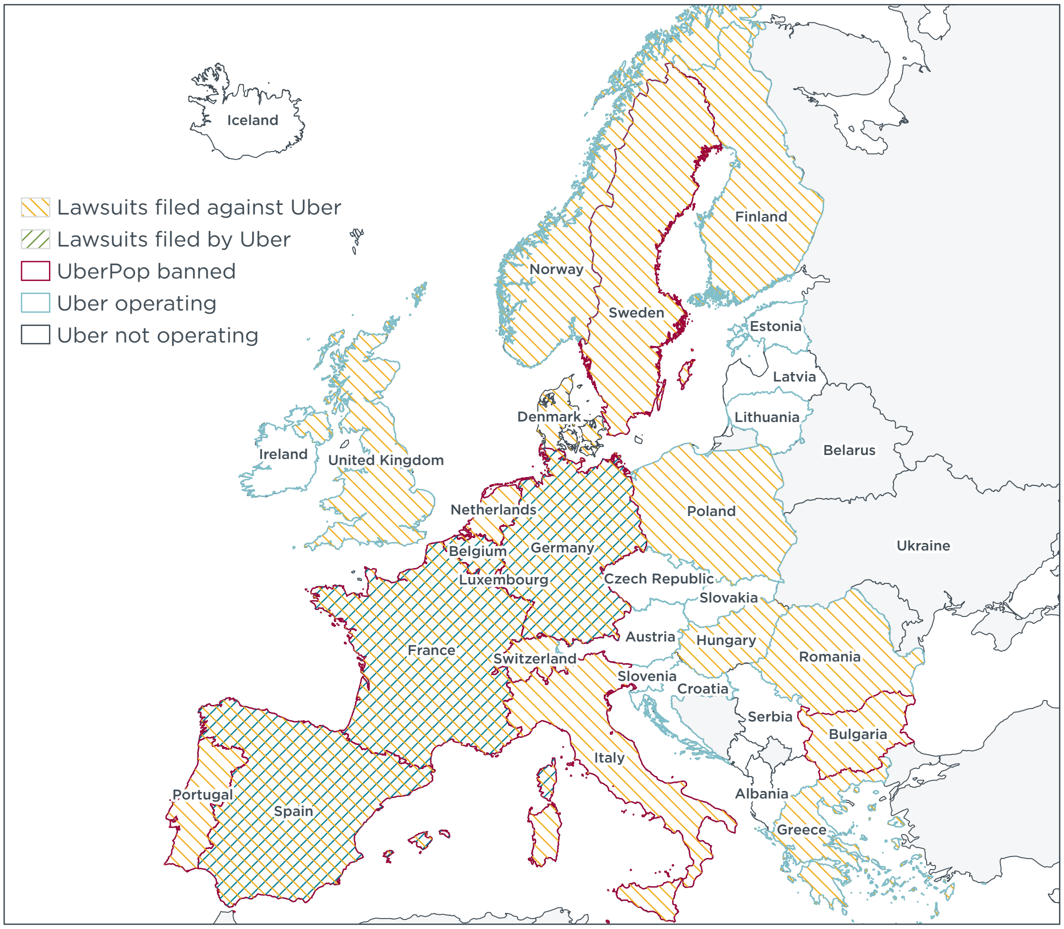

Figure 3. Map showing lawsuits filed by and against Uber and legal status of UberPop in part of Europe.

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.

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.[16] 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.[17] In London, an estimated 3% of the private hire vehicle fleet has already been electrified (including BEVs and PHEVs).[18] 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.[19]

Government phase-out requirements for fleets. While European cities and countries are increasingly setting targets for new internal combustion engine vehicles 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 CO_2/km–75 g CO_2/km, and have a Euro 6 emission standard) beginning in 2021; this requirement took effect in 2020 for vehicles less than 18 months old.[20] France has required that, by 2020, 10% of PHV and taxi fleets be low emission, emitting no more than 60g CO_2/km (effectively limited to electric and plug-in hybrid vehicles).[21] Shenzhen, China required ride-hailing fleets to be 100% electric by the end of 2020.[22]

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.[23] 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.[24]

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

16 Peter Slowik, Lina Fedirko, and Nic Lutsey, *Assessing Ride-Hailing Company Commitments to Electrification* (ICCT: Washington, DC, 2019), https://theicct.org/publications/ridehailing-electrification-commitment.

17 Damien Licata Caruso, "Les Applis de VTC Se Convertissent Peu à Peu Aux Véhicules Électriques," *Le Parisien*, February 5, 2020. https://www.leparisien.fr/high-tech/les-applis-de-vtc-se-convertissent-peu-a-peu-aux-vehicules-electriques-05-02-2020-8253327.php

18 Transport for London, "Licensing Information."

19 California Air Resources Board, "SB 1014 – 2018 Base-Year Emissions Inventory Report."

20 "Emissions standards for PHVs," Transport for London, 2020, https://tfl.gov.uk/info-for/taxis-and-private-hire/emissions-standards-for-phvs

21 LOI n° 2015-992 du 17 août 2015 relative à la transition énergétique pour la croissance verte (1), 2015-992 § (2015)

22 Dale Hall, Hongyang Cui, Marie Rajon Bernard, Shuyang Li, and Nic Lutsey, *Electric Vehicle Capitals: Cities Aim for All-Electric Mobility*, (ICCT: Washington, DC, 2020), https://theicct.org/publications/electric-vehicle-capitals-update-sept2020.

23 "Get a For-Hire-Vehicle License - TLC," NYC Taxi & Limousine Commission, 2019, https://www1.nyc.gov/site/tlc/vehicles/get-a-for-hire-vehicle-license.page.

24 "Clean Miles Standard," California Air Resources Board, accessed November 30, 2020, https://ww2.arb.ca.gov/our-work/programs/clean-miles-standard/about.

to be emission-free by 2025; in Oslo, the target year for full electrification is 2023, and in Bergen, 2024.[25] 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.[26] 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.[27] 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.[28] 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.[29] 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.

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/te/files/publications/2019_09_Briefing_LEZ-ZEZ_final.pdf.

27 C40, "C40 : Green and Healthy Streets," accessed July 20, 2020, https://www.c40.org/other/green-and-healthy-streets.

28 Sandra Wappelhorst, "The End of the Road? An Overview of Combustion-Engine Car Phase-out Announcements across Europe" (Washington, D.C.: International Council on Clean Transportation, May 10, 2020), https://theicct.org/publications/combustion-engine-car-phase-out-EU.

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.[30] 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.[31] In Europe, Free Now has pledged to electrify 50% of its fleet by 2025 and 100% of its fleet by 2030.[32] Free Now also claims to have the largest share of electric vehicles of any ride-hailing fleet in London and other major European cities.[33] Bolt, the third-largest European operator, has also promised to become entirely environmentally sustainable by 2030.[34]

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.[35] In order to accelerate the transition before this point, purchase incentives, tax reductions, or other benefits are needed to shift the economic calculus.[36] These incentives and their application are described in this section.

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30 "Nos Engagements Pour Une Mobilité Durable (Our commitments for sustainable mobility)," *Uber Blog*, September 8, 2020. https://www.uber.com/fr/blog/mobilite-durable/; "A Nossa Viagem Rumo à Mobilidade Sustentável (Our journey towards sustainable mobility)," *Uber Blog*, June 30, 2020 https://www.uber.com/pt/blog/o-nosso-compromisso-rumo-a-mobilidade-sustentavel/; "How the Clean Air Plan Works," *Uber Blog*, January 16, 2019. https://www.uber.com/en-GB/blog/clean-air/.

31 Lyft, "The Path to Zero Emissions: 100% Electric Vehicles by 2030," June 17, 2020, https://lyft-impact-assets.s3.amazonaws.com/images/path-to-zero-emissions.pdf.

32 "Sustainability," FREE NOW, accessed January 18, 2021, https://free-now.com/about-us/sustainability/.

33 "Merged ride-hailing firms FREE NOW and Kapten launch new offering through single app under FREE NOW brand," FREE NOW, July 16th 2020, https://free-now.com/fileadmin/Markets/Press/United_Kingdom/Merged_ride-hailing_firms_FREE_NOW_and_Kapten_launch_new_offering_through_single_app_under_FREE_NOW_brand.pdf

34 Invest in Estonia, "Bolt Invests over €10 Million to Reduce Its Carbon Footprint," September 17, 2019. https://investinestonia.com/bolt-invests-over-e10-million-to-reduce-its-carbon-footprint/.

35 Nic Lutsey and Michael Nicholas, *Update on Electric Vehicle Costs in the United States through 2030*, (ICCT: Washington, DC, 2019), https://theicct.org/publications/update-US-2030-electric-vehicle-cost.

36 Peter Slowik, Sandra Wappelhorst, and Nic Lutsey, *How Can Taxes and Fees on Ride-Hailing Fleets Steer Them to Electrify*, (ICCT: Washington, DC, 2019), https://theicct.org/publications/taxes-and-fees-electrify-ridehailing.

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

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

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, taxis 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

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?*

39 "Uber and EVgo Launch Partnership to Electrify On-Demand Rides and Accelerate Zero- Emission Transportation," EVgo, November 12, 2020, https://www.evgo.com/about/news/uber-and-evgo-launch-partnership-to-electrify-on-demand-rides-and-accelerate-zero-emission-transportation/."

40 ACEA, "Overview - Electric Vehicles: Tax Benefits & Purchase Incentives in the European Union," (2020), https://www.acea.be/publications/article/overview-of-incentives-for-buying-electric-vehicles.

41 Uber Germany, "Uber Green Starts in Berlin: Emission-Free Journeys Now Also in the Capital [Uber Green Startet in Berlin: Emissionsfreie Fahrten Ab Sofort Auch in Der Hauptstadt]," September 9, 2019, https://www.uber.com/de/newsroom/uber-green-berlin/.

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.[42] 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[43] and checked for consistency with available vehicle prices.[44] 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.[45] For London's congestion charge zone, we assume that ride-hailing drivers enter the congestion zone on 50% of working days.[46]

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

Input	London	Berlin	Madrid
Purchase incentive	£3,000 (€2,635)	€6,000	€4,000
Tax benefits for BEVs	Exempt from car purchase tax and annual taxes	Exempt from first year ownership tax	Exempt from purchase tax, 75% reduction in annual taxes
Congestion zone discounts	Exempt from £15/day congestion charge	-	-
Petrol price	£1.23/liter (€1.40/liter)	€1.41/liter	€1.34/liter
Home electricity price[a]	£0.18/kWh (€0.20/kWh)	€0.29/kWh	€0.18/kWh
DC fast charging price (Ionity network)[b]	£0.27/kWh (€0.30/kWh)	€0.32/kWh	€0.32/kWh

[a]Eurostat, "Electricity Prices for Household Consumers - Bi-Annual Data (from 2007 Onwards) [Nrg_pc_204]," accessed December 12, 2020, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_204&lang=en.

[b]Volkswagen, "We Charge: Volkswagen's New Charging Service Has over 150,000 Public Charging Points," accessed January 19, 2021, https://www.volkswagenag.com/en/news/2020/07/we-charge-volkswagens-new-charging-service-has-over-150-000-publ.html; Volkswager UK, "Charging Your Volkswagen Made Easy," accessed January 19, 2021, https://www.volkswagen.co.uk/electric/research/charging-and-range/we-charge.

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.[47] The value of the time spent charging is adjusted by city using the relative fare differences based on the Uber trip

42 Nikita Pavlenko, Peter Slowik, and Nic Lutsey, *When Does Electrifying Shared Mobility Make Economic Sense?* (ICCT, Washington, DC, 2019), https://theicct.org/publications/shared-mobility-economic-sense.

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

44 ADAC, "All about the Vehicle," n.d., https://www.adac.de/rund-ums-fahrzeug/autokatalog/marken-modelle/.

45 ACEA, "Overview - Electric Vehicles."

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

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

cost calculator,[48] assuming an average trip length of 10 km.[49] 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.

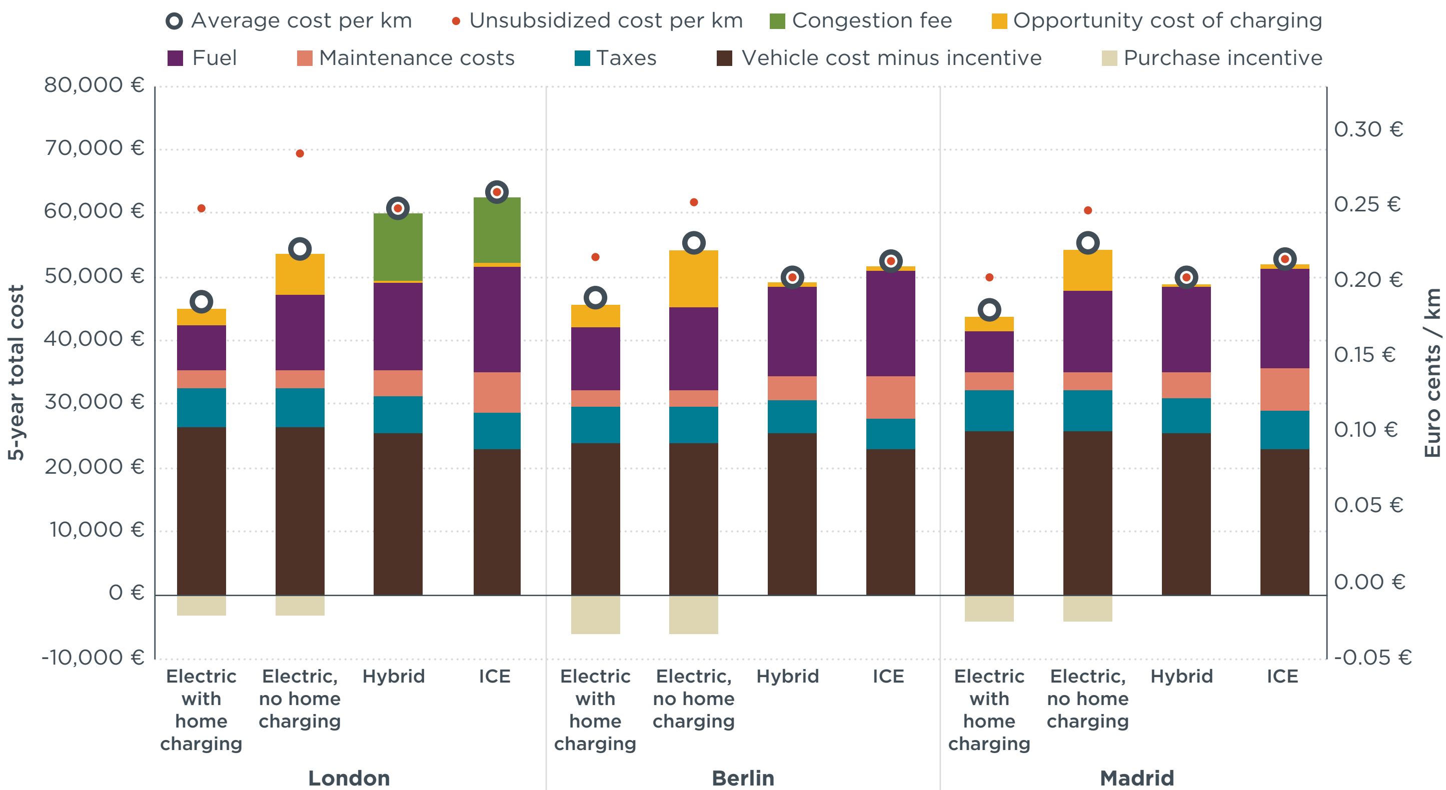

Figure 4. Comparison of 5-year TCO across vehicle technologies for full-time ride-hailing drivers in three cities in 2021 with current incentives and exemptions included.

48 Uber, "How Much Does a Ride with the Uber App Cost?," accessed January 12, 2021, https://www.uber.com/us/en/price-estimate/.

49 Department for Transport, United Kingdom, "Taxi and Private Hire Vehicle Statistics, England: 2018," accessed December 12, 2020, https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/751202/taxi-and-phv-england-2018.pdf.

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.

Incentive type	Incentive value to enable TCO parity for electric ride-hail vehicle[a]			Implementing stakeholder(s)				Real-world example of implementation
	London	Berlin	Madrid	City	National	Ride-hailing operator	Charging operator	
Zone charge (Congestion / low emission) with electric vehicles exempt	€13 per day	€18	€15	X				London: £15 (€16.50) per day exemption to enter central city
Per-trip tax/fee with electric vehicles exempt[b]	€0.47 - per trip (4% per trip)	€0.67 - per trip (4% per trip)	€0.56 - per trip (4% per trip)	X	X	X		San Francisco: 3.25% tax for combustion vehicle rides, 1.5% for zero-emission vehicles
Per-kilometer fee with electric vehicles exempt[c]	€0.05 per km	€0.07	€0.06	X	X	X		France: €0.03/km charge on all rides, which is used for driver EV rebates
Low-cost DC fast charger electricity	€0.10 per kWh	€0.03 per kWh	€0.08 per kWh			X	X	EVgo/Uber: 15%-25% (€0.04-€0.07) discount on DC fast charging rates in United States, monthly fees waived

[a] 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.

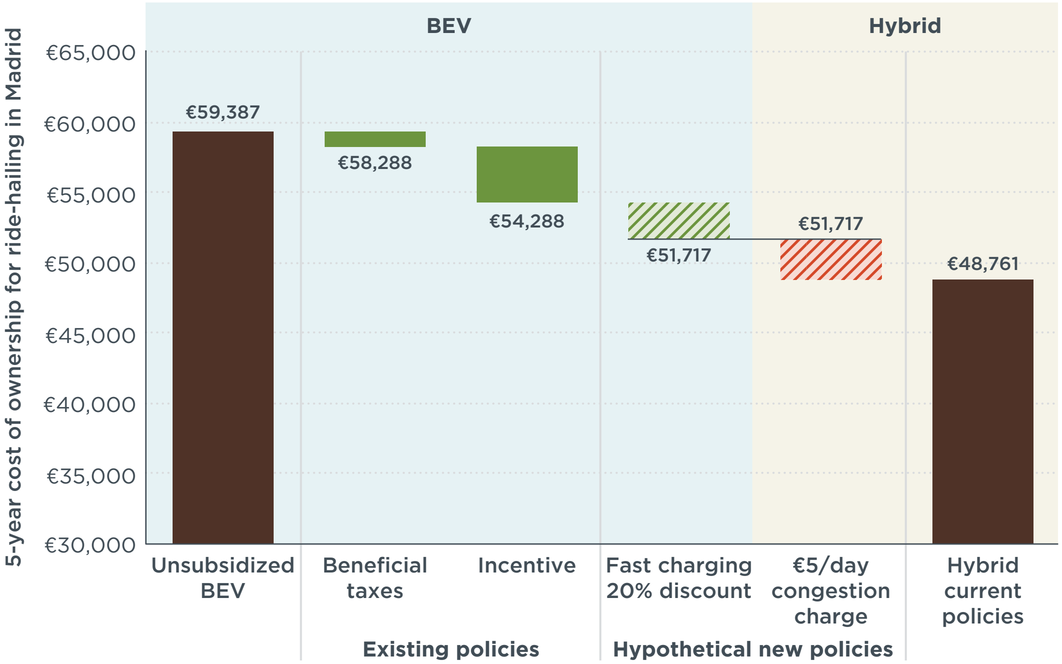

Figure 5. Illustration of how existing and hypothetical policies can enable TCO parity for BEVs with no home charging for in ride hailing in Madrid.

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.[50] 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.[51] 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

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

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

cost parity with conventional vehicles before the end of the decade without subsidies.[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.[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.[54] Assumptions have been changed to adapt to the European context and are shown in Table 3.

Table 3. Assumptions for ride hail vehicle infrastructure analysis.

Parameter	Value
Annual mileage for ride hailing	50,000 km
Charging power in 2021	45 kW
Charging power in 2025	80 kW
Share of drivers with home charging	20%
Percent of energy from fast charging when there is no home charging	100%
Percent of energy from fast charging when home charging is available	10%

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,

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/.

53 Richardson et al., "SPARK! Partnering to Electrify in Europe."

54 Michael Nicholas, Peter Slowik, and Nic Lutsey, *Charging Infrastructure Requirements to Support Electric Ride-Hailing in U.S. Cities*, (ICCT: Washington, DC, 2020), https://theicct.org/publications/charging-infrastructure-electric-ride-hailing-us-032020.

ride hail drivers with no home charging often fast charge late at night after they've finished for the day.[55] These patterns and opportunities to facilitate complimentary usage are further described in a related study.[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.

	Shared public charger			**Dedicated ride-hail charger**
Utilization threshold	**Low (4 hours public and ride-hailing combined)**	**Central (6 hours public and ride-hailing combined)**	**High (8 hours public and ride-hailing combined)**	**High (8 hours ride-hailing only)**
Ride-hail drivers supported per DC fast charger in 2021	7	11	18	25
Ride-hail drivers supported per DC fast charger in 2025	9	16	28	43

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.[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.

55 Jenn, "Emissions Benefits of Electric Vehicles in Uber and Lyft Ride-Hailing Services."

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

57 Michael Nicholas and Nic Lutsey, *Quantifying the Electric Vehicle Charging Infrastructure Gap in the United Kingdom*, (ICCT: Washington, DC, 2020), https://theicct.org/publications/charging-gap-UK-2020.

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

	Estimated public DC fast chargers	Ride-hail drivers served (20% have overnight charging)		
		Low utilization threshold	Central utilization threshold	High utilization threshold
London 2021	798	5,500	8,800	14,400
London 2025	1,381	12,400	22,100	38,700

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.

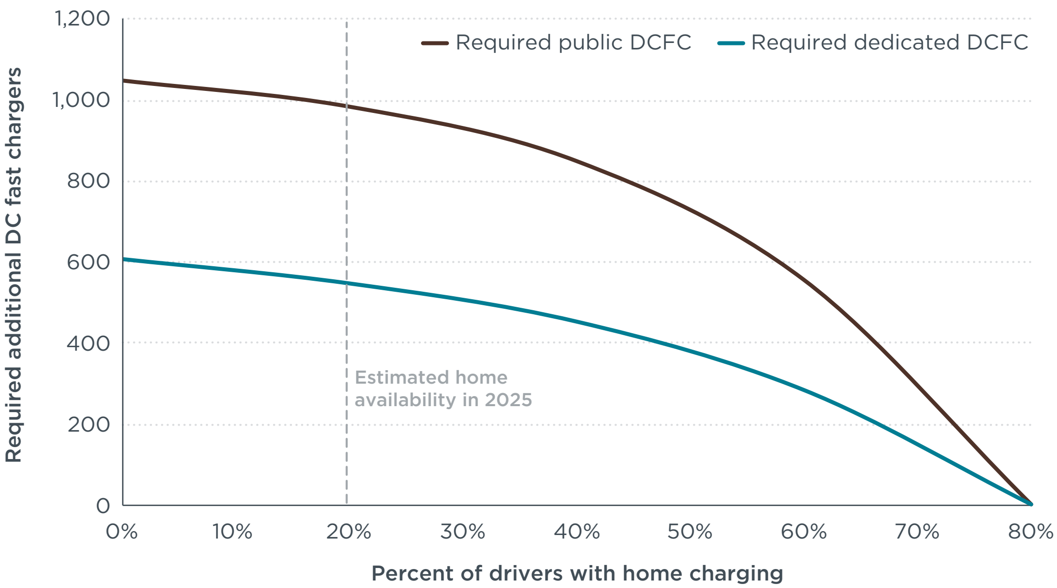

Figure 6. Ride-hail drivers supported by the current 2021 and projected 2025 London metropolitan region DC fast charger network as a function of overnight charging availability.

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.[58] 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.[59] 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.[60] 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.[61] 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.[62] 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,

58 "Les aides financières pour inciter à des mobilités propres (Financial aid to encourage clean mobility)," City of Paris, December 7, 2020, https://www.paris.fr/pages/lutte-contre-la-pollution-les-aides-a-la-mobilite-5373.

59 Sture Portvik, "The World's First Mass Market for Electric Vehicles – The Oslo Case Study," (Carbon Neutral Cities Alliance, 2019), https://carbonneutralcities.org/building-a-ubiquitous-electric-vehicle-charging-infrastucture/.

60 Richardson, Danda, Wilkes, Graves, and Decastro, "SPARK! Partnering to Electrify in Europe."

61 Robert van den Hoed et al., Emobility: *Getting Smart with Data*, (Amsterdam: Amsterdam University of Applied Sciences, June 2019), https://pure.hva.nl/ws/files/5796298/HvA_Emob_DIGI.pdf.

62 Marie Rajon Bernard and Dale Hall, *Efficient planning and implementation of public chargers: Lessons learned from European cities*, (ICCT: Washington DC, 2021), https://theicct.org/publications/European-cities-charging-infra-feb2021

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.

63 Richardson, Danda, Wilkes, Graves, and Decastro, "SPARK! Partnering to Electrify in Europe," Marie Rajon Bernard, Dale Hall, and Nic Lutsey, *Fulfilling Electric Vehicle Charging Infrastructure Needs in Greater London and Its Boroughs* (ICCT: Washington, DC, 2020), https://theicct.org/publications/London-ev-charging-nov2020.

64 Cenex. "Nottingham City Council - leading the way in greener technology." Accessed March 18, 2021, https://www.cenex-lcv.co.uk/news-media/press-releases/nottingham-city-council-leading-the-way-in-greener-technology.

65 "Embarquez Pour Le Green Summit! (Embark on the Green Summit!)" *Uber blog*, October 25, 2020. https://www.uber.com/fr/blog/green-summit/.

66 "Policy: Taxis." City of Amsterdam, accessed November 30, 2020, https://www.amsterdam.nl/en/policy/policy-traffic/policy-taxis/.

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.

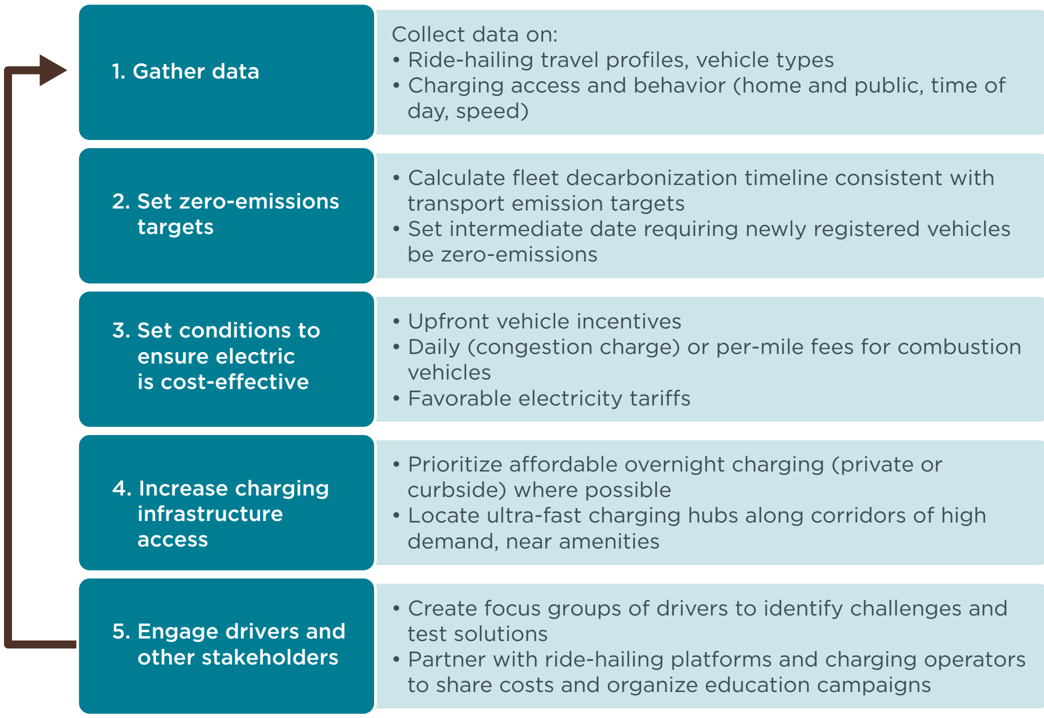

Figure 7. Key steps for city governments to electrify ride-hailing

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.[68] 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.

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

68 Simon Frazzini, Gabriele Grea, and Alessandro Zamboni, "Study on Passenger Transport by Taxi, Hire Car with Driver and Ridesharing in the EU" (European Comission, September 26, 2016), https://ec.europa.eu/transport/sites/transport/files/2016-09-26-pax-transport-taxi-hirecar-w-driver-ridesharing-final-report.pdf.