Electrifying the Ride-Sourcing Sector in California

ASSESSING THE OPPORTUNITY

California Public Utilities Commission
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April, 2018

Acknowledgements:

We wish to thank the following individuals who contributed to the development of this paper:

Michael Colvin, Senior Regulatory Analyst, Policy and Planning Division, California Public Utilities Commission (CPUC), provided substantive input.

Members of the CPUC's Internal Steering Committee for this research project provided input on the strategic direction and scope of this research project: Commissioner Liane M. Randolph; Commissioner Carla J. Peterman; Nick Zanjani, Director, Consumer Protection and Enforcement Division; Rachel Peterson, Chief of Staff to Commissioner Randolph; Edward Randolph, Director, Energy Division; Jennifer Kalafut, Chief of Staff to Commissioner Peterman; and Amy Mesrobian, Senior Analyst, Energy Division.

Members of the External Advisory Committee for this research project offered feedback on the scope, content, and structure of this paper: Mark Ferron, Former Commissioner, CPUC; Professor Susan Shaheen, University of California, Berkeley; Professor Dan Sperling, University of California, Davis; and Professor JR DeShazo, University of California, Los Angeles.

Diane Fellman and Kristin Ralff-Douglas, Senior Regulatory Analysts, Policy and Planning Division, CPUC; several other CPUC staff members; and staff at the California Air Resources Board reviewed earlier versions of this paper and provided substantive input and feedback.

In addition, this paper benefited from several conversations with key stakeholders, including Lyft and Uber, two of the major ride-sourcing companies operating in California. In order to eliminate errors, both companies reviewed their respective data, as presented in this paper, prior to publication.

A digital copy of this report can be found at: www.cpuc.ca.gov/ppd_work

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Glossary of Key Terms

BEV	Battery Electric Vehicle
CARB	California Air Resources Board
Chartering Party	A person, corporation, or other entity that prearranges with a transportation network company for transportation services.
DCFC	Direct Current Fast Charger
Deadhead miles	The sum of Period 1 VMT and Period 2 VMT.
EV/ZEV	Electric vehicle/zero emission vehicle. For the purposes of this paper, "EV" or "ZEV" includes 1) plug-in electric vehicles (PEVs), which include both pure battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), and 2) fuel cell electric vehicles (FCEVs)[1]. Given the very small number of FCEVs currently in use in California, the discussion in this paper is focused on PEVs.
eVMT	Electric vehicle miles traveled
FCEV	Fuel cell electric vehicle
GGRF	Greenhouse Gas Reduction Fund. GGRF is funded by state proceeds from California's cap and trade auctions. The California Legislature and Governor appropriate cap and trade auction proceeds from the fund to state agencies and programs through the budget process.[2]
ICE vehicle	Internal combustion engine vehicle. ICE vehicles are usually powered by fuels such as gasoline or diesel.
PHEV	Plug-in hybrid electric vehicle. PHEVs have a battery and an electric motor as well as an internal combustion engine.
Period 1 VMT	Miles driven by a TNC driver with the online-enabled TNC application (app) on, while waiting to be matched with a passenger.
Period 2 VMT	Miles driven by a TNC driver from their location to the passenger's location to pick up the passenger, after they have been matched through the TNC platform.
PEV	Plug-in electric vehicle, which includes both pure battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
SULEV	Super Ultra Low Emission Vehicle. This is one of California's six vehicle emissions ratings. SULEVs are 90 percent cleaner than the average new model year vehicle.[3]
TCO	Total costs of ownership. In the context of this paper, TCO refers to the total costs of acquiring, operating, and maintaining a vehicle in the course of its lifetime.
TCP	Charter-party carrier (e.g., limousines, airport shuttles, tour buses). TCPs charter vehicles, on a prearranged basis, for the exclusive use of an individual or group, and are regulated by the CPUC.
TNC	Transportation network company, defined as "an organization whether a corporation, partnership, sole proprietor, or other form, operating in California that provides prearranged transportation services for compensation using an

	online-enabled application (app) or platform to connect passengers with drivers using their personal vehicles."[4] Lyft and Uber are two examples. TNCs are commonly referred to as ride-sourcing companies.
ULEV	Ultra Low Emission Vehicle. This is one of California's six vehicle emissions ratings. ULEVs are 50 percent cleaner than the average new model year vehicle.[5]
VMT	Vehicle miles traveled

1 Introduction, Scope & Problem Motivation

1.1 Introduction

The emergence of on-demand transportation services offered through digital platforms has transformed the urban mobility landscape, raising complex questions about the implications for the future of transportation.

In 2013, the California Public Utilities Commission (CPUC) created rules and regulations applicable to companies offering these services – referred to as transportation network companies (TNCs) – in order to ensure public safety and customer protection. The rapid growth of the TNC sector raises new questions around its environmental impacts. This paper offers qualitative and quantitative data and analysis to allow the California Public Utilities Commission (CPUC) to address the following questions:

> **Is there a need for the CPUC to initiate regulatory changes by exercising its jurisdiction over TNCs in order to reduce greenhouse gas (GHG) emissions through increased use of electric vehicles (EVs)[6] in the TNC sector? If so, what types of regulatory tools might the CPUC consider?**

We use the definition of TNC set out in the California Public Utilities Code, i.e., a company that provides prearranged transportation services for compensation using an online-enabled application or platform to connect passengers with drivers using a personal vehicle.[7]

1.2 Objective, Scope and Limitations

Objective: The objective of this research paper is to (1) serve as a useful starting point for the CPUC to assess the opportunity for GHG emissions reduction in the TNC sector through increased use of EVs, (2) offer a framework for comparison of available regulatory options, and (3) identify key questions for the CPUC to consider, should it choose to initiate regulatory changes.

We consider the potential for increasing the use of EVs on TNC platforms through the lens of electric vehicle miles travelled (eVMT) as a percentage of total vehicle miles traveled (VMT). Whilst total GHG emissions is the ideal metric in considering the sector's overall environmental impact, it is too broad a metric to gauge the extent of EV deployment and use in the sector, which is the subject of this paper.

Scope Limitations: This paper does not consider solutions that involve energy utility ratepayer funds or the exercise of the CPUC's jurisdiction over investor-owned electric utilities. There are certain other avenues for inquiry that are beyond the scope of this paper but constitute key questions for future research.[8] The impact of TNCs on congestion[9], and the distributional effects of TNC operations[10] are two such critically important questions that are in the early stages of being considered by researchers, and merit significantly more research and analysis.

Data sources and Limitations: In addition to qualitative and quantitative information shared by Lyft and Uber, both in response to data requests, and in various follow-up meetings, this paper draws on discussions with several industry experts, market participants, state and local agencies, and other stakeholders, and on existing literature. Additional information was gathered from a focus group meeting with EV drivers on the Uber platform, organized by Uber in San Francisco on January 25, 2018, in which the CPUC participated.

To date, the CPUC has issued TNC permits to 14 companies.[11] However, the market is dominated by two major players – Lyft and Uber. Other competitors do not operate at a comparable scale. Only data relating to the operations of Lyft and Uber in California has been considered in this paper. The companies characterized data shared with the CPUC for this research project as their best estimates. Although calculation methodologies were discussed at length with both companies to eliminate differences, there may be some methodological differences in how the two companies derived these estimates that could not be identified.

Certain data gaps limited the nature and extent of analysis that could be performed as part of this research project. For instance, the lack of CPUC access to reliable data on emissions from other segments of the transportation sector, such as taxis, limited the extent to which a comparative analysis could be performed. The CPUC does not have regulatory authority over the taxi industry, which is regulated at the local level by cities and counties in California.

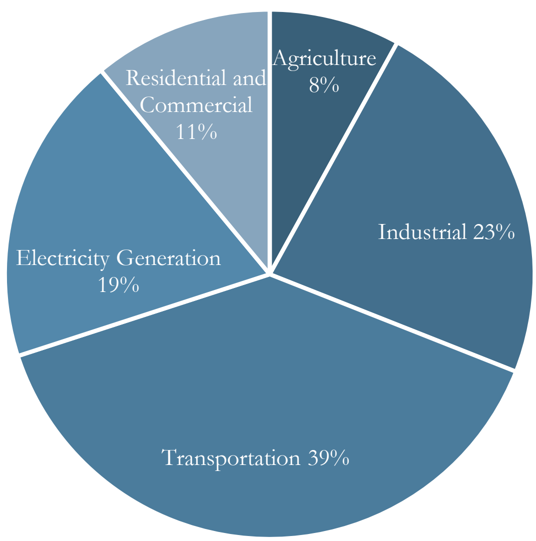
Finally, the overall impact of TNC operations on VMT in California remains ambiguous. To identify these impacts in a rigorous way, we need reliable data on how TNC passengers would have traveled if they had no access to TNC services (e.g., driving alone in a personal vehicle, using public transit, or active modes of travel such as biking), which is not currently available. The analysis presented in this paper must be considered keeping this context in mind.

1.3 Problem Motivation

1.3.1 Why consider GHG emissions from the TNC sector

The transportation sector has historically been the largest source of GHG emissions in California. In 2015, it accounted for approximately 39 percent of the state's overall GHG emissions.[12] While aggregate statewide emissions fell between 2014 and 2015, transportation sector GHG emissions increased by close to 3 percent (see Figure 1).[13]

Figure 1: California's 2015 GHG Emissions By Sector (Total Emissions: 440.4 $MMTCO_{2E}$)[14]



In order to significantly reduce emissions from the transportation sector, focusing on the light duty vehicles segment is critically important. In 2015, light duty vehicles, including passenger cars, motorcycles, and light duty trucks, accounted for about 69 percent of transportation sector GHG emissions.[15] Emissions from this segment increased by 4.44 percent from 2014-15.

Passenger car emissions accounted for approximately half of the total emissions from the light duty vehicles segment in 2015, and registered an increase of approximately 5.6 percent from 2014-15. Nineteen percent of transportation sector emissions came from on-road heavy-duty trucks, and the remaining 12 percent came from other sources (e.g., ships, boats, off-road vehicles).[16]

Relative to other categories of commercial use passenger vehicles regulated by the CPUC, the TNC sector is the largest and fastest growing, representing the biggest opportunity to reduce transportation sector GHG emissions through CPUC intervention.[17] TNC sector growth trends are addressed in Section 2.

Other segments of the transportation sector do, of course, present opportunities for emissions reduction. However, the CPUC's regulatory authority does not extend to all these segments. As previously noted, taxis fall outside CPUC jurisdiction (see Box 1)[18]. Similarly, the CPUC lacks the authority to directly regulate privately owned vehicles that do not fall within the definition of TNCs or charter-party carriers (TCPs). It may issue regulations that impact electrification of the transportation sector as a whole by exercising its jurisdiction over electric utilities. However, these aspects, as noted earlier, are being considered by the CPUC in an ongoing Rulemaking proceeding, and are therefore not discussed in this paper.

BOX 1: Taxis & TNCs – Differences Explained

Under California law, a TCP/TNC may not operate or advertise itself as a taxi service. Taxis are licensed and regulated by cities and counties, while TCPs/TNCs are regulated by the CPUC, subject to the California Public Utilities Code and CPUC regulations. The most important operational difference is that while TCP/TNC transportation must be "prearranged," no such requirement applies to taxis. In the case of TNCs, this pre-arrangement is done through a ride request submitted through the TNC platform. Taxis may provide transportation "at the curb," i.e. a customer may "arrange" taxi transportation by simply hailing a taxi from the sidewalk.

1.3.2 Why consider the potential for electrification to reduce TNC sector GHG emissions

There are two primary ways in which TNC sector emissions can be reduced:

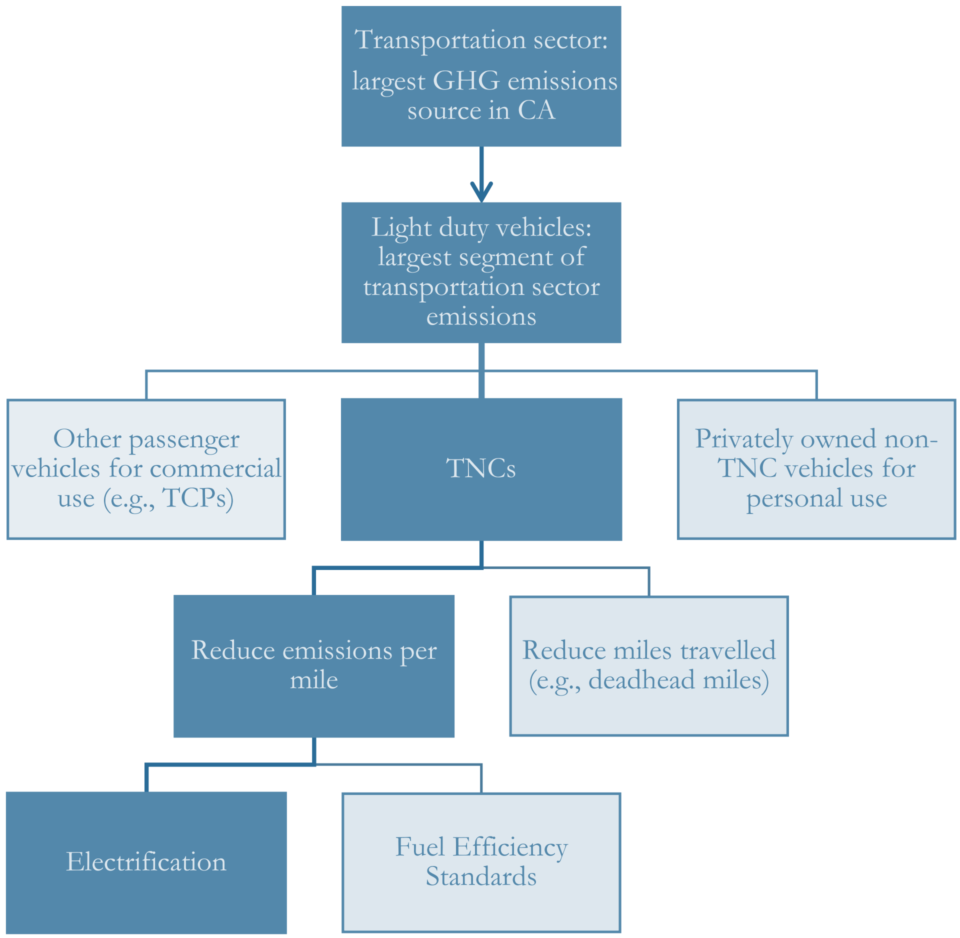
1. Reducing total miles traveled (e.g., by reducing deadhead miles or increasing use of pooled services such that it reduces total VMT); and

2. Reducing emissions per mile (e.g., by prescribing fuel efficiency standards for TNC vehicles or increasing the use of EVs on TNC platforms).

Increasing dispatch efficiency (i.e., optimally matching drivers and passengers) is a priority for TNCs because every deadhead mile represents a lost revenue generation opportunity. Deadhead miles can – to some extent – be expected to decrease organically over time as TNCs continue to improve their dispatch algorithms, and the density of TNC vehicles increases as TNC operations continue to grow.

TNC emissions per mile may be reduced by prescribing fuel efficiency standards for TNC vehicles.[19] This paper focuses on the potential to reduce TNC sector emissions through increased EV use, consistent with California's statutory framework, which is increasingly focused on reducing transportation sector GHG emissions through electrification. Figure 2 is a graphical representation of the motivation for this study.[20]

Figure 2: Why Consider TNC Sector Electrification



1.4 Background on EVs and TNCs

1.4.1 Regulatory Framework applicable to the TNC sector

In 2013, the CPUC created a regulatory framework for the TNC sector through its rulemaking process,[21] with the objective of ensuring public safety and protecting customers while encouraging the entry of new players. Under the existing regulatory framework, TNCs are required to comply with several requirements, e.g., each TNC must obtain a permit from the CPUC prior to commencing operations, establish a driver training program, comply with annual reporting requirements, and require insurance coverage as specified by the CPUC.

The CPUC clarified and expanded on these issues in a Decision (D.16-04-041) issued in 2016 as part of Phase II of this Rulemaking proceeding.[22] Phase III of the proceeding is underway.

1.4.2 An introduction to the EV market

There are two types of PEVs – pure battery electric vehicles (BEVs), and plug-in hybrid vehicles (PHEVs). BEVs run entirely on electricity stored in batteries and have an electric motor rather than a gasoline engine. PHEVs combine an electric motor that is powered by rechargeable batteries, and an internal combustion engine that can be refueled with gasoline.[23] BEVs have zero tailpipe emissions– the only emissions are associated with the generation of electricity used to charge the battery. Emissions from PHEVs depend on the electricity to gasoline ratio used. Like BEVs, fuel cell electric vehicles (FCEVs) use electricity to power an electric motor. Unlike PEVs, FCEVs produce electricity using a fuel cell powered by hydrogen, rather than drawing electricity from a battery.[24] While the TNC data presented in this paper incorporates data on FCEVs, the discussion in this paper is focused on PEVs given the very small number of FCEVs currently in use.

Level 1, Level 2 and DC Fast Charging (DCFC) are the most widely deployed classes of EV chargers. In broad terms, this classification pertains to the charger's power level, and reflects charging speed. The use of higher charging levels can significantly reduce charging time. Level 1 chargers are used in a residential setting, and Level 2 chargers are used in both residential and commercial settings. Due to the higher power requirements, DCFC stations are only suited to commercial settings. Charging speeds are increasing as EV charging technology continues to become more sophisticated.

In 2012, the Governor of California issued Executive Order B-16-2012[25], setting a goal of having 1.5 million ZEVs in California by 2025. The 2016 ZEV Action Plan outlined new actions to be taken by state agencies in order to achieve this goal. In January 2018, the Governor issued Executive Order B-48-18, setting a target of 5 million ZEVs in California by 2030, and launched an eight-year initiative to accelerate ZEV sales through a $2.5 billion package of vehicle rebates and infrastructure investments.[26]

Spurred by supportive state and federal policies, there has been a surge in the California EV market over the last few years. More than 350,000 EVs are in use in California, representing roughly half the EVs sold across the country.[27] In the first quarter of 2017, 4.8 percent of new vehicles registered in California were EVs, the highest share ever recorded.[28] Significant investments in EV infrastructure have been made in California. More than 10,000 Level 2 and 1,500 DCFC connectors have been deployed across the state. [29] More than 40 EV models are currently available in California.[30] Car manufacturers have announced the release of more than 70 new models over the next five years.[31] Several new long range EVs are in the launch pipeline. Many leading automakers – including Jaguar, Volvo, and General Motors (GM) – have announced that they will no longer manufacture new vehicle models powered solely by internal combustion engines.[32]

However, barriers to accelerated deployment of EVs remain. These issues, pertaining to the EV market as a whole, are being considered by the CPUC[33] and other state agencies. This paper discusses barriers relating to EV acquisition and use in the specific context of the TNC sector (Section 3).

2 State of the TNC Industry in California

This section analyzes trends in the California TNC sector relating to trip miles, deadhead miles, and use of pooled services, based on data provided by Lyft and Uber in response to a data request from the CPUC.[34]

We use the following definitions of trip miles, deadhead miles, and total miles in this paper.

- Trip miles are defined as the miles traveled by a TNC driver with a passenger in the vehicle, from the passenger pick-up point to the passenger drop-off point.
- Deadhead miles are defined as the sum of miles driven by a TNC driver with the TNC app on, while waiting to be matched with a passenger (Period 1 VMT), and miles driven by the TNC driver from their location to the passenger's location to pick up the passenger, after the match has been made (Period 2 VMT).[35] In other words, deadhead miles capture non-revenue generating TNC VMT, over and above trip miles. We define deadhead miles to include Period 1 miles in order to capture VMT by TNC drivers who travel from their residences into dense metropolitan areas with high demand for TNC services in search of passengers.[36] Period 2 miles are a function of TNCs' dispatch efficiency, which, as noted earlier, can be expected to improve over time. Both TNCs reported that there are several computational challenges associated with calculating deadhead miles – these are discussed in Section 2.2.
- Total miles are defined as the sum of trip miles and deadhead miles.

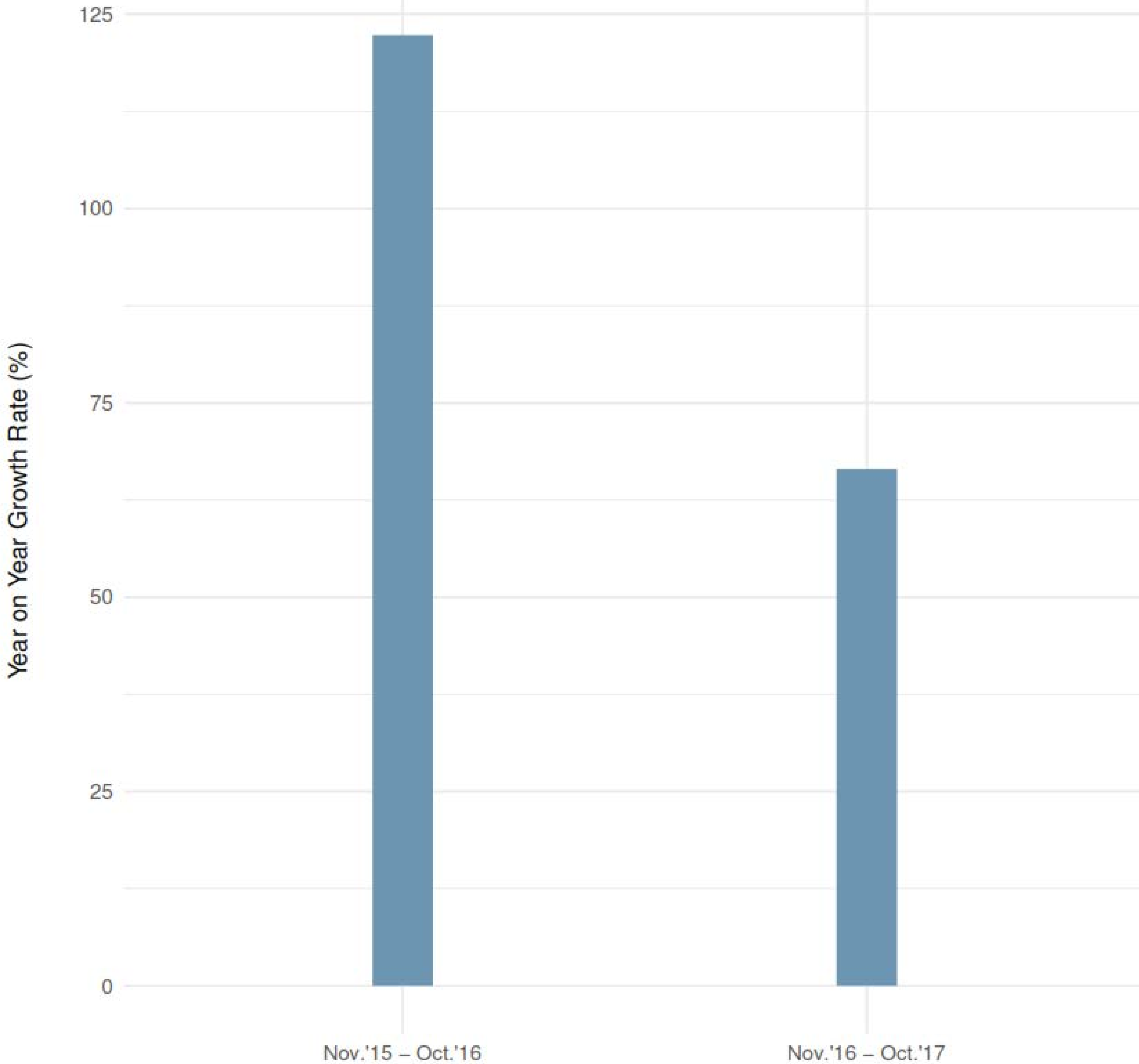
Data was requested for the period from September 1, 2014, through October 31, 2017. Lyft only submitted data relating to EV use on their platform for the period from July 1, 2016 onwards as it did not regularly track this data before then. Both TNCs provided data on deadhead miles only for the period from July 1, 2016, through October 31, 2017.

For each of the parameters considered – trip miles, deadhead miles, and use of pooled services – we offer a snapshot of key statistics for October 2017, which is the latest month for which we have TNC data. We consider the latest monthly data for these parameters, rather than annual data for 2017, as it provides us with the most recent picture of a rapidly growing industry.

2.1 Size of the TNC Sector and Growth Trends

The TNC industry has grown rapidly over the last few years, as demonstrated by Figure 3 below, which shows year-on-year growth in aggregate trip miles traveled on the Lyft and Uber platforms between November 2015 - October 2016 and November 2016 - October 2017.

Figure 3: Year on Year Growth Rate in Aggregate Trip Miles Traveled on Lyft and Uber Platforms in California (Nov. '15 – Oct. '16 & Nov. '16 – Oct. '17)



Total vehicle miles traveled on the California state highway system in October 2017 amounted to 17.22 billion miles.[37] Based on data provided by Lyft and Uber, total VMT on the two TNC platforms in California in October 2017 amounted to approximately 2 percent of that figure. As a point of reference, the California Air Resources Board (CARB) has determined that across the state's transportation sector, VMT reductions of 7 percent below projected VMT levels in 2030 are needed to meet statewide emission reduction targets.[38]

A back of the envelope calculation (see Appendix D) shows that the overall CO_2 emissions associated with TNC operations for the 12-month period between November 2016 – October 2017 is 0.918M metric tons of CO_2. This is equivalent to the annual energy use of approximately 100,000 households, and represents about 0.54 percent of California's transportation sector emissions in 2015 (the most recent year for which data on transportation sector GHG emissions is available), and about 0.8 percent of emissions from the state's light duty vehicles segment in 2015. More granular data is needed to develop a more precise estimate of the emissions footprint of the TNC sector.

While some plateauing of growth rates is inevitable, if TNCs continue to grow at a steady rate, all else being equal, the sector's GHG emissions footprint is likely to significantly expand in the coming years.

A comparison with other segments of the transportation sector (e.g., TCPs, taxis) is needed to derive an understanding of the relative size of the TNC sector's emissions footprint. However, we did not have access to the data needed to perform a robust comparative analysis. The CPUC does not collect data on VMT for the TCP sector, and we were unable to obtain VMT data for taxis, which are regulated by cities and counties in California.

This leads us to a fundamental question about the net impact of TNC operations on total VMT in California – all else being equal, is the TNC sector increasing total VMT in the state? The answer to this question depends on how TNC users might have traveled if they had no access to TNC services. TNCs compete with public transit, taxis, personal vehicles, and more active modes of transport such as walking and biking. The extent of mode-shifting, and the net effect of TNC use on total VMT is difficult to assess, as it is difficult to accurately capture the counterfactual for a TNC ride. Would the passenger have driven a personal vehicle, used a taxi or public transit or car share, or would they have biked or walked to their destination, or not made the trip at all?[39]

Some studies suggest that TNC operations likely contribute to a net increase in VMT. For instance, a 2017 University of California, Davis (UC Davis) study, which considered seven major metropolitan areas (Boston, Chicago, Los Angeles, New York, the San Francisco Bay Area, Seattle, and Washington, D.C.), found that, on average, TNC use is associated with a net 6 percent reduction in overall public transit use in these cities.[40] The substitutive/complementary nature of TNC services relative to public transit was found to vary significantly depending on the type of public transit service in question. The study found that TNC operations were associated with decreased use of bus services (6 percent net reduction) and light rail services (3 percent net reduction), and increased use of commuter rail services (3 percent net increase). The authors concluded that 49 percent to 61 percent of TNC trips would not have been made at all, or would have been made by walking, biking, or public transit, and that TNC use is likely to contribute to growth in VMT in the cities studied.

However, other studies have concluded that TNC use complements public transit use, and that it is more likely to substitute for automobile trips than public transit travel.[41] For instance, one study found that after Lyft and Uber suspended operations in the city of Austin in 2016, following a regulatory change[42], 42 percent of their users reported turning to other TNCs for trips similar to those that they made using Lyft or Uber prior to the suspension. Forty-one percent reported transitioning to a personal vehicle for such trips. Only 3 percent turned to public transit. The authors note that because this study is based on a convenience sample (i.e., a sample which is not representative of the population studied), the conclusions should not be generalized to the overall population of TNC riders in Austin.[43]

The divergent conclusions reached by these studies suggest that the impact of TNC operations on VMT (additive or subtractive) may vary depending on the specifics of the local context.[44] For instance, the impact of TNC operations on total VMT may differ by region depending on the availability of robust public transit options. In cities with a dense public transit system, such as New York, TNC users may be more likely to have walked or used public transit if they had no access to TNC services. In cities without a robust public transit system, TNC rides are more likely to have substituted rides in personal vehicles. [45]

The UC Davis study employs a representative sampling approach, designed to create a sample that is representative of urban and suburban populations in the regions studied, making its conclusions more authoritative than those of other studies, which have generally relied on convenience samples. There is, however, no study to date that has identified a causal relationship between the use of TNC services and components of travel behavior such as VMT and multimodality.[46] Further data and analysis is needed to fully understand the net impact of TNC services on VMT in California.[47]

Finally, although the overall impacts of TNC operations on total VMT in California are not fully clear, TNC deadhead miles, discussed in further detail below, are likely to be incremental miles. With the exception of taxis, none of the modes of transportation that TNCs compete with are known to generate comparable levels of deadhead miles.

2.2 Deadhead miles generated by TNC operations

Key summary statistics relating to TNC sector deadhead miles for October 2017 are presented in Table 1 below.

Table 1: Summary Statistics on Deadhead Miles Driven on Lyft and Uber Platforms in California (Oct. 1-31, 2017)

Aggregate deadhead miles	134.64 M
Deadhead miles as a percentage of trip miles traveled	64.8%
Deadhead miles as a percentage of total miles traveled	39.33%

For the two TNCs combined, deadhead miles constituted close to 65 percent of total trip miles, i.e., more than one deadhead mile was generated for every two trip miles. For the sector as a whole, deadhead miles were roughly 40 percent of total VMT. The San Francisco County Transportation Authority reports the same figure for the San Francisco taxi industry.[48] In contrast, a 2016 National Bureau of Economic Research working paper found that the percentage of non-revenue generating miles driven by a sample of taxi drivers in Los Angeles and Seattle exceeded corresponding figures for a sample of Uber drivers in the two cities. [49] This suggests that deadhead miles for the TNC/taxi industries may vary depending on the local context. We were unable to access taxi data needed to perform such a comparative analysis at the state level.

Both Lyft and Uber report that there are significant computational challenges associated with estimating deadhead miles, and that estimates of Period 1 miles may be exaggerated. Drivers may have multiple TNC apps open at the same time such that trip miles travelled on one TNC platform may be recorded as deadhead miles on another. Similarly, miles traveled by a driver with more than one TNC app open, while waiting to be dispatched by one of the TNCs, would be recorded as Period 1 miles on multiple apps. Miles driven by TNC drivers, with a TNC app open, during their commute/while running personal errands are also recorded as Period 1 VMT. These factors need to be taken into account in considering the data presented in Table 1.

In sum, TNC deadhead miles are generally likely to be incremental miles, but it is challenging to precisely measure the extent of deadheading by TNC drivers.

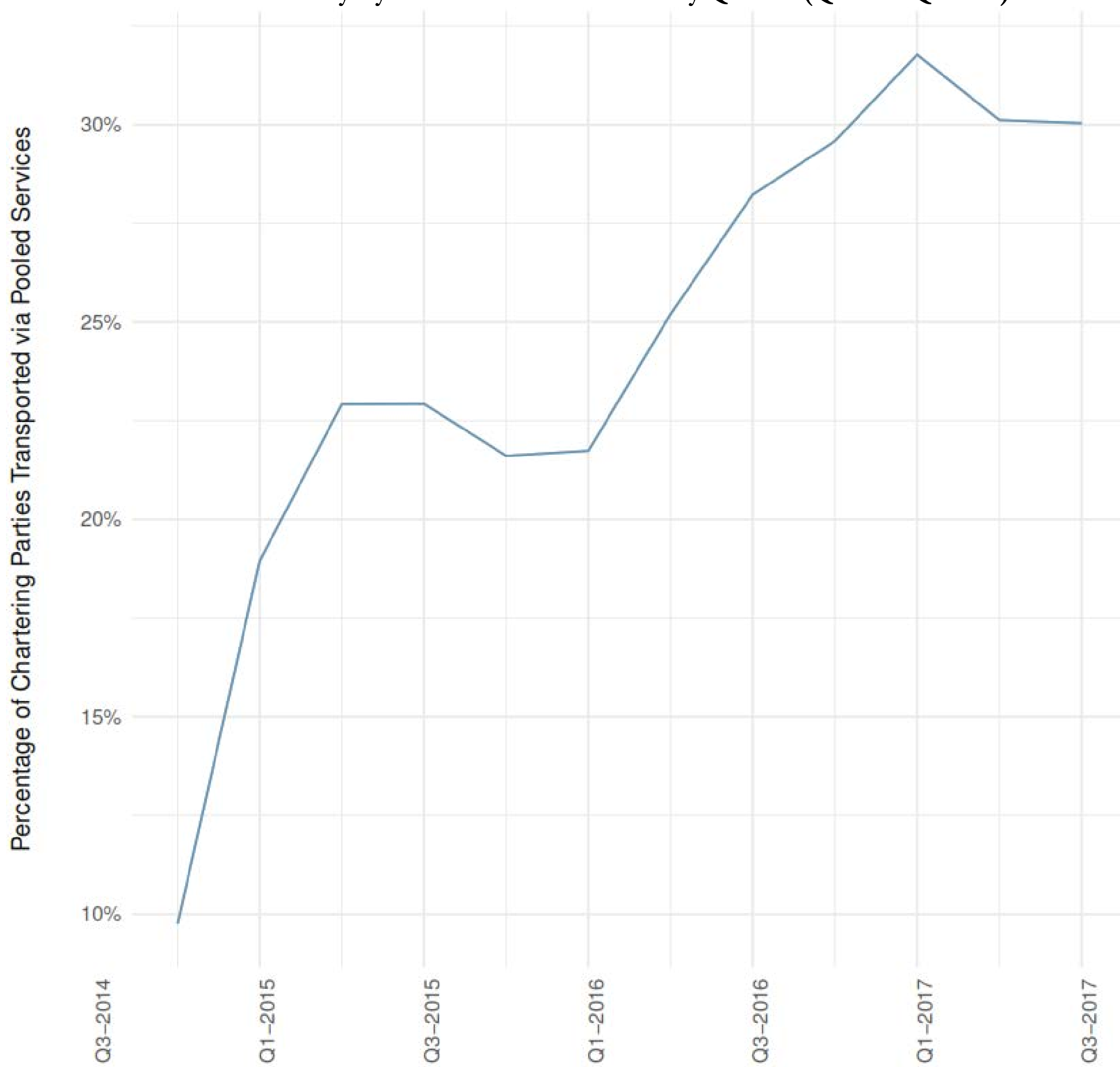
2.3 Pooled services offered by TNCs

TNCs have consistently presented their vision for the future as being shared, autonomous and electric, with the stated goal of reducing emissions from the transportation sector.[50] Both Lyft and Uber offer pooled services (Lyft Line and uberPOOL) through which passengers pay a reduced trip fare for sharing their ride, or segments of it, with other passengers traveling in the same general direction. Both companies recently launched versions of a new shared transportation service – Lyft Shuttle[51] and uberPOOL Express[52] – that picks up and drops off passengers at designated locations. Unlike Lyft Line/uberPOOL users, Lyft Shuttle/uberPOOL Express users may need to walk to their nearest pick-up location to access a ride, or from their drop-off location to their destination. Lyft and Uber have both advertised this new service as being their most affordable offering.[53] Lyft and Uber also have a fare-splitting feature, which allows customers to split the fare for a ride with passengers traveling along with them from their pick-up point to the same destination. We did not consider rides for which passengers shared the fare using the fare-splitting feature as pooled rides.

It is important to note that TNCs do not collect data on load factor (i.e., the number of passengers transported in a given ride) for non-pooled rides, which constitute the bulk of TNC rides. For each such ride, only the chartering party, i.e., the passenger who requested the ride using the TNC app, is recorded as a passenger. Therefore, the passenger count recorded by TNCs is an underestimate.[54] It is important to keep this in mind in considering data on the use of TNCs' pooling services presented in this paper. There is a strong case for collection of load factor data by TNCs for all rides, as this data would help create a fuller picture of the sector's GHG emissions profile.

In October 2017, 31.7 percent of the chartering parties recorded by Lyft and Uber used a pooled service (i.e., Lyft Line, Lyft Shuttle, uberPOOL, and uberPOOL Express). Figure 4 reflects growth in the use of pooled services on TNC platforms.

Figure 4: Chartering Parties Transported via Pooled Services as a Percentage of All Chartering Parties Recorded by Lyft and Uber in California by Quarter (Q3 2014-Q3 2017)



We consider total chartering parties transported via pooled rides as a percentage of all chartering parties recorded by TNCs (rather than pooled rides as a percentage of all TNC rides) to gauge the extent of pooling on TNC platforms. The number of pooled rides recorded by TNCs may not always be a true measure of the extent of pooling on TNC platforms – there may be cases in which a TNC customer who requests a pooled ride is not matched with other passengers, so that their ride is effectively a non-pooled ride.

A 2017 report filed by Uber with the CPUC states that over the first half of 2016, approximately 11 million vehicle miles were avoided by passengers who opted for pooled rides instead of traveling singly on the Uber platform. However, pooled trips may not always reduce total VMT. If the "detour miles" driven between passenger pick-up and drop-off points exceed VMT saved through pooling, pooled trips could potentially increase total VMT.

Broadening the appeal of pooling can be challenging. Passengers must be willing to share their ride, and dispatch algorithms must match passengers efficiently and minimize passenger and driver inconvenience.[55] TNCs will need to address these challenges in order to increase the uptake of pooled services on their platforms.

3 Use of EVs on TNC Platforms – Key Trends, Barriers & TNC Initiatives

Certain attributes of EVs make them particularly well suited for use on TNC platforms. BEVs can be expected to have lower maintenance costs than ICE vehicles as they have significantly fewer moving parts.[56] Maintenance costs can be significant for ICE vehicles with heavy duty cycles.[57]

While charging costs can vary significantly depending on factors such as the type and time of charging, EVs have been found to generally have lower fuel costs than ICE vehicles when residential electricity rates are considered.[58] Fuel costs could be even lower for EVs that are charged at night as most utilities offer cheaper electricity rates at night.[59]

A recent study based on 2017 data found that in California, BEV fuel costs could be less than half as much as for ICE vehicles, when considering the average annual number of miles traveled by light-duty vehicles in the U.S.[60] At higher levels of annual VMT – as in the case of vehicles used intensively for TNC purposes – the operational cost savings associated with EVs could be significant enough to offset the higher upfront costs. One study, based on 2015 data, found that in California, the TCO for at least one BEV model could be lower than that for a comparable ICE vehicle when considering the average annual number of miles traveled per capita on California highways.[61] These studies considered residential electricity rates, rather than rates applicable to use of DCFC stations. Estimates of EV operating costs may be higher if use of DCFC is considered. Lyft and Uber report that many EV drivers on their platforms rely on DCFC charging for their EV charging needs.

Barriers relating to EV acquisition and use (e.g., sticker price, access to charging infrastructure, and charging costs) can make it challenging for TNC drivers to capture the benefits associated with EVs. These barriers are discussed in detail in Section 3.5.

3.1 An Opportunity to Increase Economy-Wide EV Adoption

The large, growing scale of TNC operations suggests that there may be a sizeable opportunity to increase awareness of EVs through information sharing between TNC EV drivers and passengers. Multiple studies have found that the level of awareness about EVs in California is very low. For instance, a 2016 UC Davis study found that around 70 percent of new car buyers in California —who had searched for information about cars, visited new car lots, and purchased a vehicle — could not name a single BEV model.[62] Even more troublingly, EV awareness levels seem to have largely remained static over the last few years despite concerted EV marketing efforts by the government and the EV industry. Researchers at the UC Davis Institute of Transportation Studies conducted five surveys from June 2014 to June 2017 to assess Californian car-owning households' engagement with EVs.[63] The percentage of car-owning households who considered an EV when they completed their questionnaire was no higher in 2017 than in 2014. Awareness of EV purchase incentives and how PHEVs and BEVs are fueled also remained static over this time period. Even though the number of EV makes and models offered for sale nearly doubled between 2014 and 2017, *fewer* Californians were able to name an EV model for sale in 2017 than in 2014.

Knowledge of, and exposure to, EVs has been found to result in lasting positive impressions that influence subsequent vehicle purchase decisions.[64] Exposure to EVs through ride and drive events and car-sharing programs, and information from other EV drivers have been found to be the most powerful information sources influencing new buyers to opt for an EV.[65]

A key focus area in California's 2016 ZEV Action Plan is increasing familiarity with EVs through a public campaign enabling 20 million test drives of ZEVs by 2025, and by promoting ZEV use in car sharing services, rental car services, and carpool and vanpool programs.[66] The TNC sector presents a viable platform to advance these goals. TNC EV drivers have consistently reported[67] that passengers commonly notice the vehicle technology, that EV technology is routinely a topic of conversation with passengers, and that passengers generally leave with a positive impression of EV technology.[68] It is, however, difficult to assess the extent to which TNC passengers – who tend to be relatively affluent, young, college educated individuals[69] – may have had prior exposure to EVs.

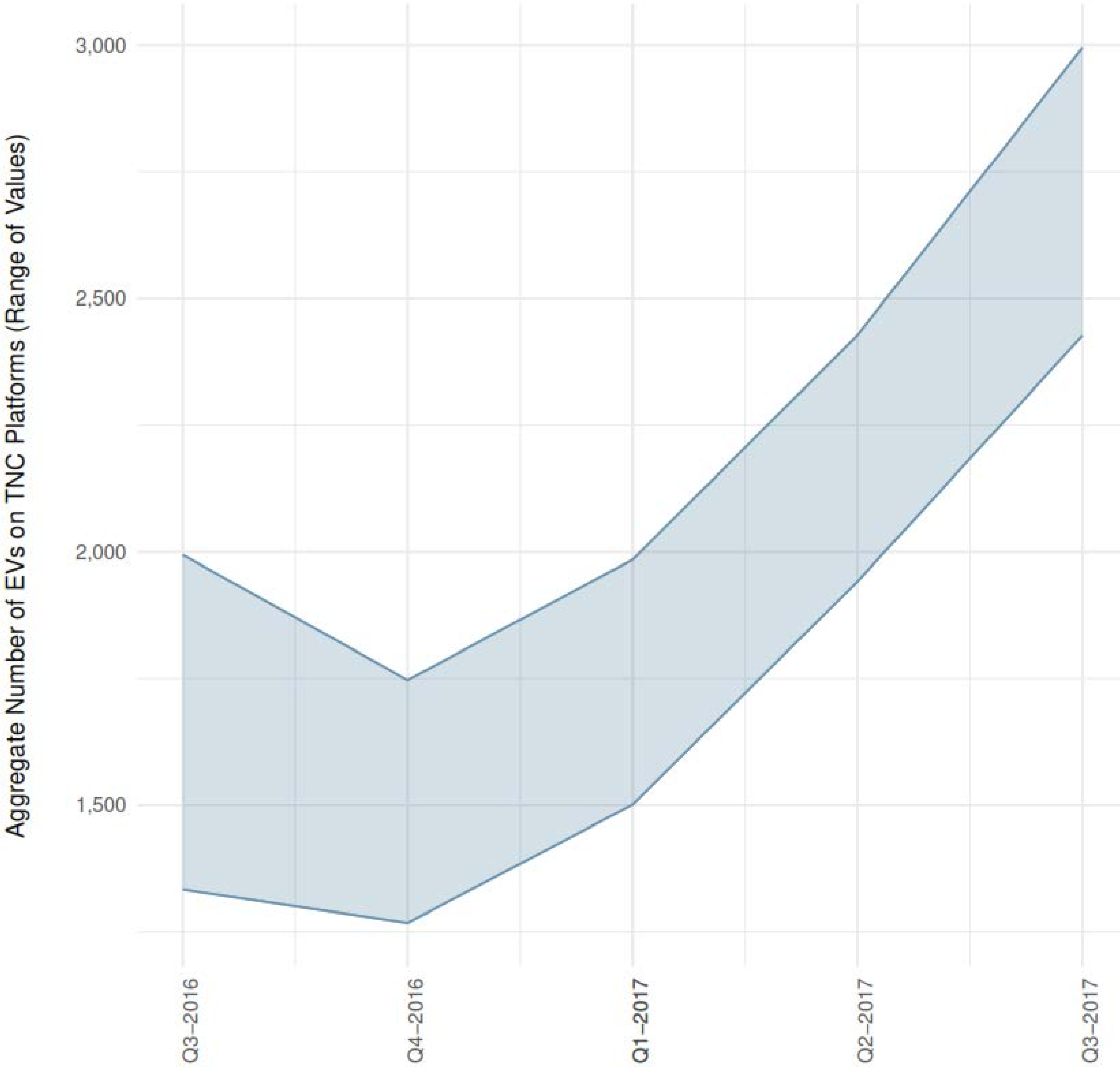
Increasing TNC drivers' exposure to EVs also creates a channel for information about acquiring and owning EVs to be disseminated to their network of friends and families who are likely to represent a different, more diverse set of demographic groups than TNC riders and the average EV owner – on average, TNC drivers tend to be lower income individuals with socioeconomic characteristics different from those of TNC riders.[70]

3.2 Use of EVs on TNC Platforms – A Statistical Analysis

Figures 5 and 6 below reflect growth trends in the aggregate number of EVs operated on TNC platforms, and EV trip miles (i.e., total number of trip miles travelled in EVs) as a percentage of total trip miles (i.e., trip miles travelled in EVs and non-EVs). Table 2 provides key summary statistics relating to EV use on TNC platforms for October 2017, including EVs as a percentage of total vehicles registered on TNC platforms. FCEVs were included within the meaning of EVs for the purposes of Figures 5 and 6, and Table 2. An extremely small number of FCEVs are currently being used on TNC platforms. The TNCs reported that a conservative approach was employed in identifying EVs registered on their platforms, and that the EV counts provided to the CPUC are low estimates. The information presented in Figures 5 and 6, and in Table 2 must be considered in light of this caveat.

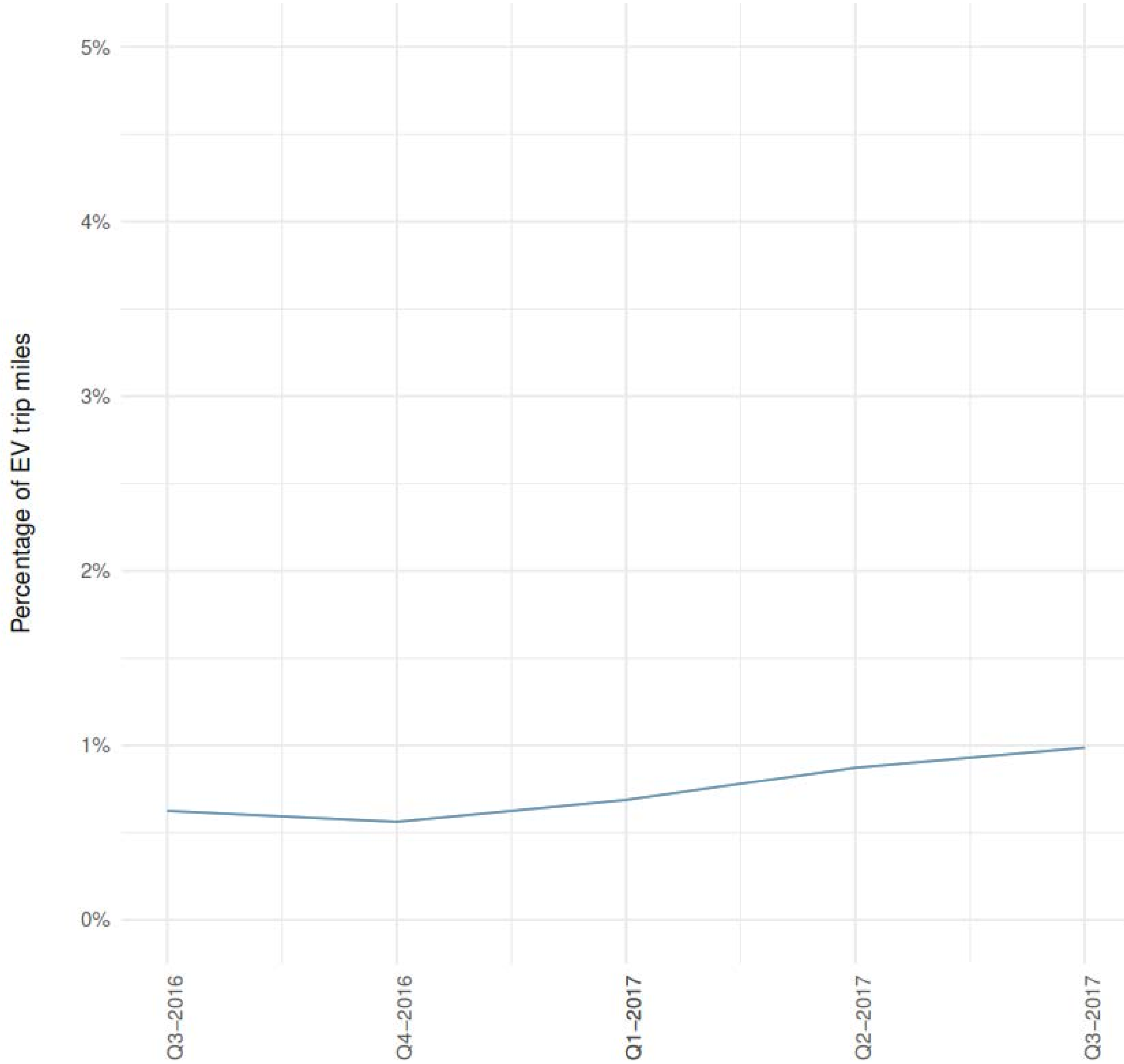
As TNC drivers often operate on multiple TNC platforms, summing the number of vehicles/EVs registered on the two platforms to derive an aggregate figure for the overall sector could lead to double counting. Therefore, we derived an approximate range of values for the aggregate number of vehicles/EVs for the two TNCs combined for the purposes of Figure 5 and Table 2 – the upper end was calculated assuming no overlap between vehicles registered on the two platforms, and the lower end was calculated assuming that all vehicles registered on one platform were also registered on the other.

Figure 5: Aggregate Number of EVs Used on Lyft and Uber Platforms in California by Quarter (Range of Values) (Q3 2016– Q3 2017)



* Lyft did not collect data on the number of EVs on its platform prior to July 2016.
** As TNC drivers often operate on multiple TNC platforms, summing the number of EVs registered on the two platforms to derive an aggregate figure for the overall sector could lead to double counting. Therefore, we derived an approximate range of values for the aggregate number of EVs for the two TNCs combined, which is represented by the shaded region.

Figure 6: EV Trip Miles as a Percentage of Total Trip Miles Traveled on Lyft and Uber Platforms in California by Quarter (Q3 2016– Q3 2017)



* Lyft did not collect data on the number of EVs on its platform prior to July 2016.
** Given data limitations, all miles traveled in EVs (including PHEVs) were counted as EV miles. Considering only miles traveled in fully electric cars would leave us with an overly conservative estimate of EV miles traveled.

In October 2017, the aggregate number of EVs as a percentage of all vehicles registered on the Lyft and Uber platforms fell in the range of 0.89 percent to 1.12 percent. It is instructive to compare EV use figures in the TNC sector with corresponding figures for California as a whole. Through May 2017, approximately 300,000 EVs had been sold in California.[71] The most recently available data shows that there were just over 25 million automobiles registered in the state at the end of 2016.[72] Based on this data, as a rough estimate, the percentage of EVs registered in California is approximately 1.19 percent.

Table 2: Summary Statistics on Use of EVs on Lyft and Uber Platforms in California (Oct. 1-31, 2017)

Aggregate number of EVs	2,596 – 3,259* (approx. range)
EVs as a percentage of all vehicles registered on the platforms	0.89% - 1.12%* (approx. range)
Aggregate number of EV miles traveled (trip miles only)	2.25 M**
EV trips (pooled and non-pooled) as a percentage of total trips	1%
EV miles traveled as a percentage of trip miles	1%
EV miles traveled as a percentage of total miles (trip miles + deadhead miles)	1%

*Given data limitations, all miles traveled in EVs (including PHEVs) were counted as EV miles. Considering only miles traveled in fully electric cars would leave us with an overly conservative estimate of EV miles traveled.
**As TNC drivers often operate on multiple TNC platforms, summing the number of EVs registered on the two platforms to derive an aggregate figure for the overall sector could lead to double counting. Therefore, we derived an approximate range of values for the aggregate number of EVs for the two TNCs combined, which is represented by the shaded region.

Comparing these figures with the corresponding figures for other modes of transportation puts them in perspective.

Public transit: Three percent of statewide buses are fully electric. An additional 7 percent are diesel electric hybrids.[73] The higher load factor generally associated with public transit translates into higher overall efficiency and lower emissions per passenger, relative to other commercially used passenger vehicles, such as TNCs. CARB is in the midst of developing an Innovative Clean Transit (ICT) proposal for complete transition of public transit fleets to zero emission technologies. The long term vision of the ICT effort is to achieve a zero emission public transit system by 2040.[74]

Taxis: Taxis operating in the largest cities in California – where TNC rides tend to be most densely clustered[75] – are subject to emission standards imposed by local regulatory bodies.[76] Some examples are set out below.

- San Francisco: In 2007, the San Francisco Taxi Commission (SFTC) passed a resolution setting a target of 20 percent reduction in emissions from 1990 levels by 2012 for taxis operating in the city, a goal that has been surpassed.[77]
- Los Angeles: In 2000, the South Coast Air Quality Management District passed Rule 1194 requiring taxis operating at local airports to transition fleet vehicles to Super Ultra Low Emission Vehicles (SULEV) or Ultra Low Emission Vehicles (ULEV).[78] As part of the Green Taxi Program, Los Angeles taxi operators have been required to bring approved "green" vehicles into taxicab service since 2011.[79]
- San Diego: In 2015, the City of San Diego announced that new taxicab permits would only be issued to drivers who drive a ZEV or low emission vehicle as defined by CARB.[80]

In addition, CARB is in the process of discussing regulatory concepts and developing a strategy to accelerate the deployment of zero-emission airport transportation.[81]

3.3 TNC Drivers' EV Charging Behavior – A Discussion of Preliminary Evidence

Data on TNC drivers' charging behavior is limited as TNCs do not collect this information. However, some preliminary conclusions may be drawn based on other sources of data. A March 2017 report by EVgo Services LLC (EVgo) – the operator of a network of DCFC charging stations – analyzes utilization data for the top three EVgo charging stations in the Los Angeles area used by drivers who rented EVs from Evercar, a company that offered all-inclusive hourly EV rental packages (including charging costs) to TNC drivers and other drivers working with companies in the sharing economy space. Evercar ceased operations in October 2016.[82]

Based on data collected over a 16-week period in 2016, EVgo reported that use by Evercar drivers led to a significant increase in the overall utilization of the three charging stations. EVgo also reported that Evercar drivers' charging patterns largely complemented charging by non-Evercar drivers during the study period (see Appendices A-C). Further information on the study can be found in Box 2.

The limited duration of the study, the small sample size, and the fact that it considered only one EV model with more limited range than the latest EV models in the market today, limit the extent to which its conclusions can be generalized.[83] Nonetheless, these results provide preliminary evidence suggesting that there may be an opportunity to increase the load factor of public charging stations through increased off-peak charging by TNC EVs, which could potentially increase charging station profitability. Some commentators have noted that the high upfront capital expenditure associated with the installation of DCFC charging stations combined with low utilization levels – due to the low number of EVs that are currently in use – limits the business opportunity for deployment of such chargers.[84] Increasing DCFC charging station utilization levels through increased TNC use would help address this challenge.

Additionally, policy interventions (e.g., target setting) that create certainty around the increased use of EVs in the TNC sector would send a clear market signal to the EV charging infrastructure industry, and potentially increase the attractiveness of investments in this space, thereby accelerating the buildout of such infrastructure.

BOX 2: EVgo Evercar Case Study: Charging Patterns of TNC EV Drivers

In the summer of 2016, EVgo began tracking the utilization of the top three charging stations used by Evercar drivers in the Los Angeles area. Evercar ceased operations in October, 2016, providing for a natural experiment to estimate the impact of charging by Evercar EV drivers on the overall utilization of the charging stations. In all, 50 fully-electric Nissan LEAFs registered with Evercar used the three EVgo charging stations over the study period.

EVgo reported the following results:

- Increased utilization of charging stations: The charging stations delivered 19 percent more electricity in the eight weeks prior to the closure of Evercar's business in October 2016 than in the following eight weeks. While Evercar vehicles accounted for only 8 percent of vehicles that used the charging stations, they were responsible for 23 percent of total electricity delivered, and for 21 percent of total plug minutes. In sum, use by Evercar drivers significantly increased the overall utilization of these charging stations. Charging costs were rolled into the hourly rates charged by Evercar, so that charging events carried no incremental costs. For this reason, drivers with access to home charging may have chosen to use EVgo's DCFC stations instead. It is unclear if the increase in charger utilization reflected in the EVgo-Evercar data would be observed to a similar extent if customers were charged for each charging session.

- Potential to complement charging by other EV drivers: Evercar drivers were responsible for a greater percentage of charging minutes during nights and weekends than they were in the middle of the day on weekdays. Evercar vehicles contributed to 20 percent of overall weekday plug minutes and 23 percent of overall weekend plug minutes. Evercar vehicles' greatest contribution to these stations' utilization (in percentage terms) occurred between 4-5 a.m. on weekdays and 2-3 a.m. on weekends. Overall, EVgo concluded that Evercar drivers' charging patterns largely complemented charging by other drivers during the study period. See Appendices A to C for more information.

3.4 Key Industry Trends Relating to EV Use in the TNC Sector

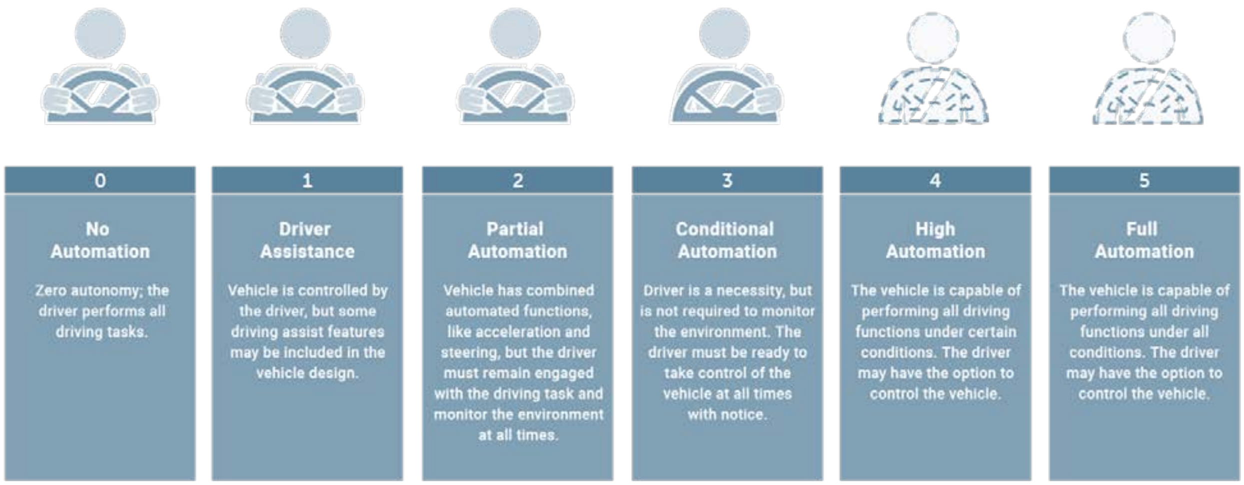
This section discusses two key trends that relate directly to the use of EVs on TNC platforms – investments in autonomous vehicle (AV) technology, and TNC partnerships/engagement with other industry players.

3.4.1 AV Technology Developments

A detailed examination of questions relating to AV testing and deployment is beyond the scope of this paper. We touch on broad trends relating to AV technology and the emerging regulatory framework in California.

Figure 7 outlines the full spectrum of levels of vehicle automation, with Level 0 representing zero autonomy, and Level 5 representing full autonomy.[85]

Figure 7: Levels of Driving Automation



Regulatory developments: Regulations to test AVs with a driver behind the steering wheel have been in place in California since 2014. To date, the California Department of Motor Vehicles (DMV) has granted AV testing permits to more than 50 companies.[86] DMV rules governing driverless testing and public use of AVs recently came into effect, paving the way for Level 5 AVs to be deployed for public use on California roads.[87] Meanwhile, the CPUC is considering various issues relating to the use of AVs as for-hire vehicles in an ongoing proceeding (R.12-12-011).

Market developments: TNCs are making significant investments in AV technology. Both Lyft and Uber[88] are developing their own AV capabilities.[89] Both companies are also partnering with automakers to advance AV technology. In 2017, Uber announced that it may purchase as many as 24,000 Volvo PHEVs equipped with AV technology from 2019-21 under a non-exclusive arrangement with Volvo.[90] Similarly, while Lyft is developing its own AV technology[91], it is also working with automakers to test and use their AVs on its network through its Open Platform Initiative.[92]

Non-TNCs are entering the fray by developing AV technology for commercial ride-sourcing purposes. Waymo, a subsidiary of Google's parent company, Alphabet, is one of several companies testing a fleet of AVs on public roads in Phoenix without a driver.[93]

Climate impacts of AV deployment: There is uncertainty around the climate implications of AV technology deployment at scale.[94] Some studies suggest that under shared AV use scenarios, there may be potential for GHG emissions savings, even if AVs lead to an increase in VMT.[95] Lyft and Uber have noted that they are developing AV technology on the premise of ride-sharing.

If the promise of shared AV use is not realized, however, widespread use of AVs could lead to an increase in emissions. Firstly, many studies suggest that widespread deployment of AVs is likely to increase overall VMT. [96] By eliminating many of the inconveniences associated with driving, such as parking and lost productivity time, and improving access to cars for those unable to drive, AV technology may increase both the number of trips made and average trip length.[97] Secondly, although several commentators predict that AVs will be zero emission vehicles powered by electric powertrain systems, market trends do not conclusively point in this direction. At least one leading automaker has indicated that hybrid-electric technology presents the best way forward for their self-driving efforts.[98] Uber's arrangement with Volvo suggests that it will, at least in part, rely on PHEVs for its self-driving efforts. In January 2018, Waymo announced an agreement with Fiat Chrysler Automobiles NV under which the automaker will supply thousands of Chrysler Pacifica plug-in hybrid minivans to Waymo.[99] Waymo is preparing to launch a commercial ride-hailing service later this year.[100]

There are widely divergent views on how quickly AVs will be deployed at scale in the ride-sourcing sector. Given that AV technology is still in early stages of development, leading to uncertainty around costs, market readiness, adoption, and the regulatory framework, current projections are largely speculative. There is general consensus that the future of transportation will be autonomous; the only uncertainty is around when AV technology will be ready for use at scale.

3.4.2 TNC Partnerships and Engagement with Other Industry Players

TNC partnerships with other industry players extend beyond the context of AV technology. Lyft and Uber have partnered with other industry players to increase access to vehicles for use on their platforms. In 2016, Lyft and GM announced the launch of Express Drive, an all-inclusive rental program allowing drivers access to vehicles, including EVs, for use on the Lyft platform.[101] Under this program, Lyft drivers in Los Angeles, San Diego, and San Francisco were offered access to fully electric Chevrolet Bolts. Similarly, Uber has entered into arrangements with car rental companies to increase drivers' access to vehicles for use on its platform.[102] Outside of the U.S., Uber has partnered with third parties to increase the availability of EVs for use on its platform.[103]

3.5 Key Barriers to Use of EVs in the TNC Sector

3.5.1 Categories of Barriers Experienced by EV drivers on TNC Platforms

In broad terms, there are two types of barriers relating to EV use:

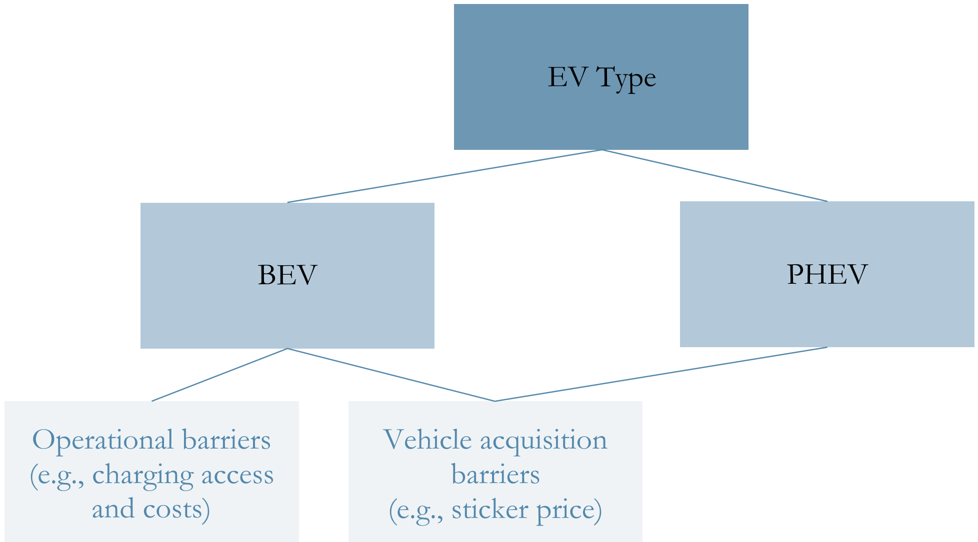
- Acquisition barriers (e.g., sticker price, access to financing, range anxiety, etc.); and
- Operational barriers (e.g., charging access and costs, etc.).

All current and prospective EV drivers face these challenges, and there is an extensive body of literature on these issues. This paper focuses on barriers relating to EV acquisition and use in the specific context of TNC drivers.

As a starting point, it is important to note that these barriers are not experienced in the same way, and to the same extent, by all TNC EV drivers. Barriers to EV use on TNC platforms cannot be meaningfully discussed or addressed without assessing how these barriers impact different categories of drivers. Table 3 below outlines how different categories of drivers experience vehicle acquisition and use barriers differently.

EV type: Vehicle acquisition and use barriers apply differently depending on whether the EV used is a BEV or a PHEV (see Figure 8 below). For instance, range anxiety is experienced exclusively by BEV drivers.

Figure 8: Types of Barriers to EV Deployment and Use on TNC Platforms



<u>Driver type</u>: Secondly, it is important to distinguish between drivers who already own an EV that they use on TNC platforms, and those who acquire an EV keeping TNC use – whether as a primary or secondary purpose – in mind. This paper discusses vehicle acquisition barriers experienced by the latter category of drivers. In other words, what are the constraints experienced by TNC drivers in seeking to acquire an EV for the primary or secondary purpose of TNC use?

There are several reasons why a prospective TNC driver may choose to purchase, lease, or rent a vehicle for TNC use. TNCs typically have restrictions on the type of vehicles that may be used on their platforms. Only vehicles manufactured in 2002 or later may be used by Uber drivers in Los Angeles, San Diego, and San Francisco. Vehicles manufactured earlier than 2004 cannot be used on the Lyft platform in California.[104] Secondly, drivers who drive intensively on TNC platforms may opt to purchase, lease, or rent an EV to save fuel costs, which could be substantial in heavy use cases. Thirdly, because of mileage restrictions contained in standard vehicle leasing contracts,[105] drivers whose existing vehicle is leased may choose to acquire an additional vehicle for TNC use. Finally, TNC drivers may prefer not to subject their personal vehicles to heavy duty cycles on TNC platforms.

TNCs do not collect data on whether vehicles registered on their platform are rented, leased or owned. It is difficult to assess the size of the segment of TNC drivers who acquire a vehicle (through purchase, leasing or short term rental) keeping TNC use in mind. Uber reports that as of June 2017, 57 percent of drivers on its California network drove more than 10 hours per week with the Uber app on.[106] In 2016, Lyft reported that in Los Angeles and San Francisco, more than 130,000 people who applied to become Lyft drivers did not have qualifying cars.[107] Combined with anecdotal evidence shared by TNCs based on focus group meetings with TNC drivers and other types of engagement with drivers, this suggests that the pool of drivers who take TNC use into account in considering vehicle acquisition (ownership, lease, or short term rental) decisions is non-trivial. Therefore, this is a segment of drivers that is worth keeping in mind when considering barriers to EV use on TNC platforms. Accordingly, the following section discusses vehicle acquisition barriers that may be experienced by this segment of drivers.

Table 3: Categories of EV Acquisition/Use Barriers and Interaction with TNC Vehicle Types

Type of EV	Vehicle acquisition barriers	Operational barriers
BEV – acquired for TNC use	Y	Y
BEV – existing vehicle	N	Y
PHEV – acquired for TNC use	Y	N
PHEV – existing vehicle	N	N

3.5.2 Vehicle Acquisition Barriers Experienced by TNC Drivers

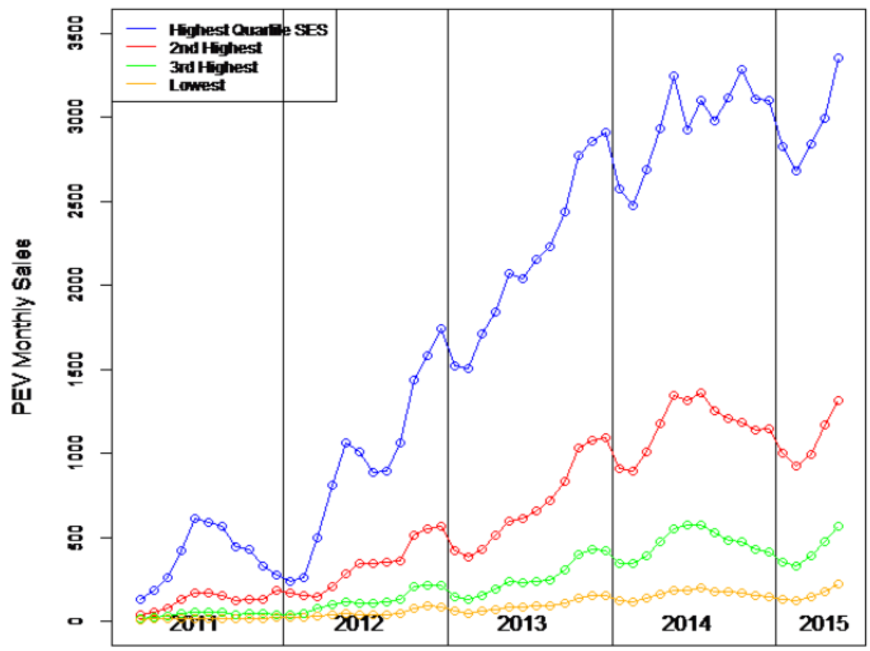
Sticker price: In their responses to a data request from the CPUC, both Lyft and Uber noted that sticker price presents a vehicle acquisition barrier to their drivers. This is consistent with available data on TNC driver income, considered in light of literature on the correlation between income and EV purchase trends.

Approximately 50 percent of the drivers surveyed by Lyft in Los Angeles, San Diego, and San Francisco reported that their annual household income is less than $50,000.[108] The median annual household income in California is $63,783.[109] Similar conclusions can be derived using Uber data.[110]

Income and other socio-economic indicators have been found to be highly significant predictors of EV purchase decisions. A study by the University of California, Los Angeles (UCLA) found that through October 2014, neighborhoods in California ranked in the top 25 percent by socio-economic status (SES) had purchased over 10 times more EVs than those in the bottom 25 percent, a divergence that has been widening over time (see Figure 9 below, which shows trends in PEV monthly sales for the four quartiles).[111] The percentage of households earning more than $200,000 explains more than 65 percent of the variance in PEV purchases between census tracts.[112]

The researchers found that these differences among quartiles in the number of PEVs purchased are not explained by differences in the propensity to purchase new vehicles more generally. Their analysis suggests that other factors, such as access, vehicle costs, and cost of infrastructure, are at play.[113]

Figure 9: Relationship Between Monthly EV Sales and Socio-Economic Indicators[114]



Source: UCLA, "Factors Affecting Plug-In Electric Vehicle Sales in California", January 2017.[115] Researchers at UCLA ranked quartiles using a socioeconomic status (SES) index that considered percentage of households earning >$200,000 a year, median home value, and the percentage of individuals over the age of 25 with more than a bachelor degree.

Given the lower upfront costs, used EVs could potentially be a good purchase or lease option for lower income TNC drivers. Both Lyft and Uber report that TNC drivers heavily rely on used cars.[116] A used EV market is emerging quickly because of the higher than average lease rates for EVs.[117] California is a net importer of used EVs, which are the fastest selling cars in the state's secondary market,[118]suggesting that demand exceeds supply, even though state and federal incentives do not generally apply to purchasers of used EVs.[119]

While used EV purchasing households have lower incomes than those that purchase new EVs, they tend to have higher incomes than conventional vehicle purchasers. In a 2015 survey, used EV owners reported an average household income of $173,400.[120] The corresponding figure for new EV owners was approximately 30 percent higher at $227,000. One point of comparison, albeit imperfect, is that as per 2012 data, the average household income for households with older vehicles was $89,000 whereas the corresponding figure for households with new vehicles was $119,400.[121] While tracts in the highest quartile of used EV ownership have been found to have higher income, and be more educated than tracts in lower quartiles, other, unobservable factors play a larger role in influencing purchase decisions.[122]

Although EV sticker prices are continuing to fall due to decreasing battery costs, cost parity between ICE vehicles and EVs for a self-sustaining EV market is not anticipated before 2025.[123] Sticker price challenges may diminish as the used EV market continues to grow, but it is difficult to predict how long it may take for a robust used EV market to emerge. Meanwhile, new business models (e.g., subscription models offering all-inclusive, short term EV rental packages) allowing TNC drivers to take advantage of the lower operating costs associated with EVs and overcome financing/sticker price barriers are emerging. Recognizing sticker price as a barrier to EV purchase, California currently offers financial incentives to EV purchasers across the state, and provides financial assistance to eligible low income households interested in purchasing clean vehicles. In December 2017, CARB approved new incentives targeted at low income households as part of a broader $663 million low-carbon transportation plan.[124]

<u>Limited driver awareness of total cost of ownership (TCO)</u>: Based on observations gathered during

several EV related focus group meetings, Uber reports that many drivers do not seem to fully understand TCO for their current vehicle, EV or not, and that many non-EV drivers are unaware of resources to evaluate hypothetical TCO, if they were to acquire an EV.

Uber also reports a mismatch between the Uber driver segment that is able to afford higher range EVs and the driver segment for which EVs' lower operational costs are most attractive. Uber notes that drivers who drive higher than average hours/miles on the app, and therefore stand to benefit most from EVs' lower per-mile costs, tend to be lower income individuals who drive close to full-time on TNC platforms, as they lack access to other income sources. This segment of drivers typically does not have access to favorable vehicle financing options, and are generally unable to afford higher range EVs. On the other hand, relatively affluent Uber drivers (e.g., home owners with access to home charging and vehicle financing/purchase options) who may be able to afford higher range EVs are less likely to be higher mileage drivers, and therefore do not stand to benefit as much from EVs' lower per-mile costs.

Range anxiety: Additional acquisition barriers apply to purchase of fully electric vehicles, e.g., range anxiety. These concerns will be addressed as new extended range models come on the market. Judging from recent announcements by automakers, these developments are well on their way.[125]

Vehicle financing: Given the income profile of the average TNC driver, vehicle financing to meet the upfront costs of EVs is especially important for TNC EV drivers.

Anecdotal evidence[126] suggests that banks are typically unwilling to lend to TNC drivers because heavy duty cycles on TNC platforms lead to faster depreciation of the vehicle. Drivers for whom TNC income is their primary or sole source of income experience additional challenges because they lack a stable source of income, and in some cases, have poor credit scores.

Leasing presents an obvious alternative to vehicle purchase. In general, EVs are leased at higher than average rates across California.[127] However, because lease contracts typically come with a mileage cap, as noted earlier, leasing may not be an ideal option for TNC drivers looking to drive their vehicle intensively.

3.5.3 Operational Barriers to BEV Use on TNC Platforms

The challenges discussed below apply specifically to fully electric vehicles used on TNC platforms.

Access to public charging: TNCs report that lack of access to sufficient fast charging infrastructure especially in areas of high mobility demand (e.g., downtown centers) is one of the greatest barriers to EV use identified by TNC drivers. [128] Lyft reports that most TNC drivers who rent vehicles through its Express Drive program have no access to home charging, and rely solely on public charging stations. It is worth noting that while California has the highest number of EVs in the U.S., it has one of the lowest ratios of public charging outlets to EVs in the country.[129]

Drivers who drive intensively on TNC platforms may need to charge their vehicle more than once a day, and may rely on public charging for at least part of their charging needs, even if they have access to charging at home. Time spent by TNC BEV drivers in searching for public charging, waiting for a charging station to become available, and in charging their vehicle, translates into lost earning potential.[130] Uber reports that this opportunity cost could be significant, given the range limits of EVs that TNC drivers can afford, combined with other factors such as lack of access to charging infrastructure.

Charging costs: A recent report by the Rocky Mountain Institute (RMI),[131] which is based on 2016 data, suggests that the prevailing electricity rate structure applicable to public charging stations, which includes demand charges, leads to prohibitively high EV charging costs in California. RMI's analysis suggests that electricity costs can be as high as $1.96/kWh at some DCFC locations in summer months, whereas for

DCFC rates to be competitive with gasoline prices (which are currently at a historic low), the electricity cost would need to be $0.29/kWh or less. RMI notes that this issue may be exacerbated by the deployment of next generation fast-charging stations (designed with more than two 50 kW DCFC per site and with higher-power DCFC (150kW or higher)). More data and analysis is needed to assess the extent of the problem. With some EV manufacturers offering complimentary charging access to new EV owners and lessees, the extent to which the financial costs of EV charging currently pose a significant challenge to TNC drivers is unclear.[132] The CPUC is considering issues relating to electricity rate design for EV charging as part of an ongoing proceeding on transportation electrification.[133]

Other operational challenges: Drivers experience additional challenges due to the dynamics of TNC driving. For instance, TNCs do not generally allow drivers visibility into the trip length or destination requested by a passenger until after they have been matched with a passenger. Lyft and Uber note that this measure is intended to address regulatory concerns around redlining. As a result, drivers usually lack the flexibility to orient driving around charging needs. This challenge is exacerbated for pooled rides, where passengers may have to be picked up and dropped off at multiple locations.[134] TNCs are making efforts to fill these gaps to make it easier for EVs to be used on their platforms.

BOX 3: Findings from Uber's EV use trial in London – A Case Study

Uber conducted a trial using more than 50 BEVs in London between August 2016 and January 2017. Most drivers who volunteered to participate rented EVs, which were offered at a discounted rate for a limited number of vehicles during the trial. Drivers were surveyed at the beginning, middle, and end of the trial. Of the 108 drivers surveyed, only 19 were identified as having completed all three surveys. Responses were analyzed by the UK based Energy Savings Trust in collaboration with Uber.

- Lack of access to fast charging was identified as the most significant barrier to EV use. Drivers who operated EVs at close to or at full-time schedules reported that they would have worked an additional 10 hours per week, on average, if they had access to faster and easier charging. Twenty percent of the drivers reported that they rejected rides daily due to insufficient range. An additional 30 percent reported that they rejected rides on a weekly basis.

- Sixty-seven percent of drivers reported that passengers discussed the car's EV technology at least once per work period, suggesting that the TNC sector can serve as a platform to expose passengers to EVs.

Several factors – substantive differences between the nature of TNC operations and the regulatory context in California and the U.K., the limited duration of the trial, the small sample size, and the fact that only three EV models were considered - limit the extent to which the conclusions of this trial can be generalized.

3.5.4 Key Takeaways

Much of the currently available information on barriers faced by TNC drivers in using EVs on TNC platforms is anecdotal. It is difficult to gauge which of these challenges is experienced most acutely by TNC drivers. Further data, analysis, and engagement with TNC drivers is needed to precisely identify the binding constraint, which, if addressed, can significantly accelerate the use of EVs on TNC platforms.

Preliminary evidence suggests that TNC drivers' charging patterns and needs are different from those of the average EV driver. The use of public fast charging infrastructure by TNC drivers may have implications for other EV owners. Tesla recently announced that new Tesla owners who use their vehicles for commercial purposes (e.g., TNC drivers) will no longer be allowed to use its fast charging stations.[135]

As the TNC sector continues to grow, and especially if it displaces use of personal vehicles to a significant degree, it will become increasing important for policymakers to consider TNC drivers' charging patterns and needs, and monitor trends, in making decisions relating to the deployment and use of fast charging infrastructure.

3.6 TNC initiatives to increase EV use

Lyft and Uber have announced targets relating to the use of EVs on their platforms, and have made a few initial efforts – primarily through pilots – to identify ways to increase EV use on their platforms. Lyft has announced a goal of providing at least 1 billion rides per year using electric vehicles by 2025.[136] In response to the announcement of new regulatory requirements in London, Uber has announced that every vehicle operating on its platform across the U.K. will be 100 percent hybrid or fully electric by the end of 2022.[137]

TNC initiatives aimed at increasing EV use fall into two categories:

- Incentive programs; and
- Expanding customer choice by offering passengers a "green" alternative, i.e., the choice to opt for an EV-only ride on the platform.

This section discusses initiatives launched by Uber and its affiliates both within and outside the U.S. For the purposes of this section, references to Uber include all Uber affiliates across the world. In all, Uber affiliates have launched programs aimed at increasing EV use in 10 cities around the world.[138] Lyft's operations are largely confined to the U.S. This section is not exhaustive; it is only intended to illustrate the types of initiatives launched by TNCs to promote EV use on their platforms. Not all of the initiatives discussed here are still in operation.

Incentive programs

- Oregon: The Oregon PUC[139] is considering a proposal by Portland General Electric, Oregon's largest utility, to develop an EV Ambassador Program with Uber, as part of which the utility will provide a monthly bill credit to EV drivers who carry educational materials about EVs for passengers.

- International efforts: In Paris, Uber offers a monthly ecological bonus to eligible drivers operating BEVs on its network. In Zurich, Uber conducted a pilot program as part of which participating drivers gained discounted access to a fleet of 25 EVs managed by a fleet management company. After the conclusion of the pilot, drivers were given the option of leasing the EVs.

In 2017, Transportation for London (TfL), which regulates all public transportation in the City of London, announced an aggressive set of measures to curb pollution, applicable to most vehicles operating in the city.[140] In response, Uber launched a pilot between September 2016 and January 2017, offering several incentives to drivers (e.g., a £300 "conversion to EV" reward, a £50 weekly participation reward, and a charging incentive). These incentives were funded by a £2m Uber investment and a per-ride surcharge applicable to all non-pooled Uber rides in London.[141] Uber has also announced plans to install a network of rapid chargers in central London that will initially be dedicated for use by Uber drivers.[142]

Expanding customer choice

In some cities, Uber offers EV rides as a distinct product. In Singapore, passengers can request a BEV by choosing the UberELECTRIC product, offered at a premium to a standard ride. In Paris, a similar UberGREEN product is available. In Dubai, Uber has launched uberONE, which is a Tesla-only service available to passengers.[143]

4 Accelerating EV Use in the TNC Sector Through Regulatory Changes

The qualitative and quantitative data presented in this paper demonstrate that the GHG emissions footprint of the TNC sector is steadily growing. The evidence discussed in this paper only serves as a starting point. More data is needed to precisely quantify GHG emissions from the sector. Under a business-as-usual scenario, TNC sector emissions can be expected to continue to grow as TNCs continue to expand the scale of their operations. With EVs being used to a very limited extent on TNC platforms, there is an opportunity to significantly reduce GHG emissions from the TNC sector by increasing the use of EVs on TNC platforms. TNCs also present a platform to raise awareness of EVs among riders by promoting information exchanges regarding EVs between TNC drivers and riders.

Meanwhile, investments in AV technology continue to grow. Multiple studies have concluded that the introduction of AVs at scale will increase overall VMT. With California DMV rules for driverless testing and public use of AVs having recently come into effect, this is an opportune time for the CPUC to closely consider the opportunity for emissions reduction from the ride-sourcing sector. Regulatory changes in other jurisdictions, such as London, have prompted TNCs to set ambitious targets to rapidly accelerate EV use on their platforms, and to develop innovative ways to meet these targets. Appendix E provides a few illustrative examples of TNC regulations applicable in cities outside California.

The scope of the CPUC's regulatory authority over TNCs, as set out in the Charter-Party Carriers' Act (Public Utilities Code § 5351 et seq.), is broad. § 5381 states in part that:

> "the commission may supervise and regulate every charter-party carrier of passengers in the State and may do all things […] which are necessary and convenient in the exercise of such power and jurisdiction."

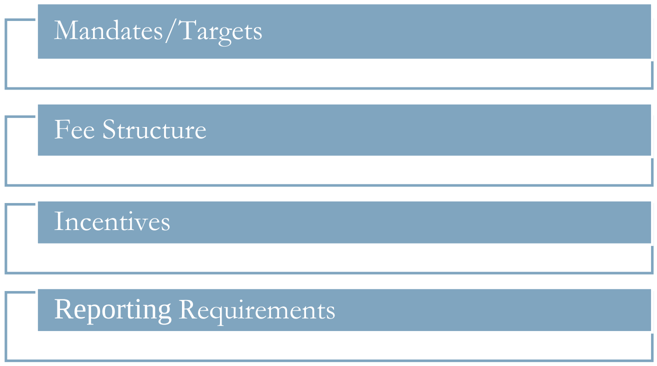
In other words, the CPUC has broad authority to create new regulations pertaining to the TNC sector if it determines that it is necessary and convenient to do so.

The threshold question for the CPUC to consider is whether to exercise this jurisdiction to create new regulations to increase EV use on TNC platforms. In view of prevailing market forces, existing regulations applicable to automakers and electric utilities, emerging legislative discussions around the use of EVs in the TNC sector, and California's overarching policy framework, all of which are geared towards increasing EV use across California, the CPUC may choose not to create any new regulations for the TNC sector in the near term, and to continue to monitor TNC industry trends instead. Various regulatory options are available to the CPUC should it choose to initiate regulatory changes to accelerate EV use in the TNC sector. We discuss four broad categories of regulatory options – a mandate/targets based approach, a fee structure, an incentive structure, and reporting requirements – but do not consider design specifics, which would be better addressed through the CPUC's Rulemaking process, should the CPUC choose to consider this issue. We consider the CPUC's broad authority to regulate the TNC sector as outlined in Public Utilities Code § 5381 as the basis of these regulatory options. A closer examination of the bounds of the CPUC's jurisdiction may be needed depending on the type of regulatory lever that it seeks to exercise.

As TNCs cannot own vehicles operated on their platforms, they are one step removed from vehicle use and deployment decisions by drivers on their platforms. In contrast, fleet operators such as taxi companies typically own and operate vehicles in their fleet, and can therefore respond directly to regulations relating to vehicle type (e.g., fuel efficiency specifications) by altering their vehicle purchase and use decisions. Although TNCs do not directly control drivers' vehicle use decisions, they can respond to regulatory requirements around vehicle use on their platforms in a variety of ways, e.g., through programs to increase TNC drivers' access to EVs, offering incentives to EV drivers on their platforms, improving EV drivers' experience on their platforms, etc. As discussed in Section 3, TNCs are experimenting with a few such initiatives. Targets announced by Lyft and Uber relating to the use of EVs on their platforms suggest that the companies have some degree of confidence in their ability to influence drivers' vehicle preferences.

4.1 Potential Regulatory Options and Key Questions for Consideration

Figure 10: Types of Regulatory Levers



4.1.1 Regulatory Mandates and Targets

The CPUC may establish progressively increasing targets for eVMT as a percentage of total VMT (eVMT%).[144] This is but one example of a mandate based approach. There are many other types of mandates that may be considered by the CPUC, e.g., requirements for TNCs to reduce deadhead miles, increase TNC driver access to charging infrastructure, or to financing for EV acquisition etc.

A mandate/targets based approach offers certain unique advantages.

First, it carries the potential for market transformation. By creating certainty around EV use in the TNC sector, a mandate based approach would send a strong market signal to investors, potentially increasing investments in the EV industry (e.g., in EV charging infrastructure), and creating the impetus for development of new business models to increase TNC driver access to EVs. Ultimately, this could increase competition, and drive down costs, accelerating the use of EVs as a whole.[145]

Second, it recognizes that TNCs are best positioned to evaluate and influence passenger and driver behavior on an ongoing basis, and allows them the flexibility to identify, and continually improve upon, the optimal approach to achieve the prescribed targets. In contrast, for a state-administered incentive-based approach to be successful, public agencies must precisely identify and properly target the primary barriers to EV use on TNC platforms at the outset.

Finally, such an approach would create certainty around emission reduction outcomes.

One of the primary downsides of this approach is that firms are left with little incentive to exceed administratively established targets. This underscores the need to set targets that are ambitious yet achievable. This is an inherently complex endeavor, which is further complicated by the fact that the TNC sector is a relatively new and evolving industry, with limited historical data on driver and passenger behavior, EV use trends, etc. Further analysis aimed at more precisely quantifying the extent to which GHG emissions can be feasibly reduced by the TNC sector would serve as a useful starting point before the CPUC considers setting EV use mandates/targets for the sector.

A few key design related issues for the CPUC to consider are outlined below.

Target-setting: In order to set targets that are ambitious yet achievable, the CPUC will need to identify an appropriate baseline, and consider several factors such as the evolving nature of the EV market, and the likely trajectory of EV use in the TNC sector under a business-as-usual scenario.

Enforcement mechanism: The CPUC will need to establish an appropriate enforcement mechanism to ensure TNC compliance with any new regulatory requirements. In the past, the CPUC has responded to violations of TNC regulations by suspending the TNC's license to operate. An assessment of the suitability of existing enforcement mechanisms – which relate to a public safety oriented regulatory framework – to environmental regulations is necessary.

Timeframe: The CPUC will also need to consider whether annual targets are preferable to more granular (e.g., quarterly) targets, and the appropriate time horizon over which the targets would apply (e.g., targets may be set through 2025, considering the state's goal of having 1.5 million EVs deployed by that year, or through 2030, taking into account California's recently announced goal of having 5 million EVs in use by then).

4.1.2 Fee Structure: Assessing a fee on TNC companies

Pricing environmental externalities, such as GHG emissions, allows the associated societal costs to be folded into firms' operational costs, thereby incentivizing them to reduce emissions on an ongoing basis, and to continually pursue the most cost-effective ways to do so.[146]

In theory, properly designed market-based instruments that use price signals to advance emissions reduction objectives, would allow such objectives to be achieved at least cost to society, because they incentivize the greatest emission reductions by firms that can achieve these reductions most cost-effectively.[147]

California's cap and trade program, which took effect in 2012, is one such market-based mechanism that allows the market to price GHG emissions. As the distribution of gasoline is covered by the program, the costs of GHG emissions associated with the use of gasoline are reflected in the price of gasoline. These price signals extend to the economy as a whole. To the extent that a sharper price signal is needed to increase EV use on TNC platforms, an emissions fee structure could be a potentially useful regulatory tool.

Under such an approach, TNCs would be subject to fee levels determined by the degree to which EVs are used on their platforms. Identifying the appropriate metric to measure firms' performance as it relates to the use of EVs on their platforms is critical. eVMT as a percentage of total VMT (eVMT%) would be a useful metric as it accounts for differences in the size and scale of various TNCs' operations. Firms with a higher eVMT% would face lower emission fee rates than those with a lower eVMT% and vice versa. A simple illustrative example is set out below.

Table 4: Illustrative Example of a Fee Structure based on eVMT%

eVMT as a % of Total VMT	Fee Level
0 - 5%	3x cents per 100 ICE VMT
5 – 10%	2x cents per 100 ICE VMT
10 – 15%	x cents per 100 ICE VMT
[…]	[…]

As TNCs are positioned to have the greatest visibility into the challenges to, and opportunities for, increasing EV use on their platforms, one possible approach is to allow the TNCs to independently choose initiatives towards which ring-fenced emission fee proceeds would be applied. Absent checks and balances, however, this could create a perverse incentive for firms to minimize use of resources that they might have otherwise drawn on, in the ordinary course of business, to fund initiatives that directly or

indirectly increase EV use.
An alternative approach is for the CPUC to determine how best to use these funds to increase EV use in the sector, e.g., by assessing TNC proposals for initiatives to increase EV use through a regulatory process, and allocating funds to those that are likely to advance the goal most effectively.

Factors to consider in establishing fee levels: Setting appropriate fee levels is inherently complex. Yet, it is of fundamental importance, and can make or break the effectiveness of such a fee structure. The CPUC will also need to consider whether to cap fees payable by TNCs, and establish criteria to identify projects to be funded by TNC emission fee proceeds.

4.1.3 Incentives to Advance Electrification of the TNC Sector

California has drawn on incentive-based policies extensively to accelerate the deployment and use of EVs. In assessing the need for new incentives to accelerate the use of EVs in the TNC sector, the CPUC must first identify the fundamental barrier to EV use in the sector. For instance, if the primary barrier is a financial one (e.g., EV sticker price), the CPUC may consider offering financial incentives to address it. Other types of incentives may be more appropriate if the primary barrier is non-financial in nature (e.g., challenges associated with the dynamics of driving EVs on TNC platforms discussed in Section 3). Second, the CPUC must consider whether an incentive-based approach is likely to be effective. In other words, are incentives likely to address the identified gap in a significant way by shifting drivers' vehicle preferences towards EVs?

As noted above, based on the limited data that is currently available, it is difficult to conclusively identify the most significant barrier to the deployment and use of EVs on TNC platforms. More information is needed to assess whether an incentive-based framework would succeed in increasing the use of EVs on TNC platforms.

If the CPUC determines that an incentive-based framework is optimal, it will need to consider several design related questions. We outline some such questions below, in the specific context of financial incentives.

Structuring an incentives framework
In theory, incentives may be routed in at least three ways.

The CPUC may prescribe that incentives be routed to drivers to reduce the costs of vehicle use and/or acquisition.

Alternatively, it may prescribe that incentives be routed to passengers to increase demand for EV rides by subsidizing the cost of TNC rides in EVs. This option presupposes that TNCs offer passengers the option to choose a "green ride" in an EV (similar to the UberGREEN product offered in some jurisdictions) voluntarily or in response to a regulatory mandate.

A third option is for the CPUC to allow TNCs to decide whether to route incentives to drivers, passengers, or both, depending on where they see the greatest opportunity to increase EV use on their platforms.

While TNCs are best placed to identify the unique constraints preventing greater use of EVs on their platforms, this last option presents the challenge of ensuring TNC accountability in disbursing incentives. The second option above is founded on the idea that, all else being equal, offering customers the option to choose an EV ride, and incentivizing them to do so, will create a new market for EV rides on TNC platforms. A 2016 study that analyzed data from nearly 50 million UberX consumer sessions[148] in Uber's four biggest U.S. markets suggests that consumer demand is largely price inelastic.[149] One survey of TNC users who replaced public transit trips with TNC trips suggests that faster travel and lower wait times are their top concerns.[150]

This data suggests that measures designed to subsidize the cost of EV rides may not necessarily be effective in increasing customer demand for EVs. Further, due to the very small number of EVs on TNC platforms, matching passengers with EVs may not be feasible in the immediate future as this may entail extraordinarily high wait times, and lead to network inefficiencies. Additionally, EV rides could generate a very large number of deadhead miles if passengers requesting a "green" ride are located far from available EVs, which is very likely in many locations, at least to begin with, because of the small number of EVs on TNC platforms.

On the other hand, anecdotal evidence suggests that TNC drivers, particularly those who acquire vehicles for the specific purpose of TNC use, are highly responsive to price signals (see Box 4). Therefore, they are very likely to respond to financial incentives.

Box 4: Lyft Express Drive Case Study – TNC Drivers' Responsiveness to Price Signals

TNCs report that drivers, especially those who acquire vehicles for the specific purpose of TNC use (e.g. through Lyft's Express Drive program) are extremely sensitive to price signals, and in general, put price economics at the center of decision-making relating to TNC driving.

Lyft reported that they have observed significant interest among Lyft drivers in renting the fully electric Chevrolet Bolt under the Express Drive program. Free charging is offered as part of this program through an arrangement between Maven Gig, a GM subsidiary, and EVgo. Lyft reports that demand for these fully electric vehicles has far exceeded supply. In the dataset shared by Lyft with the Commission, the weekly, all-inclusive rental price for the Chevrolet Bolt under the Lyft Express Drive program was $219, whereas the corresponding average figure for other vehicles made available through the program, all of which were ICE vehicles, was approximately $193. The break-even point for leasing a Bolt was approximately 260 miles per week (assuming fuel efficiency of 30 miles per gallon, and a retail gasoline price of $3 per gallon*). For every mile after the 260-mile mark, fuel cost savings would have returned a net gain for a Bolt driver relative to an ICE vehicle driver. In fact, drivers who leased the Bolt drove close to 450 miles per week on average, translating to a net gain of $570 per week. On average, the Bolt drivers leased their cars for twice as long as other drivers (~13 weeks compared to ~6 weeks for the non-EV drivers). For the total lease duration of approximately 13 weeks, this translated into a net gain of close to $2,000 for the Bolt drivers. Overall, Bolt drivers drove disproportionately more miles than their ICE counterparts because of the higher average lease duration. This is explained by the favorable economics of leasing EVs under the Express Drive program, attributable to the relatively higher range of the Chevrolet Bolt combined with the free charging offered as part of the program.

This data offers suggestive evidence that drivers who lease or rent vehicles specifically for TNC use are sensitive to price signals.

*Per U.S. Energy Information Administration data, available at: https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_w.htm

Sources of funding

As noted in the introductory section of this paper, the scope of this paper does not extend to regulatory solutions that draw on utility ratepayer funds. Assuming that the CPUC must identify alternative funding mechanisms, one option is to generate a pool of funds from the TNCs themselves, e.g., through a surcharge on rides. As discussed above, in London, Uber imposed a surcharge on a per-ride basis, to create a ring-fenced pool of funds which was used to offer financial incentives to drivers to shift from an ICE vehicle to an EV. A regulatory approach that requires TNCs to generate such a pool of funds to finance driver incentives would effectively function as a hybrid approach, which is incentive based as far as drivers are concerned, but operates as a mandate vis-à-vis the TNCs.

Another potential funding source is the Greenhouse Gas Reduction Fund (GGRF), which is funded by the proceeds of California's cap-and-trade program. These funds are allocated to eligible state programs that advance the goal of reducing GHG emissions.[151] The statutory framework stipulates that projects funded by GGRF proceeds must be directed, in part, toward the most disadvantaged communities.[152] The potential for drawing on GGRF funds is uncertain, as several emission reduction projects are being considered for these funds.

There may be equity related concerns regarding the use of any public funds to offer special incentives to TNC drivers that do not extend to the broader pool of EV drivers in California or to other sectors (e.g., TCPs). The potential for TNC drivers to play a uniquely important role in raising awareness of EV technology through engagement with TNC passengers (e.g., through incentives for TNC drivers serve as EV ambassadors, consistent with California's strategy for increasing EV adoption through such initiatives) combined with the growing emissions footprint of the TNC sector, must be considered in weighing these concerns.

<u>Targeting incentives</u>

Finally, the CPUC will need to create mechanisms to ensure that any incentives are appropriately targeted. Many drivers operate on TNC platforms on a part-time basis.[153] Concerns about incentives being captured by drivers who drive their EVs on TNC platforms on a limited basis can be addressed by offering incentives per-eVMT driven on a TNC platform.

Second, identifying TNC drivers who are likely to shift to EVs without additional incentives will help target incentives most effectively. Establishing minimum eligibility criteria based on income and/or other socioeconomic factors that have been found to be predictive of EV purchase decisions could be helpful. It would also be beneficial to progressively reduce the level of incentives offered as the gap between EVs and ICE vehicle purchase price continues to close.

EV rental programs, such as Lyft's Express Drive program, (see Box 4) allow TNC drivers to test EV technology, capture fuel savings, and to overcome EV acquisition barriers relating to sticker price, vehicle financing challenges, etc. Such programs may, therefore, serve as a promising avenue for increasing access to, and use of, EVs on TNC platforms. If the goal is to increase the percentage of eVMT driven on TNC platforms, drivers who use rented EVs on TNC platforms (rather than personally owned or leased EVs) should be eligible for any eVMT based financial incentives offered to TNC EV drivers provided that they meet other eligibility criteria. Several players in the EV charging space have noted that offering free charging as part of EV rental programs is not a scalable business model. It is unclear if EVs would be a popular renting option if free charging were not provided as part of the overall rental package.

<u>Other issues:</u> Other issues for the CPUC to consider include: the appropriate level of incentives, a cap on incentives, a framework for administration of incentives, and sunsetting. CARB notes that cost parity between ICE vehicles and EVs for a self-sustaining EV market is not anticipated before 2025 – a helpful starting point in considering sunset provisions.[154]

4.1.4 Reporting Requirements: Environmental Performance Reports

TNCs are required to submit annual reports with detailed information on certain aspects of their operations to the CPUC.[155] These reporting requirements were put in place primarily to ensure that all communities have equal access to TNC services regardless of racial or ethnic composition, and to address public safety concerns. TNCs are not currently required to report on the environmental impacts of their operations in any detail.[156]

Regular reporting of key parameters relating to the use of EVs in the TNC sector, and on the broader environmental impacts of TNC operations, would be beneficial regardless of whether new mandates/targets, incentives, or a fee structure relating to EV use on TNC platforms is put in place. This would increase transparency, allow the CPUC to monitor TNCs' environmental performance on an ongoing basis, and facilitate assessment of the need for stricter regulatory requirements over time. Among other things, it would be beneficial for the CPUC to have visibility into data on total VMT, total eVMT, number of miles driven in ICE vehicles and EVs, occupancy levels associated with pooled and other TNC trips, number of PHEVs and BEVs operating on the TNC platform, and the make, model, and fuel efficiency of each TNC vehicle. Not all of this information is currently recorded by TNCs. Depending on the scope of any new reporting requirements, TNCs may need to enhance their existing data collection processes in order to comply.

If the CPUC creates new reporting requirements relating to TNCs' environmental performance, it would need to consider whether such environmental data should be publicly released. Questions around the confidentiality of TNC data are being considered in an ongoing CPUC proceeding (R.12-12-011). Other jurisdictions have grappled with similar questions. In New York, the New York City Taxi and Limousine Commission (TLC), which regulates TNCs in New York City, publishes monthly data reported by TNCs.[157] Public access to this data has enabled analysis by non-governmental groups, which, in turn, has facilitated public dialogue around policy challenges presented by TNC operations.[158] Public disclosure of companies' environmental data, especially when combined with performance ratings, has been found to motivate improved environmental performance by enhancing external pressure to abate, and by creating a mechanism for management and employees to be better informed of their company's emissions profile and abatement opportunities on an ongoing basis.[159]

Should the CPUC choose to establish new reporting requirements for the TNC sector, it would need to consider several questions relating to design specifics. Some of these questions are highlighted below.

- Regional Reporting: TNC operations tend to be concentrated in large metropolitan areas, where the demand for TNC services is greatest.[160] There are likely significant disparities in the emissions impact of TNC operations across regions in California. Data at the regional level would be instructive in identifying these disparities, and enable tracking of the emissions impact of TNC operations in disadvantaged communities, relative to the state as a whole.

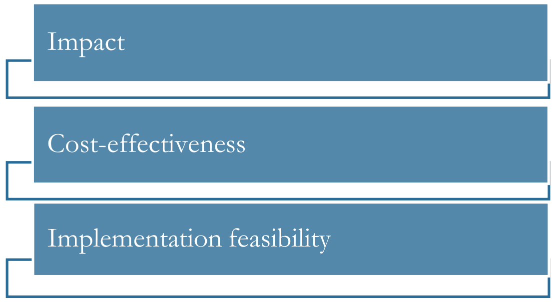
- Calculation Methodology: A standard methodology for calculation of the metrics/parameters to be reported on is necessary to draw an apples-to-apples comparison across TNCs.

- Frequency of Reporting: Requiring environmental data to be reported as part of the TNCs' annual reports would be the most streamlined and expedient approach. On the other hand, more frequent reporting (e.g., monthly or quarterly) would enable closer monitoring of the emissions footprint of the TNC sector. These benefits need to be weighed against the resource burden associated with more frequent data reporting and analysis, both at the TNC end and at the CPUC end.

4.2 A Framework for Comparison of Potential Regulatory Options

As a number of regulatory levers are available to the CPUC, a framework to compare them is necessary. Three parameters[161] – impact, cost-effectiveness, and implementation feasibility – are discussed below. We also outline a set of secondary factors for the CPUC to consider in evaluating available regulatory tools.

Figure 11: Key Parameters for Evaluation of Regulatory Tools



4.2.1 Impact

The CPUC must evaluate the potential for a regulatory tool to generate the intended outcomes, as well as any unintended consequences, in comparing the various regulatory options available to it.

- Potential to achieve state goals: The CPUC must consider the extent to which a certain type of regulatory action is likely to advance California's overall EV deployment goals and other policy imperatives (particularly the need to ensure environmental equity and justice consistent with California's statutory framework), and foster innovation to improve the environmental performance of the TNC sector and related industries.[162]

- Unintended impacts: Prior evaluation of the unintended impacts of a particular type of regulatory intervention on the TNC sector and related industries (e.g., the automotive industry, other modes of transport such as taxis, other companies in the EV infrastructure ecosystem, etc.) is necessary.[163] A pilot based approach might allow the CPUC and other stakeholders to better identify unintended consequences before a regulatory intervention is deployed at scale. Extensive stakeholder engagement (e.g., through a CPUC Rulemaking or other mechanism) to fully consider the potential repercussions of a proposed regulation may also be beneficial.

4.2.2 Cost Effectiveness

The goal of increasing EV use in the TNC sector must be pursued using the most cost-effective solutions that optimize (1) public resources, not only in terms of public funds, but also in terms of the scale of government resources needed to ensure effective implementation, and (2) private sector resources.

4.2.3 Implementation Feasibility

Finally, the CPUC must consider implementation feasibility, both in terms of the complexity of implementation at the TNC end, and the feasibility of monitoring implementation by the CPUC and other state agencies.

4.3 Key Overarching Considerations in Assessing Regulatory Options

As various state agencies are leading initiatives to increase EV use in California, coordination and collaboration between the CPUC and these agencies in developing any new regulations around EV use in the TNC sector is of critical importance. And, as noted earlier, a closer assessment of the limits of the CPUC's jurisdiction may be needed depending on the type of regulatory change that the CPUC seeks to initiate. Some other key considerations are discussed below.

4.3.1 Size Thresholds for Applicability of Regulatory Requirements

TNCs operating in California vary significantly in terms of the scale of their operations. Therefore, the CPUC may consider imposing a size threshold (e.g., based on annual revenue), such that new regulations apply only to TNCs that exceed the threshold.

4.3.2 Applicability of New Regulations to AVs Operated for Passenger Transportation

In general, AVs are unlikely to be well-suited to private ownership by TNC drivers due to the high costs of AV technology. Market trends suggest that the likely business model for AV use in the ride-sourcing sector is one in which companies own and operate a fleet of AVs.

Under the current regulatory regime, only a driver's personal vehicle may be used as a TNC vehicle.[164] By definition, TNCs cannot own and operate vehicles used on their platforms. At the time of writing this report, the CPUC was actively considering whether companies operating AVs on transportation service platforms should be required to obtain a permit to operate as a TNC, TCP, or under an alternate regulatory category to be designated by the CPUC. In the event that AVs are deployed at scale in the short to medium term, a regulatory framework applicable to TNCs only may quickly become outdated, and would need to be revised to extend to AVs used in the ride-sourcing sector. This eventuality could be avoided by establishing a regulatory framework applicable not only to TNCs, but also to the regulatory category applicable to AVs used on transportation service platforms.

4.3.3 Flexibility

As noted in an earlier section of this paper, TNCs are best positioned to assess passenger and driver behavior on an ongoing basis, and have the requisite analytical and technological resources needed to shape their operations in a manner that optimally advances environmental objectives. Therefore, any CPUC intervention must strike a balance between ensuring that environmental benefits are maximized and allowing TNCs sufficient flexibility to advance such objectives.

4.3.4 Hybrid Approaches

The CPUC might also consider whether a hybrid approach that combines one or more of the regulatory tools available to it would be most effective. In making this assessment, it is important to assess the combined impacts of two or more regulatory tools when implemented jointly, and the implications for overall emissions reduction from the TNC sector.

4.3.5 Adaptability

Given the rapid pace of technological change in the TNC sector, it is important to develop a regulatory framework that can be feasibly adapted to evolving market and technology shifts.

5 Conclusions and Questions for Future Research

The TNC sector has grown dramatically over the last few years. Yet, as the data presented in this paper shows, EVs continue to be used to a very limited degree on TNC platforms. This is particularly concerning given California's ambitious EV deployment goals, most recently expressed in a January 2018 executive order setting a new goal of 5 million EVs in the state by 2030. Several segments of the transportation sector that TNCs now compete with have historically been subject to some form of regulation pertaining to emissions reduction.

The increased use of EVs on TNC platforms will advance the state's overall EV deployment goals and put the sector on a lower emissions trajectory. There is sizeable, untapped potential to increase EV awareness through interactions between TNC EV drivers and passengers during the millions of trips being arranged on TNC platforms. This is an especially significant opportunity considering the persistently low EV awareness levels in California, the major investments being made by the state to address this problem, and the fact that firsthand exposure to EV technology is one of the most powerful information sources that influences buyers to opt for an EV.

Discussions with the two major TNCs operating in California and other stakeholders, and analysis of available data shows that TNC drivers face a range of barriers relating to both EV acquisition and use on TNC platforms, e.g., sticker price, access to vehicle financing, access to charging, etc. As data around EV use in the TNC space is limited, it is difficult to identify the most fundamental barrier that, if addressed, will most quickly accelerate the use of EVs on TNC platforms. Additional data, analysis and engagement with TNC drivers will allow more robust analysis of the impact of the rapid growth of TNCs on California's overall GHG emissions. The ambiguity around the overall impact of TNC operations on total VMT is a major analytical gap that is yet to be addressed.

There is a strong case for the reporting of data by TNCs relating to the use of EVs on their platforms. Regular reporting of key parameters relating to EV use will increase transparency, allow the CPUC to monitor performance on an ongoing basis, and facilitate assessment of the need for stricter regulatory requirements over time. Additionally, public reporting of companies' environmental data has been found to be associated with improved environmental performance over time.

In addition, or as an alternative, the CPUC may use incentives, mandates, or market based mechanisms to increase EV use on TNC platforms. Each of these options has pros and cons, as discussed in earlier sections of this paper. Deeper stakeholder engagement is needed to more fully evaluate and compare available alternatives. If the CPUC chooses to adopt one of these regulatory tools, starting with a pilot-based approach might be beneficial. Among other things, a pilot might allow the CPUC to identify potential unintended consequences before a regulatory change is implemented at scale.

Several important questions relating to the electrification of the TNC sector were beyond the scope of this paper, and merit thoughtful consideration. Some of these questions are outlined below.

- How do the regulatory tools discussed in this paper compare with each other in terms of cost effectiveness, impact, and implementation feasibility?
- What are the potential implications of increased regulatory requirements around EV use in the TNC sector on drivers and passengers, particularly for those from low income communities?
- What are the grid implications of growth in the number of EVs used on TNC platforms? To what extent can EVs used in the TNC sector complement grid needs?

In sum, there is an opportunity to advance California's overall EV deployment goals by accelerating EV use in the TNC sector, which will become increasingly significant if TNCs' current growth trends continue. The CPUC could play an important role in realizing this potential. The analysis presented in this paper is intended to serve as a starting point for the CPUC to consider key issues relating to the electrification of the TNC sector. Further data, analysis and stakeholder engagement will allow the CPUC to better quantify the extent of the opportunity, and the optimal way in which to exploit it.

Appendices

Appendix A

Figure 12 shows the total weekly usage at the top three EVgo DCFC charging stations used by Evercar customers in Los Angeles during eight weeks before and after the company's closure on Oct. 3, 2016. These sites delivered 19 percent more electricity during the eight weeks when Evercar was in operation than in the eight weeks following its closure.

Figure 12: Total kWh Delivered to Evercar and non-Evercar customers at Top 3 Evercar Sites, by week (08/07/2016 to 10/02/2016)

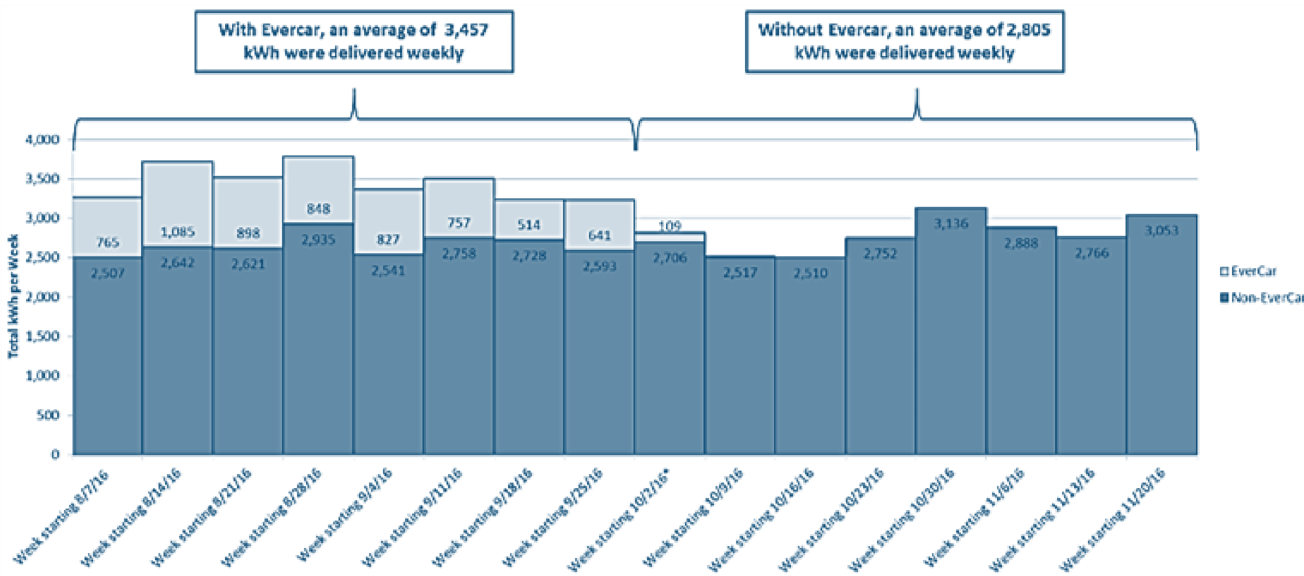


Figure 13 shows the average number of minutes per **weekday** that both Evercar and non-Evercar customers plugged in at the top three EVgo DCFC charging stations used by Evercar customers in Los Angeles, by time of day, for the period from Aug. 7, 2016-Oct. 2, 2016. Evercar vehicles were responsible for 20 percent of weekday plug-in minutes with the maximum percentage contribution (65 percent) occurring between 4-5 a.m. Evercar ceased operations on Oct. 3, 2016.

Figure 13: Average daily DCFC session minutes by Evercar and non-Evercar customers at top 3 sites Evercar sites, per site, on weekdays, by time (08/07/2016 to 10/02/2016)

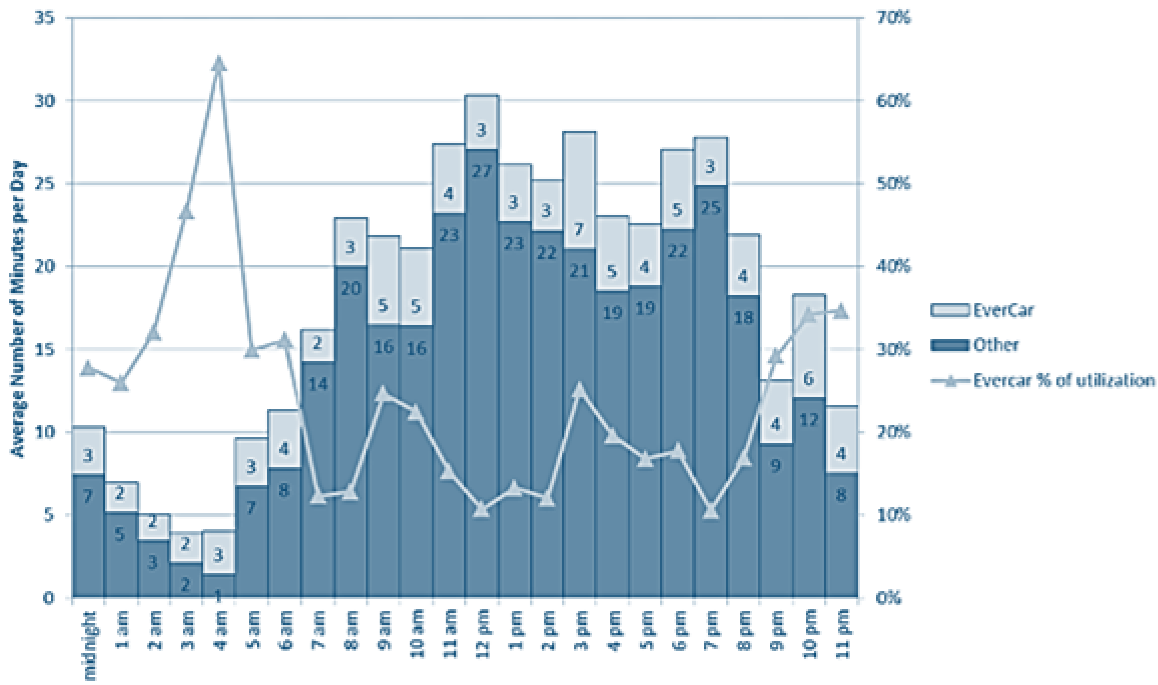
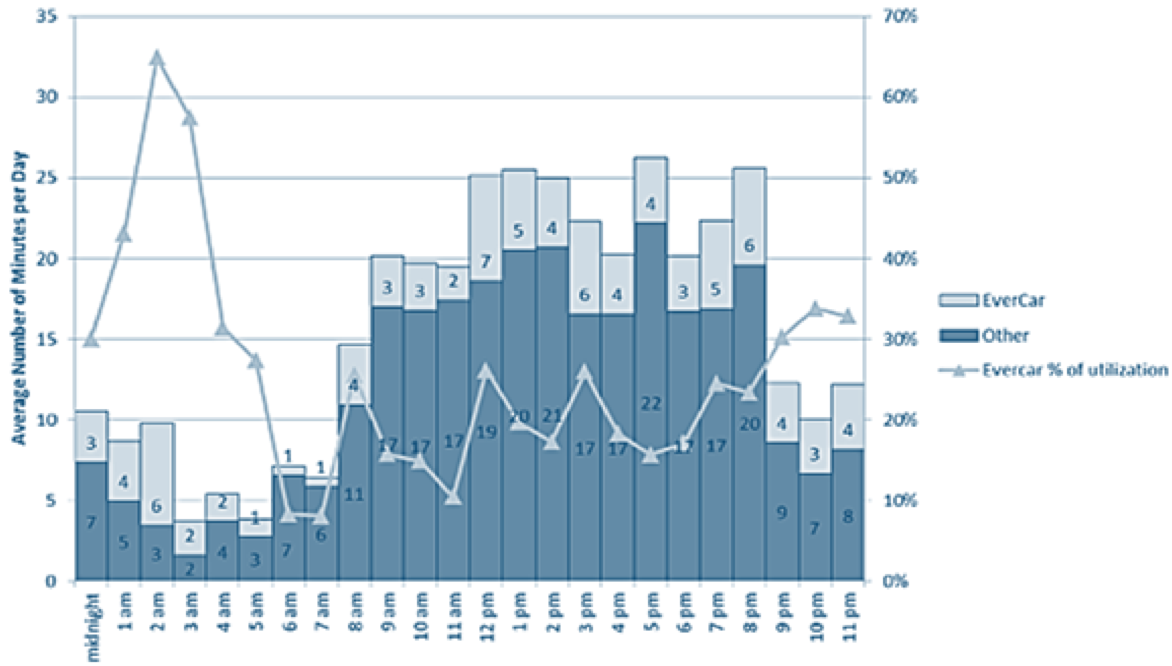


Figure 14 shows the average number of minutes per **weekend** day that both Evercar and non-Evercar customers plugged in at the top three EVgo DCFC charging stations used by Evercar customers in Los Angeles, by time of day, for the period from Aug. 7, 2016-Oct. 2, 2016. Evercar vehicles were responsible for 23 percent of weekend plug-in minutes with the maximum percentage contribution (65 percent) occurring between 2-3 a.m. Evercar ceased operations on Oct. 3, 2016.

Figure 14: Average daily DCFC session minutes by Evercar and non-Evercar customers at top 3 sites Evercar sites, per site, on weekends, by time (08/07/2016 to 10/02/2016)



Appendix D

This estimate of the CO_2 footprint of the TNC sector in California relates to the period from November 2016 – October 2017, and is restricted to data from Lyft and Uber.

1. Inputs and assumptions

- As most ICE vehicles in the U.S. are gasoline vehicles, this calculation makes the simplifying assumption that all ICE vehicles operated on TNC platforms are gasoline operated.

- Vehicles are required to meet certain criteria before they can be operated on TNC platforms. Uber's requirements vary by city. It requires that all vehicles used on its platform in Los Angeles[165], San Francisco,[166] and San Diego[167] be model year 2002 or newer. Similarly, Lyft requires that all vehicles used on its platform be model year 2004 or newer. To arrive at a conservative estimate, this calculation assumes that all vehicles registered on the two TNC platforms are model year 2004 or newer.

- Based on data made available by the U.S. Department of Transportation's Bureau for Transportation Statistics, the average fuel efficiency of light duty passenger vehicles for model years 2004-2015 is 33.2 miles per gallon.[168] Because data is not available for model years 2016 and 2017, for the sake of simplicity, this calculation assumes that all vehicles operational on TNC platforms are model years 2004-15.

- Additionally, we make the simplifying assumption that all EVs on TNC platforms are fully electric cars.

2. Estimate of CO_2 emissions from the TNC sector in California

Step 1
The average gasoline vehicle on a TNC platform has a fuel economy of 33.2 miles per gallon. Every gallon of gasoline burned creates about 8,887 grams of CO_2. Therefore, the approximate level of tailpipe CO_2 emissions per mile released by the average vehicle is:
CO_2 emissions per mile = (8,887/33.2) = 267.68 grams ("A")

Step 2
Total miles (deadhead miles + trip miles) driven in non-EVs from November 2016 - October 2017 = 3.43 billion miles ("B")

Step 3
Overall CO_2 emissions from the TNC sector from November 2016 – October 2017 = A*B = 0.918M metric tons of CO_2 ("C")

Based on data from the U.S. Environmental Protection Agency, this translates into the annual energy use of approximately 100, 000 households.[169]

Step 4
Overall emissions from California's transportation sector in 2015 amounted to 169.38 $MMTCO_2e$ ("D")[170]
CO_2 emissions from the TNC sector as a percentage of emissions from California's transportation sector in 2015 = (C/D)*100 = 0.54%

- **Seattle, Washington**

In 2014, the City of Seattle passed an ordinance regulating TNCs.[171] Among other things, the ordinance stipulates that TNC drivers shall not operate a TNC vehicle for more than 12 hours in a 15-hour span during any 24-hour period, and that drivers shall not cruise to pick up passengers or solicit trips. Additional regulatory requirements apply to TNC drivers operating at the Seattle Tacoma International Airport, which is operated by the Port of Seattle. For instance, TNCs are required to either operate a green vehicle-only airport fleet (with each vehicle meeting a minimum fuel efficiency standard of 47 miles per gallon) or comply with the Port's Environmental Key Performance Indicator (E-KPI) green standard, which establishes a minimum standard for the fleet's fuel efficiency, reduction of deadheading, and pooling.[172] TNCs are also required to submit monthly information on each vehicle servicing the airport (e.g., data regarding pick-up and drop-off times).

- **Chicago, Illinois**

In 2014, the City of Chicago passed an ordinance establishing a licensing and regulatory framework for ride-sourcing companies operating in the city.[173] The city imposes a 65 cent fee on each TNC trip, and a separate $5 fee on trips that originate or end at major airports and other high demand areas.[174]

- **New York City**

The New York City Taxi and Limousine Commission (TLC), which regulates TNCs in New York City, has established reporting requirements for all TNCs operating in the city, and routinely publishes detailed monthly data reported by the companies.[175] Among other things, TNCs are required to report the date, time and origin of each trip. In February 2018, a New York state task force proposed fees of $2-$5 on all rides in for-hire vehicles in Manhattan.[176] In 2017, New York approved a 4 percent fee on TNC trips that originate outside New York City.[177]

[1] This mirrors the definition of ZEVs in California's 2016 ZEV Action Plan. See California Governor's Interagency Working Group on ZEVs, "2016 ZEV Action Plan", October 2016, at p. 4, available at https://cafcp.org/blog/2016-zev-action-plan-state-california.
[2] CARB, "Cap-and-Trade Auction Proceeds Funding Guidelines for Agencies that Administer California Climate Investments", December 2015, available at https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/arb-funding-guidelines-for-ca-climate-investments.pdf.
[3] https://www.arb.ca.gov/msprog/zevprog/factsheets/driveclean.pdf.
[4] This definition was developed by the CPUC in "Decision Adopting Rules and Regulations to Protect Public Safety While Allowing New Entrants to The Transportation Industry" (Decision 13-09-045), issued on September 19, 2013.
[5] CARB, "Fact Sheet: Air Pollution in California", https://www.arb.ca.gov/msprog/zevprog/factsheets/driveclean.pdf.
[6] This paper focuses on plug-in electric vehicles, i.e. battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs), given that a very small number of FCEVs are currently used in California.
[7] California Pub. Util. Code 5431(c).
[8] The grid implications of EV use on TNC platforms, cost-effectiveness of potential solutions to reduce TNC sector emissions relative to other economy-wide opportunities for emissions reduction, and a detailed examination of developments relating to autonomous vehicle technology are also beyond the scope of this paper.
[9] B. Schaller, "UNSUSTAINABLE? The Growth of App -Based Ride Services and Traffic, Travel and the Future of New York City", February 2017, available at http://schallerconsult.com/rideservices/unsustainable.pdf.
[10] See generally R. Hahn et al., "The Ridesharing Revolution: Economic Survey and Synthesis", January 10, 2017, available at https://www.brookings.edu/wp-content/uploads/2017/01/ridesharing-oup-1117-v6-brookings1.pdf.
[11] A full list of companies to which the CPUC has issued TNC permits can be accessed at http://www.cpuc.ca.gov/General.aspx?id=3091.
[12] CARB, "California Greenhouse Gas Emission Inventory - 2017 Edition", available at https://www.arb.ca.gov/cc/inventory/data/data.htm.
[13] CARB, "California GHG Emission Inventory – 2017 Edition", June 2017, at p. 5, available at https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2015/ghg_inventory_trends_00-15.pdf.
[14] *Supra* note 12.
[15] Air Resources Board, "Greenhouse Gas Emission Inventory - Query Tool for years 2000 to 2015 (10th Edition)", available at https://www.arb.ca.gov/app/ghg/2000_2015/ghg_sector.php.
[16] *Ibid.*
[17] In addition to TNCs, the Commission regulates charter party carriers (TCPs) (e.g. limousines, airport shuttles, charter and scheduled bus operators). Key features of TCPs are as follows - TCPs charter a vehicle, on a prearranged basis for the exclusive use of an individual or group. Charges are based on mileage or time of use, or a combination of both. Based on data collected by the CPUC's Consumer Protection and Enforcement Division, as of October 2017, the total number of TNC vehicles registered with the CPUC (289,594) was nearly 10 times the total number of TCP vehicles in California (30,861).
[18] For further information, see CPUC Transportation License Division, "Basic Information for Transportation Network Companies and Applicants", available at http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/Licensing/Transportation_Network_Companies/BasicInformationforTNCs_7615.pdf.
[19] Major TNCs operating in California currently have vehicle requirements in place. For instance, Lyft's requirement is that all vehicles are model year 2004 or newer. See generally https://www.lyft.com/driver-application-requirements/undefined.
[20] The Clean Energy and Pollution Reduction Act, 2015 (Chapter 547, Statutes of 2015), (SB 350), which established new greenhouse gas reduction goals for 2030 and beyond, is focused on transportation electrification activities. SB 350 added Pub. Util. Code § 740.12 to address transportation electrification. P.U. Code Section 740.12(b) states that the CPUC "[…] in consultation with the State Air Resources Board and the Energy Commission, shall direct electrical corporations to file applications for programs and investments to accelerate widespread transportation electrification […]."
[21] D.13-09-045.
[22] D.16-04-041.
[23] More information available on CARB's Plug-in Electric Vehicle Resource Center webpage, "PEV Types", https://www.driveclean.ca.gov/pev/Plug-in_Electric_Vehicles/PEV_Types.php.
[24] US Department of Energy, "How Do Fuel Cell Electric Vehicles Work Using Hydrogen?", available at https://www.afdc.energy.gov/vehicles/how-do-fuel-cell-electric-cars-work.
[25] Governor's Office Executive Order B-16-2012, March 2012, available at https://www.gov.ca.gov/2012/03/23/news17472/.
[26] "Governor Brown Takes Action to Increase Zero-Emission Vehicles, Fund New Climate Investments", January 2018, https://www.gov.ca.gov/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/.
[27] California's Climate Change Investment Plan, January 2018, at p. 2, available at http://www.ebudget.ca.gov/2018-19/pdf/BudgetSummary/ClimateChange.pdf.
[28] California New Car Dealers Association, "California Auto Outlook", Vol. 13 (2), May 2017, available at http://www.cncda.org/CMS/Pubs/CA%20Auto%20Outlook%201Q%202017.pdf; R. Nikolewski, "Electric vehicle sales rise in California", *LA Times*, May 17, 2017, available at http://www.latimes.com/business/autos/la-fi-hy-electric-vehicles-

20170517-story.html.

[29] California Energy Commission, "Tracking Progress: Zero-Emission Vehicles and Infrastructure", July 2017, at p. 4, available at http://www.energy.ca.gov/renewables/tracking_progress/documents/electric_vehicle.pdf.

[30] Based on data available at http://www.veloz.org/.

[31] *Supra* note 29.

[32] See for example P. Eisenstein, "GM Is Going All Electric, Will Ditch Gas- and Diesel-Powered Cars", *NBC*, October 2, 2017, https://www.nbcnews.com/business/autos/gm-going-all-electric-will-ditch-gas-diesel-powered-cars-n806806; A. Vaughan, "Jaguar Land Rover to make only electric or hybrid cars from 2020", *The Guardian,* September 7, 2017, https://www.theguardian.com/business/2017/sep/07/jaguar-land-rover-electric-hybrid-cars-2020;

[33] A.17-01-020 et al., A.17-06-031 et al., and others.

[34] Data request from the Commission's Policy and Planning Division dated November 20, 2017.

[35] CPUC, "Insurance Requirements for TNCs", available at http://www.cpuc.ca.gov/General.aspx?id=3802

[36] "Opening Comments Of San Francisco International Airport and the San Francisco Municipal Transportation Agency to Phase IIIB Scoping Memo and Ruling of Assigned Commissioner, Track 3 – TNC Data", R.12-12-011, July 17, 2017, at p., 4, available at https://goo.gl/HXY98a.

[37] California Department of Transportation, "Travel on State Highways", October 2017, available at http://www.dot.ca.gov/trafficops/census/docs/oct2017-travel.pdf.

[38] "California's 2017 Climate Change Scoping Plan", November 2017, available at https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf, at p. 101.

[39] There are at least two other complicating factors. Where non-pooled TNC rides substitute solo rides in personal vehicles, it is likely that the deadhead miles associated with TNC rides are incremental miles, and therefore increase total VMT. On the other hand, where pooled rides in TNC vehicles substitute solo rides in personal vehicles, TNC use could potentially have the opposite effect on total VMT.

[40] R. Clewlow, "Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States", October 2017, available at http://www.reginaclewlow.com/pubs/2017_UCD-ITS-RR-17-07.pdf. Another study based on a survey conducted in San Francisco in 2014 found that 8 percent of survey respondents would not have made their ride-sourcing trip if they had no access to ride-sourcing services. Of those who would still have made the trip even if ride-sourcing services were not available, 39 percent reported that they would have used a taxi, 33 percent said bus or rail, and 6 percent reported that they would have used their personal vehicle. The authors concluded that ride-sourcing might replace some private automobile use, but might also induce travel, and that ride-sourcing competes with public transit for individual trips, but may sometimes serve as a complement, making the impact on total VMT uncertain. (L. Rayle et al., "Just a better taxi? A survey-based comparison of taxis, transit, and ride sourcing services in San Francisco", *Transport Policy,* Volume 45, January 2016, pp. 168-178, available at https://www.sciencedirect.com/science/article/pii/S0967070X15300627). This survey relied on a convenience sample, and the authors note that it is only intended to be an exploratory study, given several survey limitations.

[41] One report found that of riders who listed ride-sourcing as their preferred mode of transport, 34 percent would have driven alone or with a friend, 8 percent would have used a taxi, 14 percent would have used public transit, and 24 percent said they would have used car sharing if they had no access to TNCs. The cities surveyed generally had relatively good public transit systems (Austin, Boston, Chicago, Los Angeles, San Francisco, Seattle and Washington, DC). (See American Public Transportation Association, "Shared Mobility And The Transformation Of Public Transit", March 2016, at p. 16, available at https://www.apta.com/resources/reportsandpublications/Documents/APTA-Shared-Mobility.pdf). A survey of Uber riders in the Denver area found that 31 percent of passengers would have used a personal vehicle or rental car if TNCs were not available, 28 percent would have used public transit or carpooled as a passenger. The remaining passengers would have used taxis, other TNCs or not made the trip at all (A. Henao, "Impacts of Ride-sourcing on VMT, Parking, Mode Replacement, and Travel Behavior," presented at the 96th Annual Meeting of Transportation Research Board, Washington DC, January 2017, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2977969). All of these studies used convenience samples to derive their conclusions.

[42] In 2016, residents of Austin, TX voted against Proposition 1, which would have allowed TNCs to continue using their own background check systems. The defeat of this proposition prompted Lyft and Uber to suspend services in Austin indefinitely. For more information, see M. Mekelburg, "Austin's Proposition 1 Defeated", May 7, 2016, available at https://www.texastribune.org/2016/05/07/early-voting-austin-proposition-against/.

[43] R. Hampshire et al., "Measuring the Impact of an Unanticipated Suspension of Ride-Sourcing in Austin, Texas", May 2017, available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2977969.

[44] G. Circella et al., "The Adoption of Shared Mobility in California and Its Relationship with Other Components of Travel Behavior", February 2018, at p. 5, available at https://ncst.ucdavis.edu/wp-content/uploads/2016/10/NCST-TO-033.1-Circella_Shared-Mobility_Final-Report_FEB-2018.pdf.

[45] *Supra* note 9, at p. 31.

[46] *Supra* note 44, at p. 5.

[47] *Supra* note 9, at p. 32. See also National Academy of Sciences, "Broadening Understanding of the Interplay Between Public Transit, Shared Mobility, and Personal Automobiles", January 2018, at p. 38, available at https://www.nap.edu/download/24996#. This study which analyzed data on TNC use at the national level, concluded that further research is needed to identify TNCs' net impact on vehicle ownership and VMT.

[48] SFCTA, "TNCs Today: A Profile of San Francisco Transportation Network Company Activity", June 2017, http://www.sfcta.org/sites/default/files/content/Planning/TNCs/TNCs_Today_112917.pdf.

[49] Cramer et al., "Disruptive Change in the Taxi Business: The Case of Uber", NBER Working Paper No. 22083, March 2016, available at http://www.nber.org/papers/w22083.
[50] See for instance Uber, "Driving a More Sustainable Future of Mobility", November 2017, available at http://citysummit.nlc.org/files/2017/09/NLC-City-Summit-2017-Presentation-New-Approaches-for-a-More-Sustainable-Future-of-Urban-Mobility.pdf.
[51] See E. Castor Warren, "Reflections on Lyft Shuttle: How Microtransit Can Expand Mobility and Beat Car Ownership" July 12, 2017, available at https://medium.com/@emilycwarren/reflections-on-lyft-shuttle-how-microtransit-can-expand-mobility-and-beat-car-ownership-c39341d69c56.
[52] More information available at https://www.uber.com/ride/express-pool/.
[53] *Supra* note 51.
[54] A study based on a 2014 survey of TNC customers in San Francisco found that the average number of passengers per ride-sourcing trip was 2.1. (L. Rayle et al., "Just a better taxi? A survey-based comparison of taxis, transit, and ride sourcing services in San Francisco", *Transport Policy,* Volume 45, January 2016, at p. 3.7, available at https://www.sciencedirect.com/science/article/pii/S0967070X15300627). This survey relied on a convenience sample, and the authors note that it is only intended to be an exploratory study, given several survey limitations.
[55] *Supra* note 9, at p. 24.
[56] https://www.driveclean.ca.gov/pev/Plug-in_Electric_Vehicles/Maintenance.php.
[57] On the other hand, PHEV maintenance costs are similar to those for ICE vehicles, because they have gasoline engines. See Department of Energy, Office of Energy Efficiency and Renewable Energy, "Electric Car Safety, Maintenance, and Battery Life", available at https://energy.gov/eere/electricvehicles/electric-car-safety-maintenance-and-battery-life.
[58] Non fast-charging options are generally significantly cheaper than fueling an ICE vehicle. Charging using a DCFC charging station can be costlier per mile than fueling an ICE vehicle. See G. Fitzgerald, "From Gas to Grid: Building Charging Infrastructure to Power Electric Vehicle Demand", October 3, 2017, at p. 52, available at https://www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf.
[59] All 3 major IOUs in California – Pacific Gas & Electric, Southern California Edison, and San Diego Gas & Electric – offer such rates.
[60] M. Sivak et al., "Relative Costs of Driving Electric and Gasoline Vehicles in the Individual U.S. States", January 2018, at p. 4. See also Department of Energy, Office of Energy Efficiency and Renewable Energy, "Relative Costs of Driving Electric and Gasoline Vehicles in the Individual U.S. States", available at https://www.energy.gov/eere/electricvehicles/saving-fuel-and-vehicle-costs.
[61] K. Palmer et al., "Total Cost of Ownership and Market Share for Hybrid and Electric Vehicles in the UK, US and Japan", *Applied Energy*, 209 (2018) 108-119, available at https://www.sciencedirect.com/science/article/pii/S030626191731526X?via%3Dihub#.
[62] CARB, "California's Advanced Clean Cars Midterm Review - Appendix B: Consumer Acceptance of Zero Emission Vehicles and Plug-in Hybrid Electric Vehicles", January 2017, at p. B-41, available at https://www.arb.ca.gov/msprog/acc/acc-mtr.htm.
[63] K. Kurani et al., UC Davis Institute of Transportation Studies, "Automakers and Policymakers May Be on a Path to Electric Vehicles; Consumers Aren't", available at https://its.ucdavis.edu/blog-post/automakers-policymakers-on-path-to-electric-vehicles-consumers-are-not/.
[64] *Supra* note 62, at p. B-39.
[65] *Ibid*, at p. B-41.
[66] California Governor's Interagency Working Group on ZEVs, "2016 ZEV Action Plan", October 2016, at pp. 15-16, available at https://cafcp.org/blog/2016-zev-action-plan-state-california.
[67] Based on EV driver feedback collected by Uber in focus group meetings in San Diego, London, and San Francisco (see Box 3), and the two TNCs' response to a data request from the Commission dated November 20, 2017.
[68] For instance, in a survey of Uber drivers in London, close to 60 percent of the drivers reported that riders reacted or commented on the vehicle being electric several times in a work period. See Energy Savings Trust, "Electric Private Hire Vehicles in London – On the Road, Here and Now", May 2017, at pp. 25-26, available at http://www.energysavingtrust.org.uk/sites/default/files/reports/195268%20Uber%20EV%20Trial%20-%20Electric%20Private%20Hire%20Vehicles%20in%20London%20V2.pdf.
[69] National Academy of Sciences, "Broadening Understanding of the Interplay Between Public Transit, Shared Mobility, and Personal Automobiles", January 2018, at p. 27, available at https://www.nap.edu/download/24996#. See also R. Clewlow, "Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States", October 2017, at p. 14, available at http://www.reginaclewlow.com/pubs/2017_UCD-ITS-RR-17-07.pdf.
[70] J. Hall et al., "An Analysis of the Labor Market for Uber's Driver-Partners in the United States", Working Paper #587, Princeton University Industrial Relations Section, January 2015, available at http://arks.princeton.edu/ark:/88435/dsp010z708z67d.
[71] *Supra* note 29, at p. 4.
[72] See California DMV, "California DMV Statistics", January 2017, available at https://goo.gl/4dUi8X. Automobile is defined as "a passenger vehicle that does not transport persons for hire. This includes station wagons, sedans, vans, and sport utility vehicles" (https://www.dmv.ca.gov/portal/dmv/detail/online/fee_calc/vehdef).
[73] CARB, "Advanced Clean Transit", May 2015, at p. 15, available at https://www.arb.ca.gov/msprog/bus/workshoppresentation.pdf.
[74] CARB, "Public Workshop on the Proposed Innovative Clean Transit Regulation Discussion Document", December 15,

2017, available at https://arb.ca.gov/msprog/ict/meeting/mt171215/171215ictconcept.pdf.
[75] *Supra* note 69, at p. 3.
[76] San Francisco's 2008 Green Taxi Ordinance specified that average per-vehicle GHG emissions be reduced by 20 percent below 1990 levels by 2012. San Francisco almost doubled the size of its taxi fleet while achieving a 10 percent total reduction in GHG emissions over this time period. San Francisco's Department of the Environment, 'San Francisco Climate Action Strategy", 2013, at p. 30, available at https://sfenvironment.org/sites/default/files/engagement_files/sfe_cc_ClimateActionStrategyUpdate2013.pdf.
[77] City and County of San Francisco, "Resolution to Reduce, Offset, and Eliminate Greenhouse Gases in the San Francisco Taxi Industry", June 12, 2007, available at http://archives.sfmta.com/cms/ctaxicomm/documents/2008/Agenda%20Item6-Clean%20Air%20Policy-9pgs.pdf.
[78] South Coast Air Quality Management District (SCAQMD), "2016 Clean Car Guide", at p. 8, available at http://www.aqmd.gov/docs/default-source/publications/aqmd-advisor/2016-buyers-guide.pdf?sfvrsn=4. Full text of rule available at http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1194.pdf?sfvrsn=4.
[79] See generally Los Angeles Department of Transportation, "Los Angeles Taxicab Review And Performance Report, 2014-15", January 2017, available at http://ladot.lacity.org/sites/g/files/wph266/f/Los%20Angeles%20Taxicab%20Review%20and%20Performance%20Report%202017.pdf. The City of Los Angeles' Board of Taxicab Commissioners' Order No. 062, passed in 2010, describes all of the Green Taxi Program requirements. Four potential vehicle greening levels have been established, with minimum annual requirements for the type and number of green taxis to be added to each fleet every year. Full text of Board Order No. 062 available at http://ladot.lacity.org/sites/g/files/wph266/f/BO%20062%20-20green%20taxicab%20program.pdf.
[80] City of San Diego, "Council Policy No. 500-02 on Taxicab Permits", March 14, 2015, available at http://docs.sandiego.gov/councilpolicies/cpd_500-02.pdf
[81] See generally CARB, "Zero-Emission Airport Shuttle Bus", available at https://www.arb.ca.gov/msprog/asb/asb.htm.
[82] EVgo, "Settlement Year 4 Progress Report to the California Public Utilities Commission on Electric Vehicle Charging Station Project", March 5, 2017, available at http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442452815.
[83] Further, because charging costs were rolled into Evercar's rental package, no incremental costs were associated with each charging event. Therefore, drivers with access to other charging options may have opted for EVgo's public DCFC charging. It is unclear if the increase in charger utilization reflected in the EVgo-Evercar data would be observed to a similar extent were customers charged for each charging station.
[84] See generally G. Fitzgerald, "From Gas to Grid: Building Charging Infrastructure to Power Electric Vehicle Demand", October 3, 2017, at p. 52, available at https://www.rmi.org/wp-content/uploads/2017/10/RMI-From-Gas-To-Grid.pdf.
[85] National Highway Traffic Safety Administration (NHTSA), "Automated Vehicles for Safety", available at https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety.
[86] The list of permit holders can be accessed at https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/permit.
[87] The regulations may be accessed at https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/auto.
[88] In July 2017, Lyft announced the opening of its self-driving technology division. See L. Vincent, "Introducing Level 5 and Our Self-Driving Team", July 2017, available at https://medium.com/@lvincent/introducing-level-5-and-our-self-driving-team-705ef8989f03.
[89] M Isaac, "Lyft Adds Ford to Its List of Self-Driving Car Partners" September 27, 2017, available at https://www.nytimes.com/2017/09/27/technology/lyft-ford-self-driving-cars.html; https://www.uber.com/info/atg/.
[90] N. Pollard, "Volvo Cars to supply Uber with up to 24,000 self-driving cars", November 20, 2017, available at https://www.reuters.com/article/us-volvocars-uber/volvo-cars-to-supply-uber-with-up-to-24000-self-driving-cars-idUSKBN1DK1NH.
[91] M. McFarland, "Lyft changes gears to build its own self-driving tech", July 21, 2017, available at http://money.cnn.com/2017/07/21/technology/future/lyft-building-self-driving-vehicle-technology/index.html.
[92] Companies such as nuTonomy, Land Rover, Ford and others have joined this initiative. See M Isaac, "Lyft Adds Ford to Its List of Self-Driving Car Partners" September 27, 2017, available at https://www.nytimes.com/2017/09/27/technology/lyft-ford-self-driving-cars.html.
[93] D. Wakabayashi, "Waymo's Autonomous Cars Cut Out Human Drivers in Road Tests", November 7, 2017, available at https://www.nytimes.com/2017/11/07/technology/waymo-autonomous-cars.html.
[94] D. Anair et al., "Capturing the Climate Benefits of Autonomous Vehicles", February 2017, available at https://3rev.ucdavis.edu/wp-content/uploads/2017/03/3R.Climate.Indesign.Final_.pdf.
[95] Greenblatt et al., "Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles", *Nature Climate Change*, Volume 5, September 2015.
[96] J. Weiss et al., "The Electrification Accelerator: Understanding the implications of autonomous vehicles for electric utilities", *The Electricity Journal*, 30 (2017) 50-57, at p. 53. This paper cites a recent review of studies by the National Renewable Energy Laboratory on automated driving, which found that VMT could increase between 50 percent and 300 percent with widespread deployment of AVs. See also A. Rice et al., "How will autonomous vehicles transform the built environment?", October 16, 2017, available at https://www.brookings.edu/blog/the-avenue/2017/10/16/how-will-autonomous-vehicles-transform-the-built-environment/.
[97] H. Jennings, "Cities will need to fight zero-occupant miles with "TDM for autonomous vehicles"", May 30, 2017, available at https://mobilitylab.org/2017/05/30/tdm-for-autonomous-vehicles/#author-destination.
[98] See https://medium.com/self-driven/optimizing-our-self-driving-vehicle-to-better-serve-you-3f5d394e1df0.
[99] N. Carey, "Fiat Chrysler, Waymo expand deal for self-driving public ride-hailing service", *Reuters*, January 29, 2018, available

at https://www.reuters.com/article/us-fiat-chrysler-waymo/fiat-chrysler-waymo-expand-deal-for-self-driving-public-ride-hailing-service-idUSKBN1FJ0GN.

[100] A. Barr, "Waymo Gets the O.K. for a Commercial Driverless Ride-Hailing Service", *Bloomberg Technology*, February 16, 2018, available at https://www.bloomberg.com/news/articles/2018-02-16/waymo-gets-o-k-for-commercial-driverless-ride-hailing-service.

[101] See https://blog.lyft.com/posts/expressdrive.

[102] For instance, both Lyft and Uber have ongoing partnerships with the car rental company, Hertz, in select locations. See https://www.hertz.com/rentacar/misc/index.jsp?targetPage=UberFAQs.jsp; https://thehub.lyft.com/express-drive-hertz-update/.

[103] For instance, in London, Uber partnered with EV rental companies as part of these efforts. In India, Uber has announced that it will partner with Indian automaker, Mahindra and Mahindra, to pilot EVs on its platform. As part of this effort, Uber will initially subsidize the cost of EVs for its drivers. Mahindra will provide services such as finance, insurance, servicing etc. Both companies will partner in setting up charging stations for EVs on their platform. See P. Mukherjee, "Uber to partner with Mahindra to pilot electric vehicles in India", November 23, 2017, available at https://www.reuters.com/article/us-uber-mahindra-india/uber-to-partner-with-mahindra-to-pilot-electric-vehicles-in-india-idUSKBN1DO0MQ

[104] Information sourced from https://www.uber.com/drive/los-angeles/vehicle-requirements/; https://www.uber.com/drive/san-francisco/vehicle-requirements/; https://www.uber.com/drive/san-diego/vehicle-requirements/; https://www.lyft.com/driver-application-requirements/california.

[105] A common standard mileage restriction is 12,000 miles. The average annual VMT by a light duty vehicle in the U.S. is 11,346 miles (https://www.afdc.energy.gov/data/10309). Assuming that TNC drivers are driving their vehicles for approximately 11,000 miles for personal use, additional driving for TNC purposes would very likely lead to lease mileage caps being exceeded.

[106] Uber's Response (dated December 1, 2017) to the CPUC Policy and Planning Division's Nov. 20, 2017 data request.

[107] Lyft, "Express Drive Expands Footprint to California and Colorado", July 22, 2016, available at https://blog.lyft.com/posts/express-drive-expands-footprint-california.

[108] Lyft's Response (dated December 1, 2017) to the CPUC Policy and Planning Division's Nov. 20, 2017 data request.

[109] Information sourced from https://www.census.gov/quickfacts/CA.

[110] A December 2014 survey of Uber drivers conducted by a third party organization, at Uber's request, in 20 markets that represented 85 percent of Uber's U.S. drivers offers interesting insights. A total of 601 drivers completed the survey. The survey found that Uber income is the largest income source for 40 percent of drivers surveyed. However, only 15 percent reported working for more than 35 hours. The gross median hourly earnings of Uber drivers across the markets surveyed were reported to be $19.19/hour. For the 24 percent of drivers for whom Uber was their only source of income, the average annual income for a 35-hour work week is $34,926 ($19.19*35*52). This does not take expenses into account, or that partners are independent contractors, and therefore do not benefit from medical insurance or other benefits offered to employees. As only 15 percent of the drivers worked more than 35 hours, it is likely that of the drivers for whom Uber is the only income source, several earn less than $34,926. See J. Hall, "An Analysis of the Labor Market for Uber's Driver-Partners in the United States", NBER Working Paper No. 22843, November 2016, at p. 7, available at http://www.nber.org/papers/w22843.

[111] CARB, "California's Advanced Clean Cars Midterm Review - Summary Report for the Technical Analysis of the Light Duty Vehicle Standards", January 2017, at p. 179, available at https://www.arb.ca.gov/msprog/acc/mtr/acc_mtr_summaryreport.pdf. In addition to household income, the presence of single family homes and housing value (a proxy for wealth) are among the most significant explanatory variables with a large, positive correlation with PEV sales. The study also presents evidence suggesting that BEVs are clustered in higher-income, suburban tracts.

[112] UCLA, "Factors Affecting Plug-In Electric Vehicle Sales in California", May 23, 2017, at p. 56, available at https://www.arb.ca.gov/research/apr/past/13-303.pdf.

[113] *Ibid,* at p. 42.

[114] *Ibid,* at p. 41.

[115] *Ibid.*

[116] *Supra* note 106 and 108.

[117] *Supra* note 62, at p. B-107.

[118] An analysis of over 2.1 million sales of used cars conducted by the used-vehicle website iSeeCars.com showed that six of the 10 vehicles that spend the fewest days on the market were PEVs. J. Gorzelany, "The Fastest-Selling Used Cars Are EVs And Plug-In Hybrids", *Forbes*, September 22, 2017, available at https://www.forbes.com/sites/jimgorzelany/2017/09/22/the-fastest-selling-used-cars-are-now-evs-and-plug-in-hybrids/#49e41f549c68.

[119] California offers some financial incentives to eligible low income drivers who scrap an old car and buy a cleaner and more fuel-efficient new or used replacement car. Further information available at https://www.arb.ca.gov/msprog/aqip/efmp/efmp.htm.

[120] *Supra* note 62, at p. B-110.

[121] *Ibid.*

[122] *Supra* note 112, at p. 68.

[123] *Supra* note 111, at p. ES-48.

[124] CARB, "California Air Resources Board approves $663 million funding plan for clean cars, trucks, buses", December 14, 2017, available at https://ww2.arb.ca.gov/news/california-air-resources-board-approves-663-million-funding-plan-clean-cars-trucks-buses.

[125] S. Edelstein, "Six new electric cars coming for 2018 and 2019", March 2, 2017, available at https://www.greencarreports.com/news/1109129_six-new-electric-cars-coming-for-2018-and-2019/page-2. Several new EV models with >200 miles of range have been announced, e.g. the 2018 Hyundai Kona, the 2018 Kia Niro, and the Tesla 2018 Model 3. The 2018 Nissan Leaf has a range of 151 miles, whereas the 2018 Chevrolet Bolt has a range of 238 miles.
[126] Based on feedback shared by Uber EV drivers at focus group meetings.
[127] *Supra* note 62, at p. B-107, available at https://www.arb.ca.gov/msprog/acc/acc-mtr.htm. Uber reports that a significant number of drivers on the Uber platform rely on leases or short term rentals to acquire cars for use on the platform. This is supported by the fact that a growing market providing prospective TNC drivers with vehicles for use on TNC platforms is developing, and new market players are entering this space, suggesting latent demand for vehicles that may be used on TNC platforms.
[128] *Supra* note 106.
[129] Next 10, "The Road Ahead for Zero-Emission Vehicles in California Market Trends & Policy Analysis" January 30, 2018, at p. 25, available at http://next10.org/zev.
[130] *Supra* note 106.
[131] See G. Fitzgerald et al., "EVgo Fleet and Tariff Analysis", March 2017, available at https://www.rmi.org/wp-content/uploads/2017/04/eLab_EVgo_Fleet_and_Tariff_Analysis_2017.pdf.
[132]Nissan's 'No Charge to Charge' program is one example; further information available at https://www.nissanusa.com/content/dam/nissan/vehicles/2015/leaf/charging-range/no-charge-to-charge-page/NCTC-program-details.pdf. Tesla also offers charging incentives. See https://www.tesla.com/support/supercharging.
[133] R.13-11-007.
[134] Based on EV driver feedback collected by Uber in focus group meetings (see Box 3).
[135] B. Eckhouse, "Tesla Tells New Taxi, Uber Drivers Not to Use its Superchargers", December 15, 2017, available at https://ww w.bloomberg.com/news/articles/2017-12-15/tesla-tells-new-taxi-uber-drivers-not-to-use-its-superchargers.
[136] Lyft, "Lyft Climate Impact Goals", June 15, 2017, available at https://blog.lyft.com/posts/2017/6/14/lyft-climate-impact-goals.
[137] F. Jones, "Uber launches Clean Air Plan for a Greener Future", September 8, 2017, available at https://www.uber.com/en-GB/newsroom/uber-launches-clean-air-plan-for-a-greener-future/.
[138] *Supra* note 106.
[139] Docket No. UM1811.
[140] These measures include an Ultra-Low Emission Zone (ULEZ) in Central London, congestion charges, and an "emissions charge" for older vehicles in central London that do not meet prescribed emission standards. See https://tfl.gov.uk/modes/driving/ultra-low-emission-zone/check-your-vehicle; https://tfl.gov.uk/modes/driving/emissions-surcharge.
[141] *Supra* note 137.
[142] *Ibid.*
[143] UBERblog, "Dubai, prepare to experience UberONE", October 8, 2017, available at https://www.uber.com/en-AE/blog/dubai/introducing-uberone/.
[144] The Commission may, in addition, establish broader GHG emission targets for the sector. However, the eVMT% metric is a more direct way of measuring and evaluating progress in terms of electrifying the TNC sector.
[145] California's experience with the renewable portfolio standard (RPS) – which set aggressive targets for the procurement of renewables by electric utilities – is instructive. Although the RPS model operates differently from targets that may apply in a TNC context in fundamental ways, California's experience with the RPS demonstrates the potential for mandates to accelerate market transformation.
[146] See generally Environmental Protection Agency, "Economic Incentives", available at https://www.epa.gov/environmental-economics/economic-incentives.
[147] R. Stavins, "Economic Incentives for Environmental Regulation", June 1997, available at https://www.belfercenter.org/sites/default/files/files/publication/Economic%20Incentives%20for%20Environmental%20Regulation%20-%20E-97-02.pdf.
[148] A "session" is defined by Uber as a period of use between a customer opening the Uber app and either requesting a ride or ceasing to use the app for a period of 30 minutes. Thus, multiple closings and openings of the app in a short period of time do not generate many sessions. The median elapsed time of a session is 31 seconds. See P. Cohen et al., "Using Big Data to Estimate Consumer Surplus: The Case of Uber", September 2016, NBER Working Paper No. 22627, at p. 6.
[149] *Ibid*, at p. 4.
[150] *Supra* note 69, at p. 4.
[151] More information on the Greenhouse Gas Reduction Fund available at https://www.arb.ca.gov/cc/capandtrade/auctionproceeds/auctionproceeds.htm.
[152] Along similar lines, Assembly Bill 1532 (AB 1532, Perez) requires that GGRF programs "maximize economic, environmental, and public health benefits" and "direct investment toward the most disadvantaged communities and households in the state." Senate Bill 535 (SB 535, de León) establishes a framework to direct GGRF investments and their associated benefits to disadvantaged communities, and requires that at least 25 percent of GGRF investments be directed to programs that benefit disadvantaged communities, and that at least 10 percent of the investments be spent in disadvantaged communities. See generally Rabin et al., "A Guide to Greenhouse Gas Reduction Fund Program Designs, Expenditures, and Benefits", August 2015, available at http://innovation.luskin.ucla.edu/sites/default/files/Final%20081915.pdf.

[153] *Supra* note 106.
[154] *Supra* note 111, at p. ES-48.
[155] TNCs are currently required to submit annual reports that include data on the mean number of hours and miles driven by each driver on the TNC platform, the number of rides requested and accepted by TNC drivers within each zip code where the TNC operates, the number of rides that were requested but not accepted by TNC drivers within each zip code where the TNC operates, the number of drivers that were found to have committed a violation and/or suspended.
[156] TNCs offering fare-splitting services are required to report on the environmental impact of fee-splitting operations as part of their annual reports. CPUC Decision 16-04-041, at p. 49.
[157] See generally B. Schaller, "UNSUSTAINABLE? The Growth of App -Based Ride Services and Traffic, Travel and the Future of New York City", December 2017, at pp.4-5, available at http://www.nyctaxinews.com/unsustainable.pdf. For more information, see http://www.nyc.gov/html/tlc/html/about/trip_record_data.shtml.
[158] *Id.*
[159] See generally S. Afsah et al., "How Do Public Disclosure Pollution Control Programs Work? Evidence from Indonesia", October 2000, available at http://www.rff.org/files/sharepoint/WorkImages/Download/RFF-DP-00-44.pdf. See also H. Wang et al., "Environmental performance rating and disclosure: China's GreenWatch program", *Journal of Environmental Management*, Volume 71, Issue 2, June 2004, Pages 123-133, available at https://www.sciencedirect.com/science/article/pii/S0301479704000337.
[160] *Supra* note 158, at p. 14. See also *supra* note 44.
[161] For a useful discussion of the topic of assessing environmental tools, see U.S. Congress, Office of Technology Assessment, "Environmental Policy Tools: A User's Guide", OTA-ENV-634 (Washington, DC: U.S. Government Printing Office, September 1995), available at https://www.princeton.edu/~ota/disk1/1995/9517/9517.PDF.
[162] *Ibid*, at p. 23.
[163] See generally Gil et al., "The Impact of Competition on 'Make or Buy' Decisions: Evidence from the Spanish Local TV Industry," *Management Science* (2017).
[164] Under California law, TNCs may not own cars used on their platforms; vehicles operated on TNC platforms must be personally owned by TNC drivers. In this context, personal vehicles include not just vehicles purchased by the driver, but also leased vehicles, and vehicles rented using a short term rental service (not exceeding 30 days). See CPUC Decision 16-12-037, and California Pub. Util. Code §5431(b).
[165] Information sourced from https://www.uber.com/drive/los-angeles/vehicle-requirements/
[166] Information sourced from https://www.uber.com/drive/san-francisco/vehicle-requirements/
[167] Information sourced from https://www.uber.com/drive/san-diego/vehicle-requirements/
[168]Assuming 55 percent city and 45 percent highway-miles. See Bureau of Transportation Statistics, "Average Fuel Efficiency of U.S. Light Duty Vehicles", available at https://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_04_23.html.
[169] U.S. Environmental Protection Agency, "Greenhouse Gas Equivalencies Calculator", available at https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator.
[170] This is the latest data available for emissions from California's transportation sector. See CARB, "California Greenhouse Gas Emissions for 2000 to 2015 - Trends of Emissions and Other Indicators", June 2017, available at https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2015/ghg_inventory_trends_00-15.pdf.
[171] https://www.seattle.gov/business-regulations/taxis-for-hires-and-tncs/transportation-network-companies/tnc-companies#operatingstandards.
[172] https://www.portseattle.org/About/Commission/Meetings/2016/2016_03_22_RM_7a.pdf
[173]https://www.cityofchicago.org/content/dam/city/depts/bacp/publicvehicleinfo/publicvehicle/TNPLicenseFactSheetJan012018.pdf.
[174] W. Hu, "When Calling an Uber Can Pay Off for Cities and States", February 18, 2018, available at https://www.nytimes.com/2018/02/18/nyregion/uber-lyft-public-transit-congestion-tax.html.
[175] More information is available on the TLC's website. See http://www.nyc.gov/html/tlc/html/about/trip_record_data.shtml.
[176] *Supra* note 174.
[177] See https://www.tax.ny.gov/bus/tnc/assessment.htm.