PAYNE INSTITUTE COMMENTARY SERIES: **STUDENT VIEWPOINT**

Denver, Lyft, and the Electric Future

By Will Callahan

ABSTRACT:

Emissions from the transportation sector pose a great risk to global health. Vehicle electrification is one way to mitigate tailpipe emission, thereby reducing the health risk. Gov. Jared Polis and Lyft recently announced Lyft's plan to add 200 electric vehicles (EVs) to the Denver fleet. Data from EVI Pro Lite, Auto Alliance, and a doctoral dissertation on ride-hailing were used to estimate the impact of Lyft's decision on Denver's emission profile and existing charging infrastructure. An initial injection of 200 EVs will have a small but non-negligible effect on emissions. Larger injections, which can be expected based on statements from Lyft, will produce greater emission reductions. Projections for future charging demands show that Denver must start investing in infrastructure now if it hopes to reach its goal of 940,000 EVs by 2030. Utilization of data from ride-hailing companies is crucial for informed policy and engineering decisions, and both Lyft and Uber should be pressured to make such data available.

KEYWORDS:

Ride-hailing, Colorado, Electric Vehicle

1. **INTRODUCTION:**

By 2020, the transportation sector in Colorado is projected to account for about 33% of the state's CO_2 emissions[1]. The effects of vehicle emissions on quality of life are well studied. In a 2019 report, Anenberg et al found that vehicle tailpipe emissions were associated with 361,000 and 385,000 premature deaths globally in 2010 and 2015, respectively[2]. Actions at the individual level make a significant difference – roughly 4.6 tons of CO_2 is emitted per passenger vehicle, per year[3]. To address the emissions impact, Gov. Jared Polis and the Colorado State Legislature have set aggressive climate-centric goals – 100% renewable energy by 2040, as well as a 90% reduction from 2005-level emissions by 2050[4,5]. Additionally, Colorado has extended the state-level purchase incentives for electric vehicles (EVs) to include ride-hailing companies with HB19-1159, "Modify Innovative Motor Vehicle Income Tax Credits"[6]. Gov. Polis released an executive order at the start of his term outlining a goal of 940,000 EVs on the road by 2030[7]. Electrification of Colorado's transportation sector is a necessary step in limiting the effects of climate change and in improving quality of life.

Rocky Mountain Institute (RMI) has studied the possible effects of EV implementation at length. A 2017 report predicted a substantial increase in the number of EVs on the road by 2022, up to 2.9 million across the country. RMI also warned that the non-trivial load (11,000 GWh) that this will put on the grid will need to be well-managed and accommodated[8]. Transportation network companies (TNCs), most notably Uber and Lyft, are the perfect candidates for electrification. In a

[1] Arnold et al, "Colorado Greenhouse Gas Inventory—2014 Update Including Projections to 2020 & 2030". 2014.
[2] Anenberg et al, "The global burden of transportation tailpipe emissions on air pollution-related mortality in 2010 and 2015". Environ. Res. Lett. 14 (2019) 094012. https://doi.org/10.1088/1748-9326/ab35fc
[3] EPA, "Greenhouse Gas Emissions from a Typical Passenger Vehicle". 2005. https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle
[4] Becker, "HB19-1261. Climate Action Plan To Reduce Pollution". 2019. https://leg.colorado.gov/bills/hb19-1261
[5] Polis, "Wildly Important Priority: Set Colorado on a path to 100% renewable energy for the grid by 2040 and position Colorado as a leader in the clean energy economy". 2019. https://dashboard.state.co.us/bold4-energy-renewables.htm
[6] Jacques-Lewis, "HB19-1159: Modify Innovative Motor Vehicle Income Tax Credits". 2019. https://leg.colorado.gov/bills/hb19-1159
[7] Polis, "Executive Order B 2019 002". January 19, 2019.
[8] Fitzgerald, Nelder, "From Gas to Grid: Building Charging Infrastructure to Power Electric Vehicle Demand". Rocky Mountain Institute, 2017. https://www.rmi.org/insights/reports/from_gas_to_grid

2018 report, RMI calculated that in New York and San Francisco, replacing half of the TNC vehicles with EVs would offset 1.5 billion pounds of CO_2 per year[9]. To accommodate the required infrastructure to support this, algorithmic approaches to optimized charging station locations have been explored[10], but the greatest hinderance to these models is a dearth of data.

Lyft specifically has become a leader among TNCs in environmental activism and awareness. The company has committed to several green ideas, like full carbon neutrality and an eventual 100% utilization of renewable energy for their electric fleets[11]. Lyft also advocates for renewable energy programs, reforestation, and carbon-capture technologies[12]. Furthermore, they've implemented bike and scooter rental to encourage multi-modal transit in densely populated areas[13]. However, Lyft remains secretive about its data, and has yet to release any substantive data tools to the public despite years of pressure and conversation[14,15].

In an electric coup d'état catalyzed by HB19-1159, Lyft has announced a rollout of 200 new electric vehicles to its Denver fleet[16], which drivers can lease for a moderate monthly fee. This report examines the effect that this electrified fleet injection will have on emissions, charging infrastructure, and the need for data transparency in Denver.

2. METHODS:

Advanced technology vehicles (ATVs) is a term that encompasses hybrid-electrics (HEVs), battery-electrics (BEVs), plug-in hybrid-electrics (PHEV), and fuel cell vehicles (FCVs) – effectively,

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[9] Li, Fitzgerald, "Ride-Hailing Drivers Are Ideal Candidates for Electric Vehicles". Rocky Mountain Institute, 2018. https://rmi.org/ride-hailing-drivers-ideal-candidates-electric-vehicles/

[10] Meng, Kai, "Optimization of electric vehicle charging station location based on game theory". Proceedings 2011 International Conference on Transportation, Mechanical, and Electrical Engineering (TMEE), Changchun, 2011, pp. 809-812.

[11] Lyft, "Lyft Commits to Full Carbon Neutrality and 100% Renewable Energy". Lyft Blog, September 11, 2018. https://blog.lyft.com/posts/lyft-commits-to-full-carbon-neutrality-and-100-renewable-energy

[12] Zimmer, Green, "All Lyft Rides Are Now Carbon Neutral". April 19, 2018. https://medium.com/@johnzimmer/all-lyft-rides-are-now-carbon-neutral-55693af04f36

[13] Zimmer, Green, "Lyft's Approach To Bikes & Scooters". July 19, 2018. https://medium.com/@johnzimmer/lyfts-approach-to-bikes-scooters-90ce505ff496

[14] Cannon, Summers, "How Uber and the Sharing Economy Can Win Over Regulators". October 13, 2014. https://hbr.org/2014/10/how-uber-and-the-sharing-economy-can-win-over-regulators

[15] TransitCenter, "Accept No Substitutes for Full Trip Data From Uber and Lyft". May 15, 2019. https://transitcenter.org/accept-no-substitutes-for-full-trip-data-from-uber-and-lyft/.

[16] Lyft, "Working toward a fully electric future — and challenging partners to do the same". Lyft Blog, November 14, 2019. https://blog.lyft.com/posts/lyft-denver-ev-2019

anything that isn't a petroleum-powered vehicle[17]. To accurately assess the impact of an increased electric fleet size, it's necessary to have an approximate understanding of the current fleet size. A partnership between Auto Alliance and the Center for Sustainable Energy resulted in an ATV database. Compiled with data from IHS Markit and Hedges & Co, the "Advanced Technology Vehicle Sales Dashboard" reports ATV registration at the state level, dating back to 2011. From this, it was determined that Colorado has a total of 72,327 ATVs, of which 24,319 required charging infrastructure (15,901 BEV; 8,418 PHEV)[18].

EVI Pro Lite is a tool created by a collaboration between National Renewable Energy Laboratory (NREL) and the California Energy Commission, with additional support from the Department of Energy (DOE's) Vehicle Technology Office[19]. This is a tool for projecting consumer demand for electric vehicle charging infrastructure. EVI Pro Lite has granularity down to the regional level. A radius of 20 miles around "Denver/Aurora" was selected as the area of interest. It was assumed that 60% of electric vehicles in the state of Colorado are registered in Denver. Fleet distribution between long-range and short-range PHEVs and BEVs is a required for the calculator. It was assumed that for the baseline calculation (pre-Lyft fleet injection), there was an equal distribution for both of these types. This ratio shifted to 51% long-range BEV and 49% short-range BEV to account for the Lyft fleet injection.

Through work done by DOE's Clean Cities program, the cost of three types of charging infrastructure was determined[20]. A majority of the cost of new stations is in the installation, as undergrounding electrical power lines is a significant and expensive undertaking. Accounting for both the cost of the station and the installation cost, the average costs per station are shown in Table 1:

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[17] Canis, "The Advanced Technology Vehicles Manufacturing (ATVM) Loan Program: Status and Issues". January 15, 2015.
[18] Auto Alliance. "Advanced Technology Vehicle Sales Dashboard". https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/. 2019.
[19] EVI Pro Lite. National Renewable Energy Laboratory, California Energy Commission. 2016. https://afdc.energy.gov/evi-pro-lite
[20] Smith, Castellano, "Costs Associated With Non-Residential Electric Vehicle Supply Equipment". U.S. Department of Energy – Energy Efficiency and Renewable Energy. November 2015.

Table 1	
Workplace Level 2	$5,200
Public Level 2	$7,500
DC Fast Charge	$46,000

TNCs are private about their data. Uber has released small portion of their data through a program called Uber Movement[21], and while this is an important move towards transparency, it leaves much to be desired. Movement is available in only select cities; total number of trips are obscured; there isn't any explicit information about time with passenger versus time without passenger (i.e., "deadheading"). Lyft does not have any openly available data tools. Researchers have encountered this problem previously. To circumvent this data scarcity, Dr. Alejandro Henao at CU Denver became a subcontracted driver for both Uber and Lyft in Denver for a period of 14 weeks. During this time, he logged personal data for his trips and encouraged his passengers to complete a demography survey. He used this data to complete his doctoral dissertation. Ride-hailing data was pulled from his work and scaled to accommodate 200 vehicles driving 8 hours per day, 5 days a week[22].

3. RESULTS

Data taken from Dr. Henao is detailed in Table 2 below, as well as the approximated values for 200 vehicles. The vehicle driven for data collection was a 2015 Honda Civic, so a corresponding fuel efficiency value of 31 miles per gallon was used in all calculations.

Table 2

	14 weeks	per week	per day	per hour	Scaled to Full Time (8hrs)
Miles Driven	4951	353.6	50.52	19.13	153.0
Hours Driven	258.8	18.48	2.641	---	---

21 Uber. "Uber Movement" https://movement.uber.com/?lang=en-US. 2017.

22 Henao, "Impacts of Ridesourcing - Lyft and Uber - on Transportation Including VMT, Mode Replacement, Parking, and Travel Behavior". 2018.

Assuming 40-hour work weeks and 48 weeks of driving per year, this amounts to 30,604 miles driven per car, pear year. Burning a gallon of gasoline generates about 8.9 kg of CO_2, assuming complete combustion[23]. By adding 200 electric vehicles in lieu of traditional internal combustion engine vehicles, modeled as a 2015 Honda Civic, Lyft will effectively remove approximately 1,800 metric tons of CO2 from tailpipe emissions per year.

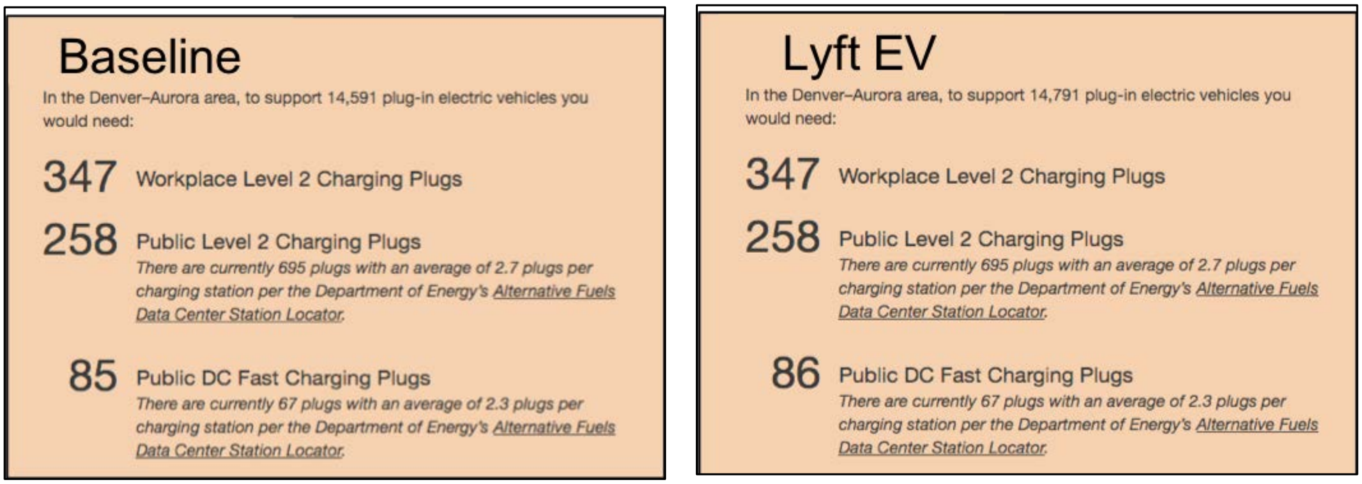

Figure 1: Baseline and post-Lyft injection charging infrastructure requirements (EVI Pro Lite, 2016)

From a pure fleet-size standpoint, an additional 200 long-range BEVs makes little difference in a fleet of ~15,000 vehicles. The entire Lyft injection can be serviced by adding another public DC Fast Charging plug, shown in Fig. 1. The assumptions made by the EVI Pro Lite calculator about station usage metrics are unspecified, so no further analysis can be made at this time.

Colorado's goal of 940,000 electric vehicles by 2030 is extremely ambitious. To service this fleet, EVI Pro Lite was used to calculate the relative ratio of three different types of charging station – Level 2 Public, Level 2 Workplace, and DC Fast Charge. The number of supported vehicles in the calculation must be greater than the number of existing plug-in vehicles and less than 10% of the light-duty vehicles that are registered in Colorado. These values were used to establish the charging station ratios at the lower and upper bounds. These ratios were then used to extrapolate to the goal fleet size. To support 940,000 electric vehicles, assuming once again an even distribution between long-range

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[23] EIA, "Carbon Dioxide Emission Coefficients", February 2, 2016. https://www.eia.gov/environment/emissions/co2_vol_mass.php

and short-range technologies, over 17,000 charging stations would be needed, with a total project cost of approximately 114 million dollars (Fig. 2).

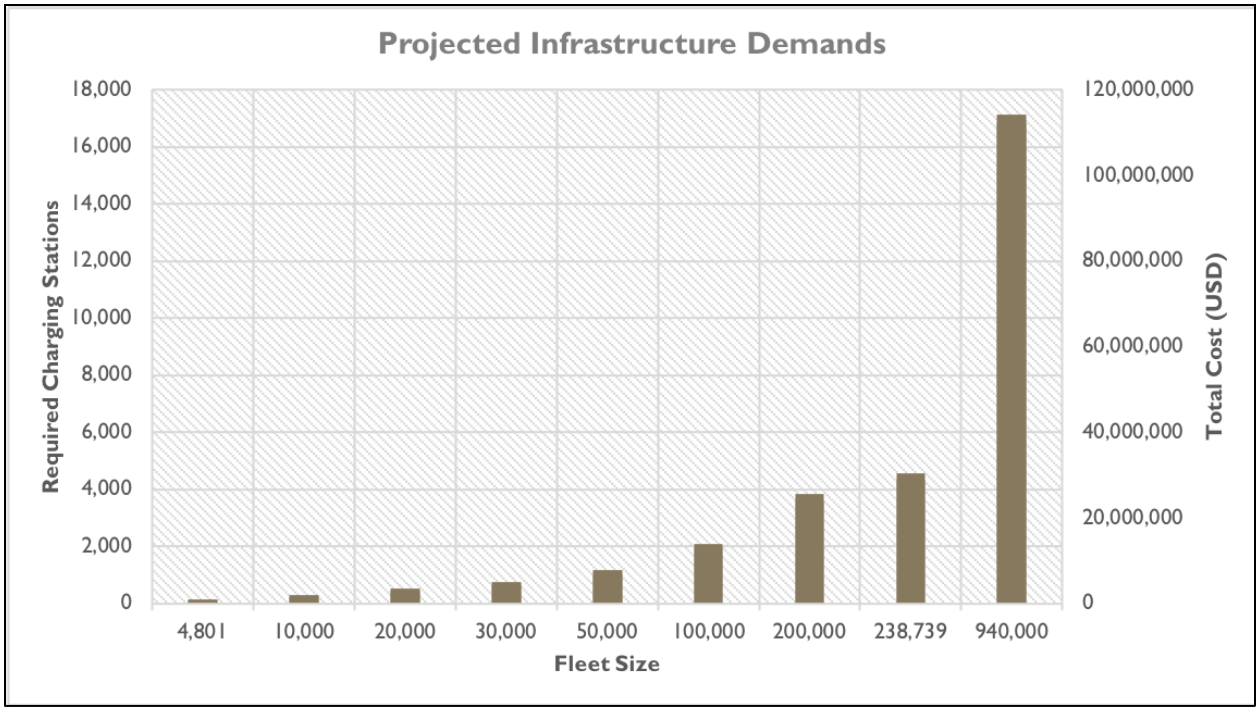

Figure 2: Projected infrastructure demand required to meet Denver EV fleet size. Charging station cost data from Smith, 2015.

4. DISCUSSION:

Uber and Lyft need to make their data available. This is the most fundamental point, as all other problems stated in this report can utilize data effectively. Having a wealth of data available informs policy and engineering decisions. This will also help reduce the information asymmetry that exists between driver and company, and encourage more equitable and sustainable wages, as well as a more professional atmosphere.

These numbers represent a prediction for several decades in the future, and are based on an extrapolation from a single data point. They represent, at best, a semi-quantitative glimpse into what infrastructure challenges might await Denver. If anything, this report will serve as an underapproximation from a technological standpoint. Barring the cataclysmic, battery and charging infrastructure will continue to get better and cheaper, as new and improved materials for energy storage will be implemented at an accelerating pace. The technological learning curve is an observed phenomenon, in which the cost decreases as the number of deployments increases[24]. We can therefore expect the total cost to decrease, based on several wide-ranging vectors.

Ride-hailing is an industry that's traditionally entirely tied to tailpipe emissions. Values calculated by the EPA make an assumption of 11,500 miles driven per year. Full-time ride-hailing can easily eclipse this, perhaps doubling or even tripling this number. Hence, the transition from internal combustion engine vehicles to EVs is especially important for TNCs, as demonstrated by New York and San Francisco calculation, as well as the Denver approximation. Furthermore, Denver's air quality is especially poor. The American Lung Association ranked Denver 12th in the nation for highest level of ozone pollution[25]. The impact of Lyft's initial vehicle injection will be small but non-negligible. Based on Lyft's stated goals of renewable energy support and advanced technology adoption, we can anticipate larger injections in the months and years to come. Likewise, public opinion towards electric vehicle adoption will likely continue to increase.

Denver needs to start building charging infrastructure now to meet its goal of 940,000 electric vehicles. With projects like Denver Moves: Transit that propose repurposing roadways into transit-oriented corridors, the available space will decrease even further as time progresses. Optimal locations for charging infrastructure can be approximated through use of theoretical means (e.g., game theory or Monte Carlo simulations). However, the most accurate (and therefore most successful) installation of charging stations will rely on vehicle data. Utilization of Lyft and Uber metrics about time spent using charging stations will be a crucial statistic. One can imagine a scenario in which, instead of deadheading and generating roadway congestion, a driver will instead opt to spend time between trips charging their vehicle, thereby generating charging station congestion. Indeed, if this is unregulated by Lyft and a significant portion of the fleet occupies public charging stations, the projected infrastructure might not be sufficient. To offset some of the cost of infrastructure construction, it is worth considering a tariff on DCFC usage, as suggested by RMI[26].

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24 Wiesenthal et al. "Technology Learning Curves for Energy Policy Support". *Energy Research Centre of the Netherlands*. 2012.
25 Martinez, "New Report: Denver Air Quality Worsened for Ozone Pollution". April 24, 2019. https://www.lung.org/local-content/_content-items/about-us/media/press-releases/new-report-denver-air.html
26 Fitzgerald, Nelder, "DCFC Rate Design Study". Rocky Mountain Institute, 2019. https://rmi.org/insight/dcfc-rate-design-study/

5. CONCLUSIONS:

Recent legislation in Colorado has resulted in a far-reaching vision to incorporate more EVs into the transportation sector. Lyft has agreed to an initial deployment of 200 EVs into its ride-hailing fleet in Denver. Data utilized in this paper for ride-hailing calculations and projections should be considered with a high degree of skepticism, as it was heavily extrapolated from a single data point. Calculations regarding EV charging infrastructure make unknown assumptions about the level of use. Introducing more ride-hailing EVs will likely generate more plug congestion. EVI Pro Lite should either make their assumptions clear, or be re-developed the program to allow user-defined usage statistics. The new decade symbolizes an exciting time for Colorado as it surges ahead and becomes a leader in electrified transportation.

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Will graduated from the College of Idaho in 2017 with a B.Sc. in Mathematics-Physics and minors in Analytical Chemistry, English, and Psychology. He's currently a first-year Ph.D. student in the Advanced Energy Systems at Colorado School of Mines, where his primary research is focused on modeling, synthesizing, and characterizing thermoradiative devices, as well as computational discovery of earth-abundant or other alternative materials. Additionally, he has an interest in data driven energy policy, with specific focus on electrification of the transportation sector, and Idaho's energy future. Prior to joining the AES program, Will was a research technician at NREL, where he worked in both electrochemical characterization for low-temperature electrolysis components, as well as a software developer for metadata collection and management tools in collaboration with the HydroGEN consortium.

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