State of California
AIR RESOURCES BOARD

Clean Miles Standard and Incentive Program

Standardized Regulatory Impact Assessment (SRIA)

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Air Resources Board

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A. INTRODUCTION

The proposed Clean Miles Standard regulation is a first-of-its-kind, light-duty fleet rule that reduces GHG emissions and promotes the state's electrification goals by proposing electrification targets, greenhouse gas emission targets, and reporting requirements for transportation network companies (TNCs). The required targets combined encourage TNCs to use fuel-efficient internal combustion vehicles, zero emission vehicles (ZEVs), and to reduce vehicle miles traveled (VMT) without passengers. Given that this unique regulation will require TNC companies to work with their drivers to enable the required targets, the regulation is also taking into account the population of low-income drivers and drivers living in disadvantaged communities by incorporating feasible cost assumptions, and evaluating outreach and incentive programs available to the drivers as part of the regulatory process.

Regulatory History

As new mobility options are growing at a rapid pace, Senate Bill (SB) 1014, enacted in 2018, proposes a new light-duty fleet rule – the Clean Miles Standard and Incentive Program (Clean Miles Standard, or CMS). SB 1014[1] directs the California Air Resources Board (CARB) to develop, and the California Public Utilities Commission (CPUC) to implement, new requirements for TNCs to employ innovative ways to curb GHG emissions.

The need to curb GHG emissions was highlighted in the California Global Warming Solutions Act of 2006 – Assembly Bill (AB) 32 – which designates CARB as the regulatory agency to monitor and regulate sources of GHG emissions in the State of California. AB 32 requires CARB to reduce GHG emissions in the state to 1990 levels by 2020. With the passage of SB 32 in 2016, expanded GHG emission requirements were established at 40% below 1990 levels by 2030. Subsequently, Executive Order B-55-18 established a statewide goal of achieving carbon neutrality no later than 2045.[2]

Historically, CARB has regulated the performance of new light-duty vehicles, most recently under the Advanced Clean Cars regulations,[3] which apply to vehicle manufacturers. In addition, historically, CPUC has authority to regulate TNCs as established under the Passenger Charter Party Carriers' Act: Commission Decision 13-09-045. TNCs are defined in the Public Utilities Code as providers of pre-arranged ride-hailing services using an online-enabled application or platform to connect passengers using personal vehicles.[4] TNCs are currently required to submit data to CPUC on an annual basis, per CPUC Decision 13-09-045,[5]

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[1] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1014, accessed 6/22/20.

[2] https://www.ca.gov/archive/gov39/wp-content/uploads/2018/09/9.10.18-Executive-Order.pdf

[3] CARB LEV III Program. https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/lev-program/low-emission-vehicle-lev-iii-program

[4] Public Utilities Code Division 2, Chapter 8, Article 7, §5431(c)

[5] https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M077/K192/77192335.PDF

using the data templates provided on the CPUC website. The data currently required of TNCs include a number of fields for trip-level information regarding trip requests accepted.

CARB and CPUC staff began working on the proposed CMS regulation immediately following the passage of SB 1014 by forming an inter-agency team and engaging stakeholders. The first statutory deadline, January 2020, was to establish a base year emissions inventory for the TNC sector using 2018 as the base year. For this effort, CARB and CPUC staff jointly requested trip-level data from TNCs to establish the 2018 base year emissions inventory and released a white paper establishing the base year inventory in December 2019.[6]

On January 23, 2020, CARB staff presented an informational item to the Board describing the base year emissions as well as principles that staff intended to use in developing the Clean Miles Standard regulation. The Board adopted a resolution that encompassed the guiding principles for developing the CMS program and directed staff to design the regulation using compliance metrics consistent with SB 1014,[7] which are annual grams-CO2 per passenger-mile and percent zero emission miles traveled. The proposed regulation should promote pooling, empty miles traveled reduction, use of ZEVs, and connections to transit. CARB and CPUC staff have continued to work with stakeholders and the proposed CMS regulation is a result of a robust public process.

Proposed Regulatory Action

The regulation will set electrification and GHG emission targets (GHG targets) for TNC fleets beginning in 2023 with increasing stringency to 2030. The proposed regulation also includes requirements for annual data reporting and biennial compliance plans which will be outlined in the regulation.[8]

The proposed regulation would apply to all passenger services offered by TNCs (i.e., basic and premium as well as non-shared and shared services) in vehicles that carry eight passengers or less. Food and other goods delivery services fall outside the jurisdiction of this proposed regulation, even if operated by a TNC. This regulation does not apply to taxis or limousines, as they are exempt from the regulation by statute.

CARB staff continue to take comments on the proposed CMS regulation through public workshops and discussions with stakeholders. Further changes to the electrification and GHG targets may be considered in addition to optional credits from modes such as micro-mobility devices, transit connections, and active transportation that are facilitated by a TNC that

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[6] CARB, 2019. Clean Miles Standard 2018 Base-year Emissions Inventory Report. Technical Documentation. https://ww2.arb.ca.gov/resources/documents/2018-base-year-emissions-inventory-report.

[7] CARB Resolution 20-4. https://ww2.arb.ca.gov/board-resolutions-2020

[8] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1014, accessed 6/22/20.

reduce GHG emissions. Additionally, CARB staff will continue to assess the impact of COVID-19 pandemic on the TNC market and the changing demand for service.[9] The economic impact of the final rule, including any modifications to the current proposed CMS regulation that occur during the regulatory process, will be fully analyzed and submitted to the Department of Finance (DOF) and Office of Administrative Law (OAL) with the final regulatory package. The proposed regulation requirements are summarized below.

Electrification Targets (Percent eVMT)

CARB staff are proposing annual electrification targets for the TNC companies in the metric of percent electric vehicle miles traveled (eVMT). These targets apply starting in 2023 and increase in stringency through 2030. The proposed electrification targets are provided in Table 1, increasing to 60% eVMT by 2030.

Electric miles traveled that qualify to meet this target are miles traveled while providing TNC services with a battery electric vehicle (BEV) or a fuel cell electric vehicle (FCEV), which this report will collectively refer to as zero-emission vehicles, or ZEVs. Use of conventional vehicles with a high voltage battery or plug-in hybrid electric vehicles (PHEVs) do not count toward these targets as they both use internal combustion engine (ICE) technology and contribute to tailpipe emissions. The metric of percent eVMT is defined as the total eVMT for a TNC in a year divided by the company's total VMT in that same year, accounting for all the vehicles operating on their service platform. Given that this metric is relative, the percent eVMT performance by a TNC does not depend on a company's market growth.

The Electrification targets are based on data from the 2018 base year and are proposed for 2023 to 2030 calendar years. The proposed targets are provided in Table 1. Beyond 2030, the requirements remain fixed at the 2030 stringency level.

Table 1: Proposed Annual Percent eVMT Targets

Year	Percent eVMT
2023	2%
2024	4%
2025	8%
2026	18%
2027	27%
2028	38%
2029	48%
2030+	60%

CARB staff used an economic cost model to inform the development of the annual electrification targets. The conceptual process for how these targets were developed are shown in Figure 1. First, staff used market cost estimates as input values for an economic cost

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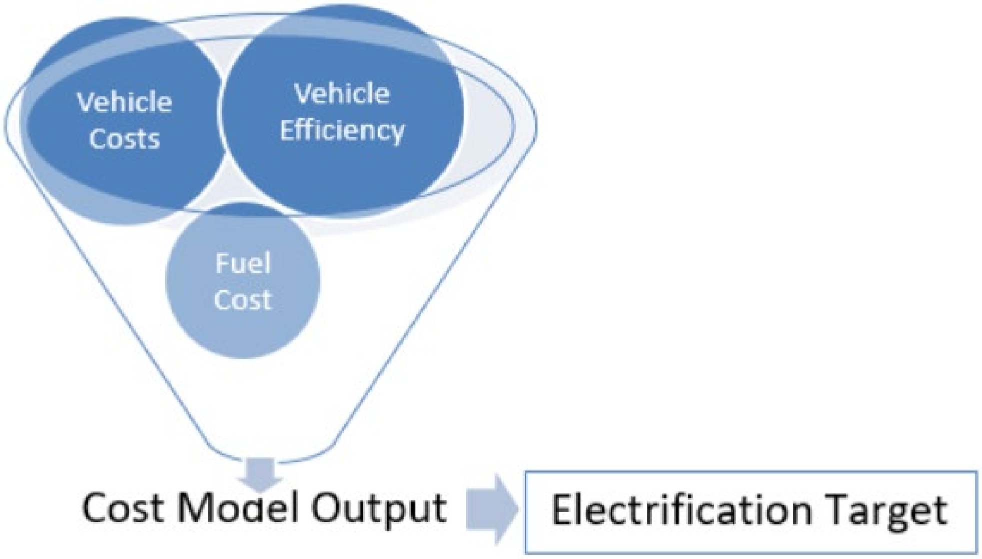
[9] COVID-19 is the Coronavirus Disease 2019 that has impacted the ridership demand for TNCs and has temporarily forced the TNCs to stop offering pooling services.

model that estimates the total costs for individual TNC drivers switching to a ZEV. Several of the most influential parameters, namely vehicle purchase costs, vehicle efficiency, and fuel costs, are shown in the figure. A number of additional parameters are included as well, and are described in Section C and the Technical Appendix later in this report. The cost model results in a trajectory of percent eVMT values for each year based on an economic net cost calculation for individual TNC drivers. The model results of percent eVMT are then smoothed to derive the proposed eVMT targets.

Figure 1: Conceptual Process for Development of Electrification Targets



The cost model was developed based on the economic principles that the TNC driver market is perfect (drivers can liquidate vehicles at market rate, and purchase vehicles at market rate at will), and that drivers could be encouraged to make decisions based on economics. Thus, the first in the model to switch to a ZEV are those drivers who would benefit the most: drivers with the least fuel efficient vehicles and the highest mileage on TNC services. Under the proposed electrification targets, any particular driver who is switched to a ZEV, with his or her annual weeks of TNC service, vehicle's associated fuel economy and age, would be able to recoup at a minimum, the entire incremental vehicle capital cost of a comparable ZEV, a significant portion of home charger costs, and additional costs associated with barriers to ZEV adoption through fuel and maintenance savings within a year. CARB staff believes that targets set in this way would provide reasonable protections for low-income drivers, should they become responsible for bringing ZEVs to the TNC platform. Additional details of the cost model such as simulating future TNC fleets, and which drivers switch to ZEVs appear in the Technical Appendix, Percent eVMT Cost Model.

Greenhouse Gas Targets

In addition to electrification targets, SB 1014 also directs staff to set GHG targets.[10] The proposed GHG targets are intended to achieve additional GHG emission reductions than from electrification targets alone in order to encourage additional actions such as increased use of fuel efficient vehicles, reductions in VMT and increased use of pooling, reduction in miles driven without a passenger (deadhead miles), and increased linkages between TNC rides and transit. To accomplish this, CARB staff is proposing annual GHG targets shown in Table 2. The GHG targets are in the metric of grams of carbon dioxide (gCO_2) equivalent tailpipe emissions per passenger mile traveled (PMT). Emissions related to fuel production and distribution (upstream emissions) are not included in the calculations since only tailpipe CO_2 is specified in the bill, along with the complexity of accounting for the varying carbon intensity profiles for fuel supply systems each year.

Table 2: Annual GHG Targets

Compliance Year	gCO_2 / PMT Targets
2023	255
2024	240
2025	222
2026	193
2027	168
2028	140
2029	116
2030+	88

The GHG targets can be met using a number of strategies, as noted above. For example, the GHG targets specified in Table 2 could be achieved through additional electrification of the TNC fleet beyond the electrification targets in Table 1. Alternatively, the GHG targets could be met with minimum compliance with the electrification targets in addition to year-over-year increases in passenger occupancy of approximately 1% (see the Technical Appendix, Pooling and Occupancy Section for details). CARB staff believe that this increase in occupancy would be optimistic but feasible.

With respect to passenger occupancy, staff is proposing the use of pre-defined occupancy factors for measuring compliance with the proposed regulation since TNC companies do not currently collect data on the number of passengers in the vehicles. Occupancy factors are included for three types of trips taken on TNCs that potentially have different occupancies: non-pooled, pool-requested/unmatched, and pool-requested/matched trips. Due to limited availability of occupancy data and because increasing overall occupancy is a difficult and potentially expensive undertaking, staff is proposing to use middle occupancy values for pool-

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[10] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1014, accessed 6/22/20.

requested/matched and pool-requested/unmatched occupancies as default values. Using these middle occupancy values means the proposed regulation incentivizes TNCs to increase their pooled services. For non-pooled and pool-requested/unmatched trips, the proposed occupancy factors are 1.5, [11] whereas for pool requested/matched trips the proposed value is 2.5.[12]

Equation 1 shows the calculation of gCO_2/PMT. This equation will be used to calculate a TNC's compliance with the annual GHG targets defined in Table 2. As noted earlier, Equation 1 shows TNCs have multiple strategies they could take to meet annual GHG targets.

Equation 1.

$$\frac{g\ CO_2}{PMT} = \frac{\sum\left(VMT_{Periods\ 1,2,3} \times FC \times C_{fuel}\right)}{\sum(VMT_{Period\ 3} \times Occupancy\ Factor) + zPMT}$$

Where,

FC – fuel consumption
C_{fuel} – fuel conversion factor: 8,887 g CO_2 / gal gasoline; 10,180 g CO_2 / gal diesel
Occupancy Factor – 1.5 for non-pooled and pool-requested/unmatched rides, 2.5 for pool-requested/matched rides
zPMT – zero-emission PMT credit that can be earned through connected transit trips or active transportation trips facilitated by TNCs

For reference, the proposed regulation captures emissions from miles travelled in periods 1, 2 and 3 of TNC services. Period 1 is when the driver has initiated a work session and is waiting to accept a ride and has not been matched with a passenger. Period 2 is when the driver has accepted a ride and is en route to the rider. Period 3 is when the rider is in the vehicle and en route to the destination.

Potential strategies to meet the GHG targets include:

- *Reducing fuel consumption or the emissions per mile that any TNC vehicle emits.* For example, TNCs could motivate a driver to use more fuel efficient vehicles, such as a

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[11] The average size of a party requesting a pooled ride is typically smaller than the size of a party requesting a non-pooled ride. The average number of occupants in a non-pooled ride is 1.55. Setting the occupancy factor of pool-requested/unmatched rides equal to non-pooled rides provides incentives to TNCs to encourage pool-request rides.

[12] This value was derived by multiplying the average number of parties per matched ride and the average number of occupants per party. Staff assumed there is an average of two parties per matched rides, higher than the 1.4 average in the 2018 TNC data. And that each party has 1.25 passengers, the middle between one passenger (the minimum) and 1.55 (the non-pooled occupancy). In other words, 2 x 1.25 = 2.5. This assumed pool-requested matched middle occupancy also incentivizes TNCs to increase the matching of pool-requested rides.

hybrid electric vehicle (HEV). Alternately, TNCs could motivate a driver to use a ZEV to avoid emitting GHG emissions altogether.

- *Reducing VMT by pooling and increasing the passenger occupancy during trips.* For example, this could be achieved through increased matching of trips traveling along a similar route. If a TNC driver picks up two different parties from nearby locations and transports them to a local airport together, the TNC would conceivably be credited with 2.5 passenger miles for each mile traveled.
- *Reducing deadhead miles (Period 1 and Period 2 miles) relative to Period 3 miles.* Period 1 miles and Period 2 miles are also referred to as "empty miles traveled" as there is no passenger in the vehicle. Reducing deadhead miles could require building or designating places for vehicles operating as TNCs to park temporarily for free. While these places are very limited in urban areas, these types of agreements between TNCs and cities would be beneficial to both parties: cities would benefit from reduced congestion and TNCs would reduce their GHGs per passenger mile emissions
- Increasing zPMT, which represents zero-emission PMT that can be earned through TNC-connected transit trips and active transportation facilitated by the TNC app.

The magnitude of the emission reduction for each TNC is determined by the estimated emissions for all of a TNC's given year of travel by all of the vehicles that provided service for the TNC in that year. Only miles traveled while a TNC driver is logged onto the ride-hailing app count towards the total used for compliance (TNC service miles).

Data Reporting Requirements

Authority granted by SB 1014 provides CPUC and CARB authority to require reporting by TNCs that is sufficient to estimate annual emissions and electrification of each TNC company.

Reporting for TNC Compliance

A list of additional data elements required for reporting for compliance with the CMS regulation is outlined in Table 3

Table 5:, with a justification for each element. Additional data elements should be included in the "Requests Accepted" template provided by the CPUC. [13]

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[13] Required reports TNCs must provide the CPUC: https://www.cpuc.ca.gov/General.aspx?id=3989

Table 3: Additional Trip-Level Annual Reporting for Compliance

Data Element	Justification
Vehicle make/model/year	Needed for inventory purposes.
Vehicle type: passenger car (PC) or light truck (LT)	Needed to determine value from the technology-based fuel-consumption look-up table used for calculating emissions. Fuel consumption values are different for PCs and LTs.
Fuel type (gasoline, diesel, electricity, hydrogen, etc.)	Needed for inventory purposes.
Technology type (conventional ICE, HEV, PHEV, BEV, FCEV, etc.)	Needed to determine value from the technology-based fuel-consumption look-up table used for calculating emissions.
Pool-matched (Y/N)	Verifies whether the pool-requested trip was matched with other pool-requested trips.
Vehicle Occupancy	Allows for more accurate calculation of emissions per PMT for the purpose of updating the GHG inventory.
Compliance occupancy	An occupancy value used for calculating GHG/PMT compliance is needed based on the pooling status of the trip. Compliance occupancy values are different for non-pooled (1.5), unmatched pool-request (1.5), and matched pool-request (2.5).

Biennial Compliance Plans

Beginning in 2022, TNCs will be required to submit to CARB and the CPUC for approval a two-year plan for complying with the regulation. This plan should include a description of the TNC's strategies for meeting the annual GHG and electrification targets for the subsequent two compliance years. For each plan submitted, CARB and CPUC will verify that the elements required have been included.

For example, by January 31, 2022, each eligible TNC will be required to submit a compliance plan outlining how they expect to meet the regulation targets for compliance years 2023 and 2024. Subsequently, by January 31, 2024, TNCs will submit the next compliance plan outlining their strategies for meeting the 2025 and 2026 targets. The compliance plan shall include, at a minimum:

Current and two-year projected:

- Average annual fleet size
- Average annual fuel economy
- Average annual vehicle occupancy
- Pool-request rates
- Pool-match rates
- Period 1 and Period 2 VMT percentage (deadheading)
- Total annual VMT (the sum of vehicle driven miles during Periods 1, 2, and 3)
- Annual g CO_2/PMT
- Percent of BEVs and FCEVs
- Percent eVMT
- Use of transit and active transportation credit provisions

Exemptions for Small TNCs

For the purpose of this regulation, small TNCs will be defined as permitted TNCs that have less than or equal to 5 million VMT annually. The regulation will exempt small TNCs from meeting the GHG and electrification targets, as well as exempt them from submitting the biennial plans and annual compliance reports for the regulation. Small TNCs will not be exempt from continued annual data submittal that is already required per the CPUC's permit requirements.

From analysis of TNC 2018 base year data, staff determined that 10 of the 12 permitted TNCs have annual VMT below 5 million. Two of the 12 permitted TNCs dominate the market with annual VMT that is orders of magnitude greater than the other 10 TNCs combined. Together, all small TNCs make up only 0.14 percent (1/7th of 1 percent) of the total TNC VMT. If a TNC's annual VMT eventually grows to exceed 5 million, they will be subject to meeting the targets of the regulation with certain flexibilities.

Flexibilities

For small TNCs or new market entrants that exceed 5 million VMT for the first time in a given compliance year, their first 2-year compliance plan (biennial plan) will be due the following calendar year. There will be a phase-in of the targets over time beginning with the first year of required compliance, as described in the example below.

> *Small TNC phase-in example:*
> *If a small TNC or new entrant expects to exceed 5 million VMT in 2027, they will be required to submit a 2-year compliance biennial plan by 2028 to meet GHG and electrification targets in 2029 and 2030. For electrification targets, the phase-in would require that the TNC meet half of the 2029 % eVMT target, then meet the full 2030 % eVMT target. The phase-in would not apply in this situation if the TNC already begins with % eVMT greater than half of the 2027 eVMT target.*

For GHG targets, the TNC will be expected to meet the industry-wide target beginning the second year of compliance – 2030 in this example.

For all TNCs, an additional flexibility option will be provided in the form of carry-over compliance credits available for use for up to 3 years into the future.

Carry-over flexibility option example:

If a TNC over-complies with their GHG target in 2027, they may carry forward that credit up to 3 years to apply a portion of that credit to any of the 3 years. An example of how this may work is shown in Table 4.

Table 4: TNC A Compliance Example

Compliance Year	gCO_2/PMT Target	TNC A gCO_2/PMT Calculations	Over-compliance Credit	Credit Available (up to 3 yrs.)	Credits Applied
2027	168	140	28	28	
2028	140	138	2	30	
2029	116	128*	--	30	12
2030	88	100*	--	18	12
2031	88	90*	--	2	2

**Non-compliant prior to applying flexibility*

Statement of the Need of the Proposed Regulation

The transportation sector accounts for approximately 50 percent of GHG emissions in California when accounting for fuel production, with light-duty vehicles comprising 70 percent of the transportation sector's direct emissions.[14,15] GHG emissions from TNCs in data collected for 2018 base year represented approximately 0.88% of California's transportation sector GHG emissions. Furthermore, TNC emissions represented approximately 1.25% of California's light-duty vehicle GHG emissions.[16]

The TNC sector is the fastest growing sector relative to other categories of commercial passenger vehicle fleets regulated by the CPUC.[17] BloombergNEF projects the global VMT

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[14] CARB 2017 Scoping Plan: https://ww3.arb.ca.gov/cc/scopingplan/scopingplan.htm

[15] CPUC 2019. *Electrifying the Ride-Sourcing Sector in California.*

[16] CARB

[17] California Public Utilities Commission. *Electrifying the Ride-sourcing Sector in California*. 2018. (TNC emissions compared to 2015 data, the most recent year California transportation sector data was available at time of report.)

share of TNCs to grow from five percent today to 19 percent by 2040.[18] Some research suggests that TNCs may cause a net increase in VMT and a reduced use of other travel modes such as mass transit and active transport, while other research suggests TNCs actually complement mass transit.[19]

In California, the VMT share by TNCs was estimated to be approximately 1.2 percent of California's VMT in 2018.[20] CARB staff estimate TNCs' VMT in California will grow about 40% by 2030 compared to 2018 (see the Technical Appendix, eVMT Model Input Values Section for details and data sources).

As outlined in the 2017 Scoping Plan, additional GHG emission reductions beyond those from programs currently in place are necessary to ensure California meets the SB 32 goals. CARB staff have previously determined that light duty VMT reductions of 7% below the anticipated level for 2030 is needed to meet emission reduction targets.[21]

The proposed CMS targets help California achieve its GHG emission reduction goals by encouraging electrification of high mileage fleets and reducing VMT. Higher electrification rates of high mileage fleets such as TNCs are possible in this timeframe given vehicle purchase cost parity between BEVs and ICE vehicles will be reached for some vehicle classifications before 2030 and the operational cost savings for a ZEV are opportune. The authority for the CMS regulation is provided by SB 1014, which requires CARB to create and the CPUC to enact such a regulation.[22]

Major Regulation Determination

CARB staff determined that the Proposed Regulation is a major regulation as the analysis shows a greater than $50 million in direct costs and $50 million in direct savings in multiple years of the regulatory timeline. The first requirements for TNCs begin in 2022 with requirements for biennial compliance plans. Electrification and GHG targets commence in 2023 and the rule will be fully implemented in 2030. The SRIA analyzes the costs and benefits from 2021 to 2031, 12-months before and after the period of the regulation.

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[18] BloombergNEF. *Electric Vehicle Outlook 2019*. (Global projection of total kilometers traveled by passenger vehicles operating in TNCs.)

[19] Clewlow, Regina R., and Gouri Shankar Mishra. "Disruptive transportation: The adoption, utilization, and impacts of ride-hailing in the United States." University of California, Davis, Institute of Transportation Studies, Davis, CA, Research Report UCD-ITS-RR-17-07 (2017).

[20] CARB 2019. *2018 Base-Year Emissions Inventory Report*

[21] CARB. *California's 2017 Climate Change Scoping Plan*: The strategy for achieving California's 2030 greenhouse gas target. November 2017.

[22] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1014, accessed 6/22/20.

Methodology for BAU and Compliance Scenarios (Baseline Information)

To estimate the impacts of the Proposed Regulation, a baseline or business-as-usual (BAU) scenario was developed. The economic and emission impact of the proposed regulation is evaluated using the compliance scenario compared against the BAU scenario for the analysis period 2021 to 2031. As the Proposed Regulation allows for multiple compliance pathways, it is not possible to predict the exact TNC actions used for future compliance. The compliance scenario represents one potential way to achieve the GHG and electrification targets.

The BAU scenario forecasts TNC VMT activity, TNC vehicle populations, GHG and criteria emissions and gCO2/PMT metrics in the absence of the Proposed Regulation. The BAU scenario reflects implementation of currently existing state and federal laws and regulations. Staff developed the BAU forecast activity using the 2018 base year TNC data, TNC region-specific growth assumptions, and other TNC BAU scenario assumptions as presented below. To estimate emissions, staff also developed California specific criteria and GHG emission rates that reflect future improvements on emission control technologies and fuel efficiency, as well as TNC fleet and driving characteristics. Assumptions used in developing the BAU forecast scenario are summarized in the following sections, with details on the methodology, data, and assumptions discussed in the Technical Appendix, BAU Section.

BAU Scenario Assumptions

The BAU scenario adopted assumptions on TNC fleet and operation characteristics including occupancy, deadheading, percent eVMT, ZEV technology mix, and fleet mix in terms of vehicle class population mix and age distribution. Table 5 presents a summary of assumptions used in the BAU scenario. Many of these assumptions were developed at the regional level, where a region is defined by sub-area and urbanicity level. Sub-area is the geographic designation of area that is cross-classified by county, air basin and air district. Urbanicity, in the context of SB 1014, is a geographical designation of areas based on the unique characteristics of the region such as socioeconomics, TNC activity, and transportation infrastructure. The defined urbanicity helps CARB to form reasonable assumptions (i.e., eVMT and deadhead miles) for BAU and regulatory scenarios assessment by urbanicity.

Table 5: BAU Assumptions for TNC Fleet and Operation Characteristics

Inputs	Assumptions
%eVMT (ratio of TNC eVMT to VMT)	Growing from TNC 2018 base year percent eVMT, assume the same growth rates relative to 2018 as in CARB on-road emission model (EMFAC 2017), which are based on Advanced Clean Car compliance[23].
BEV/FCEV/PHEV split	Represents the fraction of all TNC ZEV and PHEV vehicles that are either BEV, FCEV, or PHEV. Assume to be same as 2018 base year.
Utility factor for PHEV	This is the fraction of a PHEV's mileage from electricity. Assume to be same as in 2018 base year inventory (22.7%). See Base-year Report[6], page 36.
Occupancy	TNC fleet-wise average occupancy of 1.55, consistent with 2018 base year analysis (see Base-year Report[6] , page 44)
% Deadheading	Same as in 2018 base year TNC data, by sub-area and urbanicity
Fleet mix (vehicle classification)	Same Car/Truck distribution as 2018 base year TNC by region for all years
Age distribution (vehicles)	Same vehicle age distribution as 2018 base year TNC by region for all years
Connection to transit	Negligible for all years and all regions as in 2018 base year inventory
Connection to active transportation	Negligible for all years and all regions as in 2018 base year inventory

In the BAU scenario, the TNC percent eVMT is assumed to grow at the same relative growth rate as the percent eVMT for California light duty vehicles projected in the EMFAC2017 inventory model, which accounts for the Zero Emission Vehicle Regulation requirements. For TNC fleets, while the percent eVMT varies by region in the base year, the same eVMT growth rates with reference to the 2018 base year are applied for all regions. The percent eVMT growth rates and the BAU statewide aggregated percent eVMT are presented in Table 6.

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[23] CARB LEV III Program. https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/lev-program/low-emission-vehicle-lev-iii-program

Table 6: Statewide Percent eVMT Growth Trend Relative to 2018 and BAU Percent eVMT

Year	%eVMT growth rate relative to 2018	TNC BAU Percent eVMT
2021	176%	1.0%
2022	214%	1.2%
2023	259%	1.4%
2024	309%	1.7%
2025	365%	2.0%
2026	408%	2.3%
2027	447%	2.5%
2028	483%	2.7%
2029	515%	2.9%
2030	544%	3.0%
2031	570%	3.2%

BAU TNC Market Growth

Regional growth assumptions based on historical TNC activity data were developed for the BAU scenario. Historical P3 VMT data from 2013 to 2019 provided by CPUC was aggregated to the regional level. Staff then categorized regions based on differing levels of market maturation. The historical data shows rapid growth since TNCs first launched. The year-to-year growth rates, however, have continued to decline. Staff assume these trends will continue to estimate regional growth assumptions. Relative to the 2018 base year, these assumptions imply a statewide 37 percent increase in market growth by 2023, the first year of the electrification and GHG targets, and a 42 percent increase in market growth by 2030. Notably, a significant portion of market growth is assumed to have occurred between 2018 and 2023, while only an additional 5 percent of market growth occurs between 2023 and 2030.

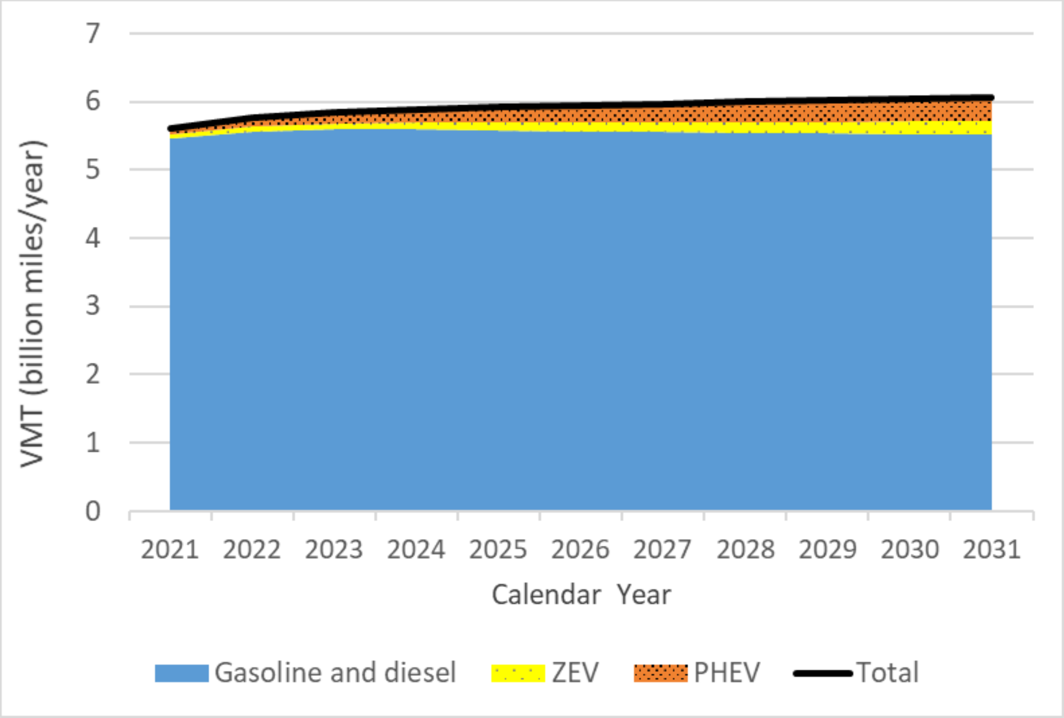
CARB is aware that events such as the COVID-19 pandemic, the ensuing economic recession, and the passage of California's AB 5 may all have a significant impact on the trajectory of growth experienced by TNCs. CARB's detailed trip-level data from the TNCs for the base year analysis only covers the year 2018. Staff do not have access to 2019 or 2020 trip level-data. However, staff are aware of aggregate current market trends reported in the media and from informal discussions with stakeholders. TNCs have discontinued pooling services nationally, temporarily during the pandemic, and their traditional rider demand has declined substantially as communities have sheltered in place across the state. Similarly, the passage of AB 5 occurred following the CMS base year analysis, and CARB staff were never granted access to driver income data for the data shared by TNCs. Therefore, staff are not in a position to evaluate changes to driver income or benefits as a result of labor contract changes as TNCs implement AB 5.

Due to the wide fluctuations in TNC demand this year during the pandemic, and the uncertainty surrounding the long term impacts from the recession and AB 5 business model changes, CARB staff has prepared an additional sensitivity analysis of a delayed growth scenario. The sensitivity analysis pauses the market growth assumptions until 2023. For example, in the sensitivity analysis, the market size and VMT of the TNC fleet in 2023 is assumed to be the same as in 2018 and the market growth assumptions used in the BAU for calendar year 2019 would be applied to calendar year 2024. The assumption in the sensitivity analysis would be consistent with decreased demand for TNC services and a decreased supply or decreased demand for TNC drivers relative to the main SRIA analysis. See Appendix H for more details.

BAU TNC VMT and Populations

The TNC VMT projection under the BAU reflects the TNC market growth, as well as projected percent eVMT growth and other assumptions presented earlier. While eVMT and ZEV population grow as discussed previously, TNC vehicle class population mix and age distributions remain the same as in the 2018 base year. Figure 2 illustrates the TNC VMT forecast by fuel types under the BAU scenario. For reference, the 2018 base year statewide TNC VMT was 4.3 billion miles/year.

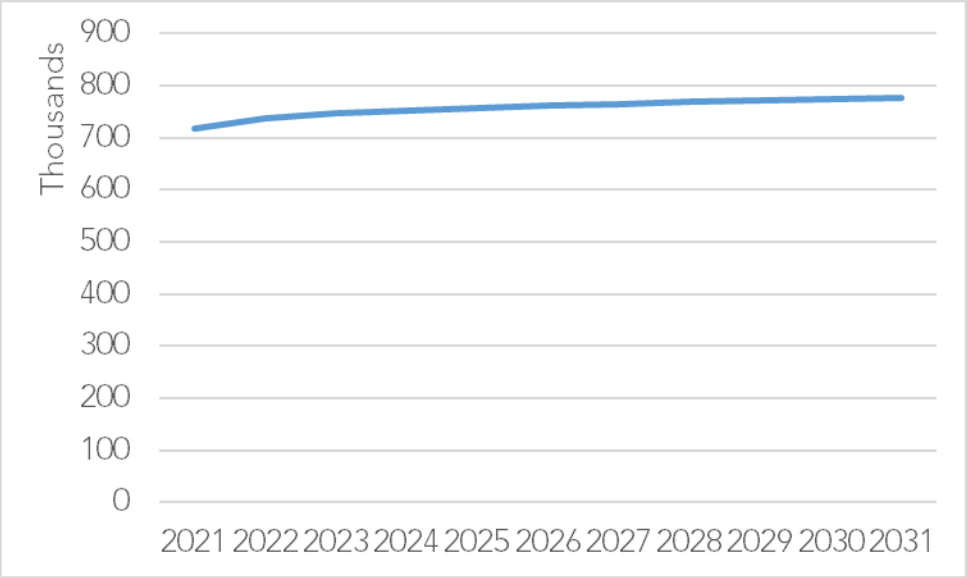
Figure 2: Statewide TNC VMT by Fuel Types under the BAU Scenario



The same market growth projections are used to estimate the population of the TNC fleet in future years. Applying the market growth projections in this manner assumes that in future years, there would be a similar distribution of low mileage and high mileage drivers as in the

2018 base year TNC fleet. Figure 3 illustrates the BAU TNC vehicle population assumption used in this analysis. For reference, the 2018 Base-Year Emissions inventory report provided a conservative TNC vehicle population estimate of approximately 642 thousand vehicles.[24]

Figure 3: Assumed BAU TNC Vehicle Population



Compliance Scenario Assumptions

The compliance scenario used to assess the environmental and economic impacts depict the case where both the GHG and electrification targets are met through increased electrification of the TNC fleet. CARB staff believe this is one reasonable compliance scenario given Lyft's recent commitment to greater electrification and also because of the uncertainty around demand and costs of shared rides. This scenario maintains all other assumptions used in the BAU scenario except for the percent eVMT trend.

Table 7 shows the percent eVMT used for compliance with both the proposed electrification and GHG targets and illustrates the TNC VMT by fuel type in this compliance scenario. To comply with the GHG targets through electrification, the percent eVMT achieved by the TNCs must be slightly greater than the targets shown in Table 1. Details on how TNCs would achieve these targets is described in Section C.1: Direct Cost Inputs.

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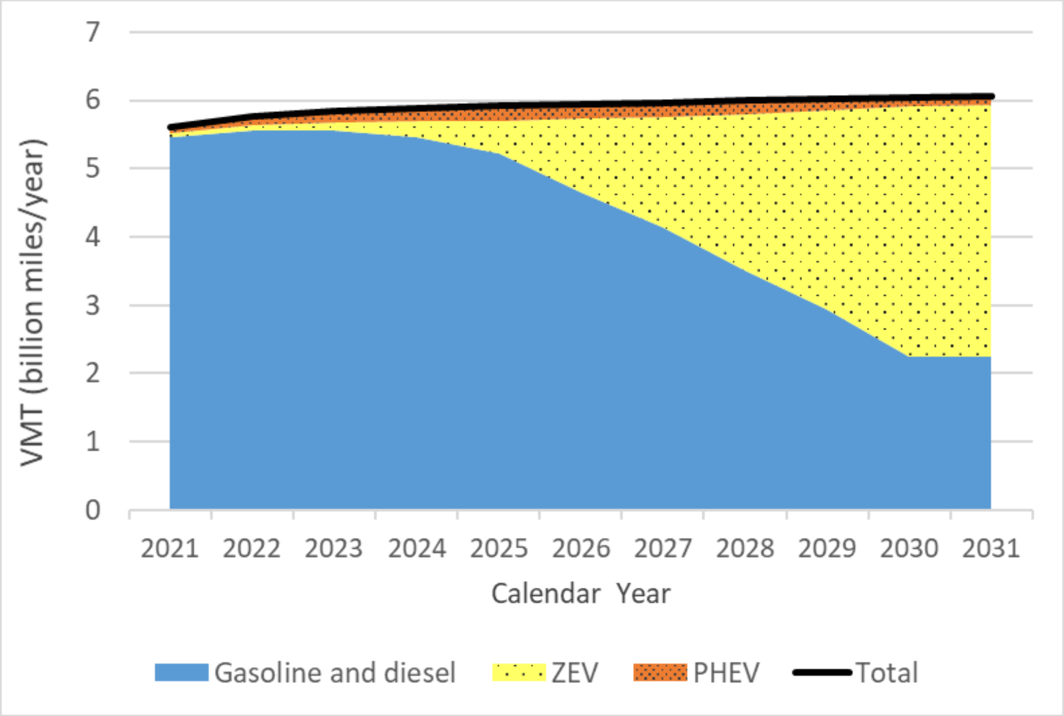
[24] 642,000 is a conservative estimate from the *2018 Base-Year Emissions Inventory Report.* This estimate was based on approximately 585,000 unique vehicle identification number (VIN) patterns and adjusts for things such as overlapping trips and instances where a particular VIN was recorded providing multiple trips at the same time. This analysis utilizes the dataset of unique VIN patterns to estimate TNC populations in each year. Before applying the TNC market growth factors, vehicles with less than one (1) total P1, P2, and P3 miles and vehicles with zero (0) P3 miles were removed from the dataset. This results in a 2018 base year fleet size of approximately 537,000 vehicles.

Table 7: Compliance Scenario Percent eVMT for Achieving Electrification and GHG Targets through Electrification of the TNC Fleet

Year	Percent eVMT for GHG target compliance
2023	2.0 %
2024	4.0 %
2025	8.0 %
2026	18.2 %
2027	27.1%
2028	38.4%
2029	48.4%
2030	60.6%
2031	60.6%

Figure 4: Statewide TNC VMT by Fuel Types under the Compliance Scenario



Interactions with Overlapping Regulations

The BAU scenario includes compliance, but not over compliance, with existing regulations and standards. In particular CARB's Zero Emission Vehicle Regulation[25] specifies new vehicle credit requirements and staff estimate the anticipated number of ZEVs in California; the

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[25] https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program

regulation is credited with the associated costs and emissions benefits. The Proposed CMS Regulation is not anticipated to increase or decrease the number of ZEVs in California, but instead, is anticipated to shift the use of the ZEVs towards TNC use. Although the CMS regulatory analysis accounts for more current ZEV technology costs than those used in the Zero Emission Vehicle Regulation adopted in 2012, Zero Emission Vehicle Regulation compliance populations were still relied upon to be consistent with existing programs and emission inventory estimates.

While TNC companies, drivers, and riders may bear direct costs or savings associated with the purchase of ZEVs and BEV charging equipment, overall purchases of ZEVs and charging equipment within California are not anticipated to change as a result of the Proposed Regulation. However, if utilization of a ZEV by a TNC driver is greater than that of a typical non-TNC driving ZEV owner, the Proposed Regulation will result in statewide incremental increases in eVMT and decreases in GHG emissions. The net benefits in Section B are assessed based on such incremental utilization of ZEVs. To calculate the net emission benefits, for each additional ZEV under the compliance scenario, staff compared its annual eVMT in the TNC service with the annual eVMT the same vehicle would have driven as a normal California non-TNC ZEV.[26] The incremental eVMT is calculated as the sum of the incremental mileage that all ZEVs produced when driving in TNC services. The net emissions are assessed by calculating the difference between the emissions associated with incremental eVMT, and those emissions associated with the same amount of gasoline VMT that the eVMT are replacing. These emission impacts account for both the vehicle direct emissions as well as the upstream fuel production and delivery emissions.

Because of the interactions with the Zero Emission Vehicle Regulation, CARB staff present the costs in Section C in two ways. First, costs and cost savings that would be borne within the TNC service industry for increased electrification of the TNC fleet are presented to show direct impacts to the regulated industry (TNCs, drivers, and riders). These costs are presented without regard to any offsetting costs or savings that might result from interactions with the Zero Emission Vehicle Regulation.

Second, to show the total costs to California attributable specifically to the Proposed Regulation, the analysis presents impacts that subtract the costs and savings that are attributable to the Zero Emission Vehicle Regulation. Because the number of ZEVs and amount of charging equipment in the state is expected to be the same as under the Zero Emission Vehicle Regulation, the California statewide costs and savings exclude vehicle and home charging capital costs. When accounting for statewide impacts of the Zero Emission Vehicle Regulation, only TNC mileage in excess of what a typical California household vehicle drives is applied when calculating costs and cost savings associated with fueling and maintenance. As described above, the emission and health benefits discussed in Section B account only for the TNC GHG and criteria pollution emission benefits that go beyond what the Zero Emission Vehicle Regulation would have achieved.

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[26] "Annual eVMT of the same vehicle" refers to the VMT a vehicle of the same fuel type, vehicle class, model year, age, and region as estimated in the EMFAC2017 Model.

Public Outreach and Input

CARB staff sought input from stakeholders and the public through various outreach events, including public workshops, a public board hearing, stakeholder working groups, an expert panel convening, as well as individual meetings with stakeholders. CARB staff solicited for regulatory alternatives at the May 15, 2020 Public Workshop. A complete listing of previously held public outreach and events appears in Table 8. Staff will continue to engage stakeholders and the general public throughout the development of this regulation, leading up to the regulatory proposal. A list of planned additional public outreach appears in Table 9.

Table 8: Dates and Objectives for Events Held Previously

DATE	EVENT	OBJECTIVE
February 22, 2019	Public Workshop 1	Staff introduced the requirements of SB 1014 to the public and began the regulatory development process.
May 8, 2019	Stakeholder Working Group Meeting 1	The working group discussed options for addressing overlapping trip miles between TNCs in the 2018 base year TNC dataset.
May 15, 2019	Stakeholder Working Group Meeting 2	Staff solicited feedback for 2018 base year and BAU assumptions for occupancy, deadheading, and fuel efficiency.
May 15, 2019	Stakeholder Working Group Meeting 3	Staff solicited feedback for eVMT assumptions for 2018 base year and BAU forecasting.
July 9, 2019	Stakeholder Working Group Meeting 4	Staff solicited feedback from stakeholders for the preliminary regulation design.
September 25, 2019	Public Workshop 2	Staff presented the 2018 base year emissions inventory assumptions and methodology.
January 23, 2020	Public Board Hearing	Staff presented the 2018 base year emissions inventory to Board Members and the public. The Board adopted Resolution 20-4 during the hearing.
March 20, 2020	Expert Panel Convening	Staff sought input from academic and industry experts on topics

DATE	EVENT	OBJECTIVE
		including the BAU modeling, pooling strategies, electrification strategies, and other topics.
April 1, 2020	Public Workshop 3	Staff presented the BAU modeling assumptions and methodology.
May 15, 2020	Public Workshop 4 Solicitation for Alternatives	Staff presented the percent eVMT target development including assumptions and methodology for cost modeling. Additionally, GHG target development updates and potential exemptions for small TNCs were discussed. At this public workshop, staff solicited for economic alternatives.

Table 9: Events and Objectives Planned

DATE	EVENT	OBJECTIVE
July 2020	Public Workshop 5 Solicitation for Alternatives	Staff will present proposed regulatory requirements including annual GHG and electrification targets for TNCs. Additional workshop content will include potential regulatory credits for connected transit trips and active transportation.
September 2020	Public Workshop 6	This will be the final workshop to present the proposed regulation to stakeholders and the public.
December 10, 2020	Public Board Hearing	Staff will present the regulatory proposal for the Board's consideration and to hear public comments.

B. BENEFITS

Benefits to Typical Businesses

Electric Vehicle Service Providers and Businesses Adjacent to Public Charging

The Proposed Regulation will increase the total amount of eVMT in the state, which in turn could increase utilization of charging stations across the State and lead to increased revenue for these businesses. TNC drivers account for up to 35% of utilization at changers making the business model for their investment more stable and predictable.[27] This allows investor capital and venture capital funds to be accessed for increased deployment rates of ZEV infrastructure.

Increased use of public charging stations may also have benefits to businesses near charging stations. Many charging stations are located in areas with available shopping, food to go or dine in, or other services such as dry cleaning. Commercial businesses that provide services that TNC drivers may want to make use of may benefit from the presence of the BEV chargers nearby.

Utility Providers

The Proposed Regulation will increase the total amount of eVMT in the state, which in turn will increase the amount of electricity supplied by utility providers. Currently, the charging of BEVs represents the single largest growth area for electric utility companies as traditional areas of growth have been hampered by conservation efforts. Even more recently, the utility companies in California have been proactively shutting down large sections of the grid, sometimes for several days, in order to avoid starting wildfires during windy dry seasons. The use of ZEVs to provide grid services and decentralized backup power for California citizens is feasible within the regulation period. Further, commercial or TNC use of ZEVs is thought to be more compatible, than consumer owned ZEVs, with providing these power services and that the grid services may additionally provide another revenue stream for commercial ZEV fleet operators.

The Proposed Regulation also helps the state’s investor-owned utilities meet the goals of Senate Bill 350, the Clean Energy and Pollution Reduction Act of 2015. Senate Bill 350 requires the state’s investor-owned utilities to develop programs “to accelerate widespread transportation electrification,” with goals to reduce dependence on petroleum, increase the adoption of zero-emission vehicles, help meet air quality standards, and reduce greenhouse gas emissions. Southern California Edison and San Diego Gas & Electric have both proposed programs that are awaiting CPUC decision as extensions of earlier light-duty EV infrastructure pilots. Pacific Gas & Electric has been approved for a direct current fast charging make-ready program, and the three smaller investor-owned utilities have also been approved for light-duty EV infrastructure programs. Furthermore, all three large investor-owned utilities have

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[27] Jenn 2020 Emissions benefits of electric vehicles in Uber and Lyft ride-hailing services. Nature Energy: https://doi.org/10.1038/s41560-020-0632-7 .

either proposed or have been approved to establish new electricity rates for commercial ZEV infrastructure use cases. By ensuring additional eVMT will be available to make use of these utility investments and rates, the Proposed Regulation supports the utilities' programs and the goals of SB 350.

Other California Businesses

The Proposed Regulation may result in benefits to the used ZEV market as TNC drivers gain access to the longer-range but lower-cost used ZEVs that are coming off leases. Dealerships and other businesses involved in the sale of used vehicle may benefit.

To the extent that this regulation improves the demand for used ZEVs, a benefit to overall ZEV residual values could occur. Specifically, costs of new vehicles are traditionally off-set by used residual values particularly for commercial purchases such as for rental companies or other commercial fleets. Currently, ZEV used values are lower than their ICE counterparts, Tesla vehicles excepting.[28] If the regulation improves the used ZEV demand, the residual values will improve, and then the economics for purchasing new ZEVs also improves. This could help the private investment in the transition to ZEVs for the State of California as a key barrier would be mitigated.[29,30,31] In particular, vehicle rental companies would benefit directly from these improved ZEV residual values.

Benefits to Small Businesses

For the purpose of this analysis, a small business is defined as one that is independently owned and operated, not dominant in its field of operation, and has fewer than 100 employees. Small businesses may obtain benefits similar to those described for typical businesses. Approximately half of the electric vehicle service providers in the State are considered to be small businesses based on employee size.[32] CARB staff recognizes that some TNC drivers may be part of a small business, but for this analysis considers impacts to TNC drivers as a separate category. CARB has no data suggesting that TNC drivers who

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[28] https://www.greencarreports.com/news/1123583_beyond-tesla-electric-cars-lose-value-faster-than-other-vehicles, accessed 6/24/20.

[29] Levay, Drossinos, and Thiel 2017 The effect of Fiscal incentives on market penetration of electric vehicles: a pairwise comparison of total cost of ownership. *Energy Policy*, Vol. 105, pp 525-533.
https://www.sciencedirect.com/science/article/pii/S0301421517301404?via%3Dihub

[30] Seattle Office of Sustainability & Environment 2014 Removing Barriers to Electric Vehicle Adoption by Increasing Access to Charging Infrastructure: http://www.seattle.gov/Documents/Departments/OSE/FINAL%20REPORT_Removing%20Barriers%20to%20EV%20Adoption_TO%20POST.pdf

[31] Coffman, Bernstein, and Wee 2015 Factors Affecting EV Adoption: https://www.hnei.hawaii.edu/sites/www.hnei.hawaii.edu/files/Factors%20Affecting%20EV%20Adoption.pdf

[32] The Electrical Vehicle Service Providers operating in California include Greenlots, EVgo, ChargePoint, Electrify America, Blink and EVconnect.

operate or are part of a small businesses are disproportionately benefited or impacted by this regulation, as compared to other individual TNC drivers.

Benefits to TNC Drivers

For the purposes of this analysis CARB staff is considering TNC drivers in a separate category from typical businesses, small businesses, and individuals. TNC drivers with driving patterns and BAU vehicles that are well suited for switching to ZEVs may see significant cost savings, even within a single year of typical operation. ZEVs have operational costs savings due to less expensive fuel and reduced maintenance. Both the costs and cost savings that a driver may incur are discussed further in Section C: Direct Costs.

Benefits to Individuals

The Proposed CMS Regulation will benefit individual California residents (not including TNC drivers) mainly from reductions in criteria emissions such as nitrous oxide (NOx) and particulate matter (PM), and from improvements in California air quality and reduced impact on adverse health impacts. The reduction of GHG emissions, while being a global pollutant, will also benefit California residents. If TNCs complied with the GHG targets, in part through decreases in VMT, this could also benefit California individuals through lower levels of congestion.

Criteria Pollutants and GHG Emission Benefits

The projected benefits of the proposed CMS regulation are identified in Table 10 with respect to NOx, PM2.5, and GHG emissions. Emissions benefits are projected by comparing well-to-wheel (WTW) emissions of the forecasted compliance scenario with those of the BAU scenario. As discussed in Section A5, this includes only the emission benefits that go beyond the Zero Emission Vehicle Regulation. The WTW emissions include both on-road and upstream (fuel production and delivery) emissions. The on-road emissions, or tank-to-wheel (TTW) emissions, includes running exhaust, brake wear and tire wear. Calculation of the on-road emissions reflects TNC driving conditions as well as future fleet mix and technology improvement. In addition, for brake wear, staff assumes a 50% brake wear reduction for electric vehicles (BEVs and FCEVs) compared to conventional vehicles due to the effects of regenerative braking.

The upstream emissions, or well-to-tank (WTT) emissions, include those from fuel production facilities such as electricity power plants and gasoline refineries, in addition to fuel feedstock collection (e.g. crude oil extraction from in-state wells) and finished fuel transportation and distribution. The emission factors capture criteria emissions emitted in California and GHG emissions within the scope of AB 32. The emission factors for gasoline fuels were developed based on California-specific data, including Low Carbon Fuel Standard (LCFS) reporting data, CEIDARS/CEPAM, and CA-GREET, while considering LCFS compliance scenarios. Electricity emission factors reflect compliance with SB 100 Renewable Portfolio Standard targets.[33] The proposed regulation, compared to the BAU, increases electricity and hydrogen consumption while reducing gasoline consumption. The net upstream emissions associated with increased electricity consumption are spatially distributed according to the location of electricity consumption. The net upstream emission reductions associated with reduced gasoline consumption are spatially distributed based on refinery capacity and location.

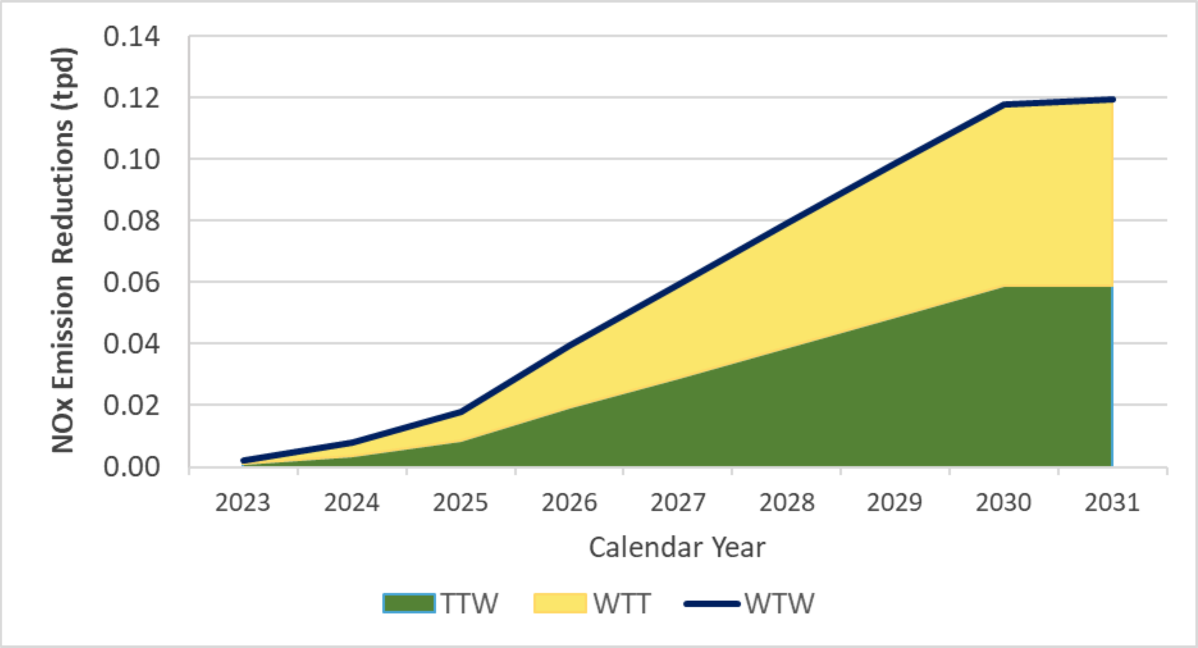
The net annual emissions in 2031 are presented in Table 10. This result reflects the additional electrification in the compliance scenario as well as the TNC market growth projection discussed in Appendix G. The proposed regulation would result in an estimated cumulative net reduction of 188 tons NOx and 114 tons of PM2.5 between 2023 and 2031 compared to the BAU.

Table 10: Proposed CMS Regulation WTW NOx, PM2.5 and GHG Emissions Benefits Relative to BAU

Calendar Year	NOx(tpd)	$PM_{2.5}$ (tpd)	CO2(MMT/yr)
2031	0.12	0.07	0.26

The NOx and PM2.5 emissions impact of the Proposed CMS Regulation relative to the BAU are presented in Figure 5 and Figure 6 respectively and are shown in tons per day (tpd).

Figure 5: Projected WTW NOx Emission Reduction from Proposed CMS Regulation



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[33] Senate Bill (SB) 100 requires renewable energy and zero-carbon resources supply 100 percent of electric retail sales to end-use customers by 2045. For renewable source target in a specific year, refer to https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB100

Figure 6: Projected WTW PM2.5 Emission Reduction from Proposed CMS Regulation

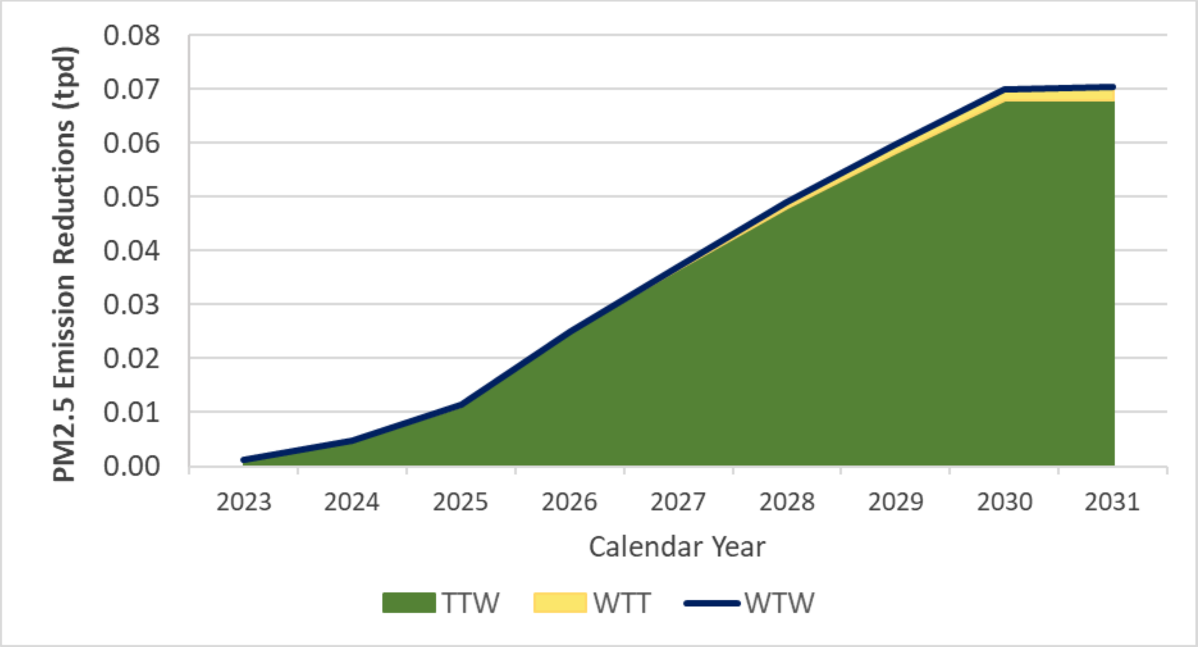
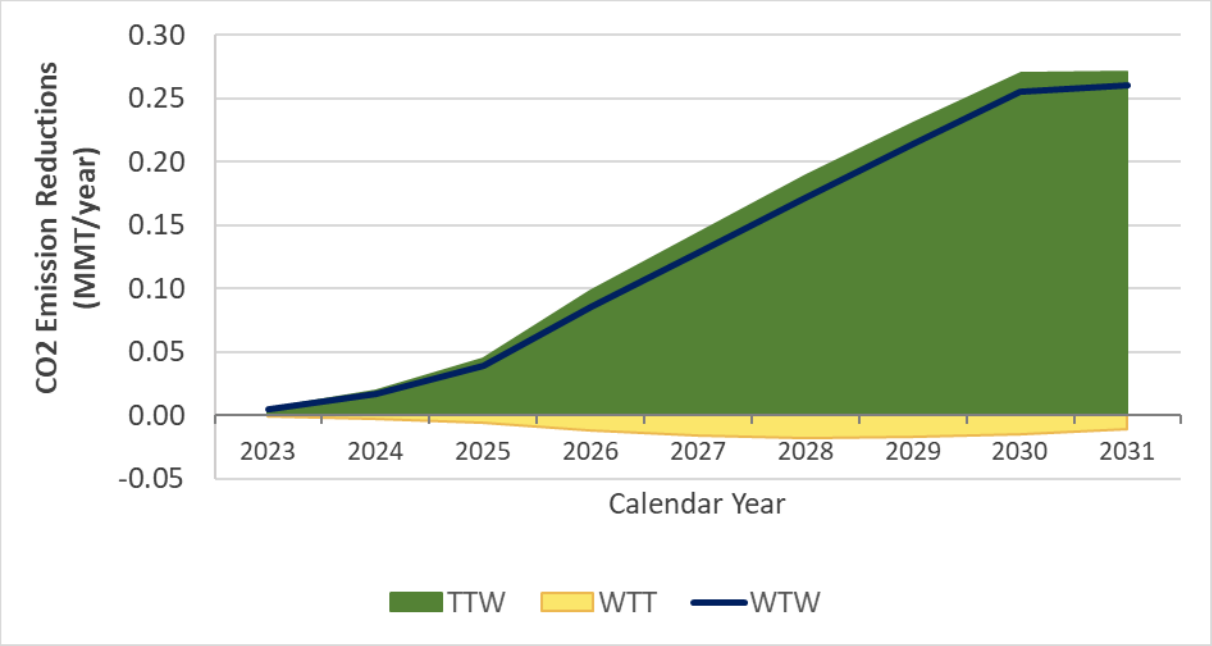


Figure 7 presents the CO2 reductions in million metric tons per year (MMT/year) in the TTW, WTT and WTW phases. During the analysis period between 2021 and 2031, a significant reduction occurs in TTW due the expanded use of ZEVs. The reduction in TTW emissions compensate the slight increase in upstream emission due to fuel substitution, and yields a positive net reduction in WTW emissions. During this analysis period, electricity power generation emits more GHG emissions for each gasoline gallon equivalent unit of energy produced compared to actual gasoline production, creating a GHG dis-benefit. As the electric grid becomes cleaner through additional renewable source of energy, this dis-benefit diminishes, resulting in net WTT GHG reductions after 2033.

Figure 7: Projected WTW CO_2 Emission Reduction from Proposed CMS Regulation



The benefit of the GHG emission reductions can be estimated using the Social Cost of Carbon (SC-CO_2), which provides a dollar valuation of the damages caused by one ton of carbon pollution and represents the monetary benefit today of reducing carbon emissions in the future.

In this analysis, CARB utilizes the current Interagency Working Group (IWG) supported SC-CO_2 values to consider the social costs of actions taken to reduce GHG emissions. This is consistent with the approach presented in the Revised 2017 Climate Change Scoping Plan [34] and is in line with Executive Orders including 12866 and the OMB Circular A-4 of September 17, 2003, and reflects the best available science in the estimation of the socio-economic impacts of carbon.[35]

The IWG describes the social costs of carbon as follows:

> *The social cost of carbon (SC-CO_2) for a given year is an estimate, in dollars, of the present discounted value of the future damage caused by a 1-metric ton increase in carbon dioxide (CO_2) emissions into the atmosphere in that year, or equivalently, the benefits of reducing CO_2 emissions by the same amount in that year. The SC-CO_2 is intended to provide a comprehensive measure of the net damages – that is, the*

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[34] California Air Resources Board, California's 2017 Climate Change Scoping Plan, released in November 2017 (web link: https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf, last accessed June 2019).

[35] Office of Management and Budgets, Circular A-4 (web link: https://www.transportation.gov/sites/dot.gov/files/docs/OMB%20Circular%20No.%20A-4.pdf, last accessed June 2019).

> *monetized value of the net impacts- from global climate change that result from an additional ton of CO_2.*
>
> *These damages include, but are not limited to, changes in net agricultural productivity, energy use, human health, property damage from increased flood risk, as well as nonmarket damages, such as the services that natural ecosystems provide to society. Many of these damages from CO_2 emissions today will affect economic outcomes throughout the next several centuries.*[36]

The SC-CO_2 is year specific, and is highly sensitive to the discount rate used to discount the value of the damages in the future due to CO_2. The SC-CO_2 increases over time as systems become more stressed from the aggregate impacts of climate change and future emissions cause incrementally larger damages. This discount rate accounts for the preference for current costs and benefits over future costs and benefits, and a higher discount rate decreases the value today of future environmental damages. While the Proposed Regulation cost analysis does not account for any discount rate, this social cost analysis uses the IWG standardized range of discount rates from 2.5 to 5 percent to represent varying valuation of future damages. Table 11 shows the range of IWG SC-CO_2 values used in this assessment.[37] These values were transformed into constant 2018 dollars using California Department of Finance's CPI for all urban consumers.[38]

Table 11: SC-CO_2, 2020-2035 (in 2018$ per Metric Ton)

Year	5 Percent Discount Rate	3 Percent Discount Rate	2.5 Percent Discount Rate
2020	$15	$53	$78
2025	$18	$58	$85
2030	$20	$63	$92
2035	$23	$69	$98

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[36] National Academies of Sciences, Engineering, Medicine, Valuing Climate Damages: Updating Estimation of Carbon Dioxide (web link: http://www.nap.edu/24651, last accessed June 2019.

[37] Interagency Working Group on the Social Cost of Carbon, Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis -Under Executive Order 12866 (web link: https://obamawhitehouse.archives.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf, last accessed June 2019).

[38] California Department of Finance, Consumer Price Index (web link: http://www.dof.ca.gov/Forecasting/Economics/Indicators/Inflation/documents/CPI_All_Item_CY.xlsx, last accessed July 1, 2020).

If all GHG emission reductions under the Proposed Regulation are assumed to be carbon reductions, the avoided SC-CO_2 from 2021 to 2031 is the sum of the annual WTW GHG emission reductions multiplied by the SC-CO_2 in each year. The cumulative GHG emission reductions along with the estimated benefits from the Proposed Regulation are shown in Table 12. These benefits range from about $18 million to $84 million through 2031, depending on the chosen discount rate.

Table 12. Avoided Social Cost of CO_2

		Avoided SC-CO_2 (Million 2018$)		
Year	GHG emission reductions (MMT)	5% discount rate	3% discount rate	2.5% discount rate
2023	0.00	0.06	0.20	0.29
2024	0.02	0.23	0.76	1.12
2025	0.04	0.54	1.79	2.64
2026	0.09	1.24	4.02	5.92
2027	0.13	1.90	6.10	8.97
2028	0.17	2.60	8.29	12.16
2029	0.21	3.33	10.51	15.39
2030	0.25	4.08	12.75	18.61
2031	0.26	4.27	13.27	19.25
Total	1.17	18.25	57.68	84.35

It is important to note that the SC-CO_2, while intended to be a comprehensive estimate of the damage caused by carbon globally, does not represent the cumulative cost of climate change and air pollution to society. There are additional costs to society outside of the SC-CO_2, including costs associated with changes in co-pollutants, the social cost of other GHG emissions including methane and nitrous oxide, and costs that cannot be included due to modeling and data limitations. The Intergovernmental Panel on Climate Change (IPCC) has stated that the IWG SC-CO_2 estimates are likely underestimated due to the omission of significant impacts that cannot be accurately monetized, including important physical, ecological, and economic impacts.

Health Benefits

The Proposed Regulation reduces NOx and $PM_{2.5}$ emissions, resulting in health benefits for individuals in California. The value of these health benefits are due to fewer instances of premature mortality, fewer hospital and emergency room visits, and fewer lost days of work. As part of setting the National Ambient Air Quality Standard for PM, the U.S. EPA quantifies the health risk from exposure to PM and CARB relies on the same health studies for this evaluation.[39] The evaluation method used in this analysis is the same as the one used for the CARB proposed Low Carbon Fuel Standard 2018 Amendments, and the Heavy-Duty Vehicle Inspection Program and Periodic Smoke Inspection Program.[40]

CARB analyzed the value associated with five health outcomes in the BAU, proposed amendments, and alternatives: Cardiopulmonary[41] mortality, hospitalizations for cardiovascular[42] illness, hospitalizations for respiratory[43] illness, emergency room (ER) visits for respiratory illness, and ER visits for asthma.

These health outcomes were selected because U.S. EPA has identified these as having a *causal* or *likely causal* relationship with exposure to $PM_{2.5}$.[44] The U.S. EPA examined other health endpoints such as cancer, reproductive and developmental effects, but determined there was only *suggestive* evidence for a relationship between these outcomes and PM exposure, and insufficient data to include these endpoints in the national health assessment analyses routinely performed by U.S. EPA.

The U.S. EPA has determined that both long-term and short-term exposure to $PM_{2.5}$ plays a *causal* role in premature mortality, meaning that a substantial body of scientific evidence shows a relationship between $PM_{2.5}$ exposure and increased risk of death. This relationship persists when other risk factors such as smoking rates, poverty and other factors are taken into account.[45] While other mortality endpoints could be analyzed, the strongest evidence exists for cardiopulmonary mortality.[46] The greater scientific certainty for this effect, along with the greater specificity of the endpoint, leads to an effect estimate for cardiopulmonary deaths that is both higher and more precise than that for all-cause mortality.[47]

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[39] United States Environmental Protection Agency, Health and Environmental Effects of Particulate Matter (web link: https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm, last accessed June 2019)

[40] A detailed summary of the health modeling methodology is included on CARB's webpage: https://ww2.arb.ca.gov/resources/documents/carbs-methodology-estimating-health-effects-air-pollution

[41] Outcomes related to the heart or lungs

[42] Outcomes related to the heart or blood vessels

[43] Respiratory illness such as chronic obstructive pulmonary disease, and respiratory infections

[44] U.S. EPA, 2010. Quantitative Health Risk Assessment for Particulate Matter (Final Report). https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf

[45] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959

[46] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959

[47] Air Resources Board (ARB), 2010. Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology. https://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf

The U.S. EPA has also determined a *causal* relationship between non-mortality cardiovascular effects and short and long-term exposure to PM2.5, and a *likely causal* relationship between non-mortality respiratory effects (including worsening asthma) and short and long-term $PM_{2.5}$ exposure.[48] These outcomes lead to hospitalizations and ER visits, and are included in this analysis.

In general, health studies have shown that populations with low socioeconomic standings are more susceptible to health problems from exposure to air pollution.[49,50] However, the models currently used by U.S. EPA and CARB do not have the granularity to account for this impact. The location and magnitude of projected emission reductions resulting from many proposed regulations are not known with sufficient accuracy to account for socioeconomic impacts, and an attempt to do so would produce uncertainty ranges so large as to make conclusions difficult. CARB acknowledges this limitation.

Results

The estimated avoided premature mortality, hospitalizations, and ER visits because of the Proposed Regulation for 2023 through 2031 by California air basin, relative to the baseline are shown in Table 13. Only the regions with values of one or higher are shown, and regions with zero or insignificant impacts are not shown. Values in parenthesis represent the 95 percent confidence intervals of the central estimate. As detailed in the previous section, the Proposed Regulation is estimated to reduce overall emissions of $PM_{2.5}$ and NOx, and lead to net reduction in adverse health outcomes statewide, relative to the baseline.

The Proposed Regulation may decrease the occupational exposure to air pollution of California TNC drivers. CARB staff cannot quantify the potential effect on occupational exposure due to lack of data on the typical occupational exposure for these types of workers.

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[48] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959

[49] Krewski et al. (2009) Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. https://ephtracking.cdc.gov/docs/RR140-Krewski.pdf.

[50] Gwynn RC, Thurston GD. (2001) The burden of air pollution: impacts among racial minorities. Environ Health Perspectives;109(4):501–6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240572/

Table 13: Regional and Statewide Avoided Mortality and Morbidity Incidents from 2023 to 2031 under the Proposed Regulation*

Air Basin	Avoided Premature Deaths	Avoided Hospitalizations for cardiovascular illness	Avoided Hospitalizations for respiratory illness	Avoided ER visits
San Diego County	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 1)
San Francisco Bay	5 (4 - 6)	1 (0 - 1)	1 (0 - 1)	3 (2 - 4)
South Coast	14 (11 - 17)	2 (0 - 4)	3 (1 - 5)	7 (5 - 10)
Statewide	**20 (16 - 25)**	**3 (0 - 6)**	**4 (1 - 6)**	**11 (7 - 14)**

*Values in parenthesis represent the 95% confidence interval. Only regions with values of one or higher are shown, and regions with zero or insignificant impacts are not shown. Totals may not add due to rounding.

The year by year values of avoided mortality and morbidity from 2023 to 2031 under the Proposed Regulation are shown in Table 14. The number of avoided incidents grows over time as the electrification and GHG targets strengthen.

Table 14: Year by Year Avoided Mortality and Morbidity Incidents from 2023 to 2031 under the Proposed Regulation*

Year	Cardiopulmonary mortality	Hospitalizations for cardiovascular illness	Hospitalizations for respiratory illness	Emergency room visits
2023	0	0	0	0
2024	0	0	0	0
2025	1	0	0	0
2026	2	0	0	1
2027	2	0	0	1
2028	3	0	1	2
2029	4	1	1	2
2030	4	1	1	2
2031	4	1	1	2

* Totals may not add to Statewide total values due to rounding.

In accordance with U.S. EPA practice, health outcomes are monetized by multiplying each incident by a standard value derived from the economic studies.[51] The value per incident is shown in Table 15. The value for avoided premature mortality is based on willingness to pay,[52] which is a statistical construct based on the aggregated dollar amount that a large group of people would be willing to pay for a reduction in their individual risks of dying in a year. While the cost-savings associated with premature mortality is important to account for in the analysis, the valuation of avoided premature mortality does not correspond to changes in expenditures, and is not included in the macroeconomic modeling (Section E). As avoided hospitalizations and ER visits correspond to reductions in household expenditures on health care, these values are included in the macroeconomic modeling.

Unlike mortality valuation, the cost-savings for avoided hospitalizations and ER visits are based on a combination of typical costs associated with hospitalization and the willingness of surveyed individuals to pay to avoid adverse outcomes that occur when hospitalized. These include hospital charges, post-hospitalization medical care, out-of-pocket expenses, and lost earnings or both individuals and family members, lost recreation value, and lost household production (e.g., valuation of time-losses from inability to maintain the household or provide childcare).[53] These monetized benefits from avoided hospitalizations and ER visits are included in macroeconomic modeling (Section E).

Table 15: Valuation per Incident for Avoided Health Outcomes

Outcome	Value per incident (2018$)
Avoided Premature Mortality	$9,579,924
Avoided Cardiovascular Hospitalizations	$56,588
Avoided Acute Respiratory Hospitalizations	$49,359
Avoided Emergency Room Visits	$810

Statewide valuation of health benefits were calculated by multiplying the value per incident by the statewide total number of incidents for 2023-2031 as shown in Table 15. The estimated total Statewide health benefits derived from criteria emission reductions is estimated to be $194.93 million, with $194.57 million resulting from reduced premature mortality and $0.36 million resulting from reduced hospitalizations and emergency room visits. The spatial

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[51] U.S. EPA, Appendix B: Mortality Risk Valuation Estimates, Guidelines for Preparing Economic Analyses (240-R-10-001, released December 2010) (web link: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-22.pdf/$file/EE-0568-22.pdf

[52] U.S. EPA, An SAB Report on EPA's White Paper Valuing the Benefits of Fatal Cancer Risk Reduction (EPA-SAB-EEAC-00-013, released July 27, 2000) (web link: https://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/41334524148BCCD6852571A700516498/$File/eeacf013.pdf

[53] Chestnut, L. G., Thayer, M. A., Lazo, J. K. and Van Den Eeden, S. K. (2006), The Economic Value Of Preventing Respiratory And Cardiovascular Hospitalizations, Contemporary Economic Policy, 24: 127– 143. doi: 10.1093/cep/byj007

distribution of these benefits across the State follows the distribution of the health impacts by air basin as described in Table 13.

Table 16: Statewide Valuation from Avoided Health Outcomes from 2023 to 2031

Outcome	Avoided Incidents	Valuation (Million 2018$)
Avoided Premature Mortality	20	$194.57
Avoided Cardiovascular Hospitalizations	3	$0.17
Avoided Acute Respiratory Hospitalizations	4	$0.18
Avoided Emergency Room Visits	11	$0.01
Total		**$194.93**

Other Benefits

Increased Mobility Options through More Pooling

While the compliance scenario only analyzes the benefits of increased electrification, TNCs could also comply with the GHG targets, in part, through increases in occupancy by increasing the availability of pooled rides. Limited data exists for non-pooled versus pool requested trip fares in California. Using the publicly available Chicago TNC data,[54] CARB staff estimated the average trip fares normalized by Period 3 miles as $2.03 per mile for non-pooled trips and $1.39 per mile for pool requested trips. Because fares for TNC pool requested trips can be significantly cheaper than those of a non-pooled trip, increasing the availability of pooling services beyond what was available in 2018 could increase mobility access among those with limited mobility options. Indeed, a study based on Lyft data in Los Angeles County indicates that people living in lower-income census tracts[55] use shared services more often than those in middle-[56] and higher-income[57] census tracts (38% vs 30% vs 24%, respectively).[58] Similarly, an analysis by CARB staff of the 2018 California TNC data shows that trips originating in zip codes containing disadvantaged communities in the Los Angeles metropolitan region have a pool request rate that is 38% higher than zip codes that do not contain disadvantaged communities. Because shared services are already being used at a higher rate by people living in lower-income and traveling from disadvantaged communities, an expansion of pooling services to new areas could increase the mobility options of these priority populations.

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[54] City of Chicago, 2020. Transportation Network Providers – Trips. Chicago Data Portal. https://data.cityofchicago.org/Transportation/Transportation-Network-Providers-Trips/m6dm-c72p. Data downloaded 5/2/20.

[55] Defined in the study as census tracts with a median income equal to or less than $38,319.

[56] Defined in the study as census tracts with a median income between $38,320 and $76,364.

[57] Defined in the study as census tracts with a median income greater than $76,365.

[58] Brown, A.E. (2020), Who and Where Rideshares? Rideshare travel and use in Los Angeles, Transportation Research Part A, 136: 120-124. doi: 10.1016/j.tra.2020.04.001.

C. DIRECT COSTS

As discussed above, there are many actions available to the TNCs to achieve the GHG and electrification targets. Due to a lack of available data and research, CARB staff was unable to estimate costs and impacts associated with many of the actions available to TNCs, such as education and marketing campaigns to increase awareness of shared services, incentivizing good passenger behavior on pooled trips,[59] improving the matching algorithm and communication with drivers to increase the demand for pool services, or strategies aimed specifically at reducing deadhead miles. CARB staff did perform an exploratory analysis of costs to decrease the fares of pool services as a means for increasing TNC occupancy. However, both the uncertainty of the impacts on demand for TNC services and the costs were high, suggesting that TNCs are unlikely to take that approach in response to the Proposed Regulation. Therefore, for the purposes of estimating the costs of this Proposed Regulation, CARB staff is presenting costs associated with meeting the GHG and electrification targets only through increases in eVMT, which staff believes is the most likely response of TNCs to the Proposed Regulation.

Section C.1 presents the direct cost inputs and total costs from compliance with the Proposed Regulation. As discussed in Section A.5, both the total cost borne by the TNC service industry (TNCs, drivers, and riders) and the costs to California, after accounting for interactions with the Zero Emission Vehicle Regulation, are presented.

Sections C.2 through C.5 provide examples of how the costs of the Proposed Regulation may be borne across TNCs, drivers, riders, and also among individuals of varying socioeconomic status. Currently, the majority of drivers bring their own personal vehicles to use on the TNC platform. However, it is unknown what types of short-term (e.g. weekly) rental models may be utilized in the future as TNC companies push for higher levels of electrification. As a result, the distribution of costs among TNCs, drivers, or individual riders is uncertain. For example, a TNC could place the burden of acquiring a ZEV fully on the driver or the TNC could increase fares to riders to help provide incentives to help facilitate the switch to a ZEV. The discussion in Sections C.2 through C.5 provide illustrative examples of possible ways the costs could be borne.

Direct Cost Inputs

Direct Costs of the regulation are estimated in this section. The direct costs that would be borne across TNCs, drivers, and riders from the Proposed Regulation include: upfront vehicle

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[59] Including, but not limited to, only requesting a pool trip if traveling with up to one other passenger, having limited luggage or stuff with you, and not needing to change the trip's destination; being ready for pick-up on time; using a headset for phone calls or while listening to music/watching videos instead of the device's speaker; being respectful of other passengers and the driver and especially not using violence or making sexual advances on another passengers.

purchase costs, home electric vehicle charging infrastructure costs, costs reflecting barriers to ZEV adoption in TNC service, and ongoing operating costs, which include fueling and maintenance. In the short term, ZEVs are anticipated to have higher upfront purchase costs than gasoline vehicles, and face additional barriers to adoption such as time costs due to charging and range anxiety. Thus increasing the number of ZEVs in the TNC fleet in the short term would increase upfront costs. However, operating costs of a ZEV are typically less than that of a gasoline vehicle; electricity is forecasted to be a cheaper fuel than gasoline, and ZEVs require less maintenance than their gasoline counterparts. Depending on the utilization of the vehicle, there may be net cost savings from switching to a ZEV.

The Proposed Regulation also imposes requirements on TNCs for annual compliance reporting and the submission of biennial compliance plans. The assumptions underlying the direct costs are detailed in the following sections.

Compliance with the GHG and Electrification Targets

As described above, this analysis estimates the costs of compliance with both the GHG and electrification targets through increased electrification of the TNC fleet. (See Table 7). To estimate the costs and savings of electrifying TNC vehicles in California, an economic Cost Model was developed with evaluations for each year of the regulation. In each year of the analysis, the model sequentially assesses each vehicle in the BAU TNC fleet and evaluates the costs and cost savings if that vehicle were to maintain the same level of VMT, but the driver switched into a BEV of the same age and vehicle class. The costs include incremental vehicle purchase price, ongoing costs of ZEV operation, costs associated with home charging infrastructure, and some additional required savings to overcome other ZEV barriers in the market. The model then assumes that the vehicles with the lowest net costs (or highest net savings) will switch to ZEVs until the percent electrification and GHG targets are met.[60] For more details and references to assumed input values for the model, see the Technical Appendix, eVMT Cost Model Input Values Section. Table 17 provides summary characteristics of the vehicles switched to ZEVs in each calendar year. In early years of the regulation, relatively few vehicles are needed to switch to ZEVs to comply with the Proposed Regulation and compliance with the Proposed Regulation could be achieved primarily through targeting vehicles that are high mileage and spend a significant portion of the year on the TNC platform. In 2023, the average VMT on the TNC platforms of a vehicle switched to a ZEV is greater than 60,000 miles and the vehicles are in active TNC service in nearly every week of the year.[61] Over time, as the targets strengthen and ZEV vehicle costs decline, more

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[60] When there are net cost savings, vehicles with the greatest savings are the first to switch. When all vehicles with cost savings are switched, the vehicles with the lowest net cost per mile are switched first.

[61] Staff evaluated the driving range of BEVs anticipated to be in the California market by 2023 and concluded that sufficient long-range electric vehicles would be available for TNC drivers to meet their TNC needs, in fleet volumes necessary to support the percent eVMT targets. This analysis does assume a portion of a TNC BEV charging comes from public fast

vehicles would be required to switch over to ZEVs. By 2030, the number of vehicles switching to ZEVs makes up approximately 30 percent of the anticipated TNC fleet. In all years, the average age of the vehicles that switch to ZEVs is less than the average age of a vehicle in the TNC fleet. This is because younger TNC vehicles tend to drive more miles and therefore would accumulate a greater amount of fuel and maintenance savings. The ICE vehicles that get switched to ZEVs are assumed to enter back into the California fleet as a consumer operated vehicle and will have no TNC miles associated with it.

Relative to minimum compliance with the Zero Emission Vehicle Regulation, the number of ZEVs used for compliance with the Proposed Regulation would be approximately 4 percent of the ZEVs in California in 2023 and 40 percent of the ZEVs in California in 2030. (See Technical Appendix: California ZEV Population Section for details).

Table 17: Characteristics of Vehicles that Switched to ZEV in the Model

Year	Number of Vehicles	Average VMT	Average Active Weeks	Average BAU Vehicle MPG	Average Vehicle Age
2023	479	63,413	48.6	32.9	1.2
2024	2,996	46,979	45.5	38.8	0.7
2025	9,061	41,009	44.4	41.9	0.9
2026	30,167	31,878	40.6	45.5	1.0
2027	53,478	27,986	37.9	46.7	1.2
2028	112,842	19,046	29.0	48.1	1.0
2029	146,310	18,768	29.8	48.2	1.3
2030	234,224	14,803	25.9	48.2	1.5
2031	243,738	14,274	25.1	47.9	1.4

Incremental Vehicle Purchase Price

This section describes the assumptions used to estimate the incremental cost of purchasing a ZEV of the same age and vehicle class. Staff assumed that the incremental cost of purchasing a ZEV includes the sum of incremental vehicle capital costs, available state incentives, and depreciation based on the age of the vehicle.

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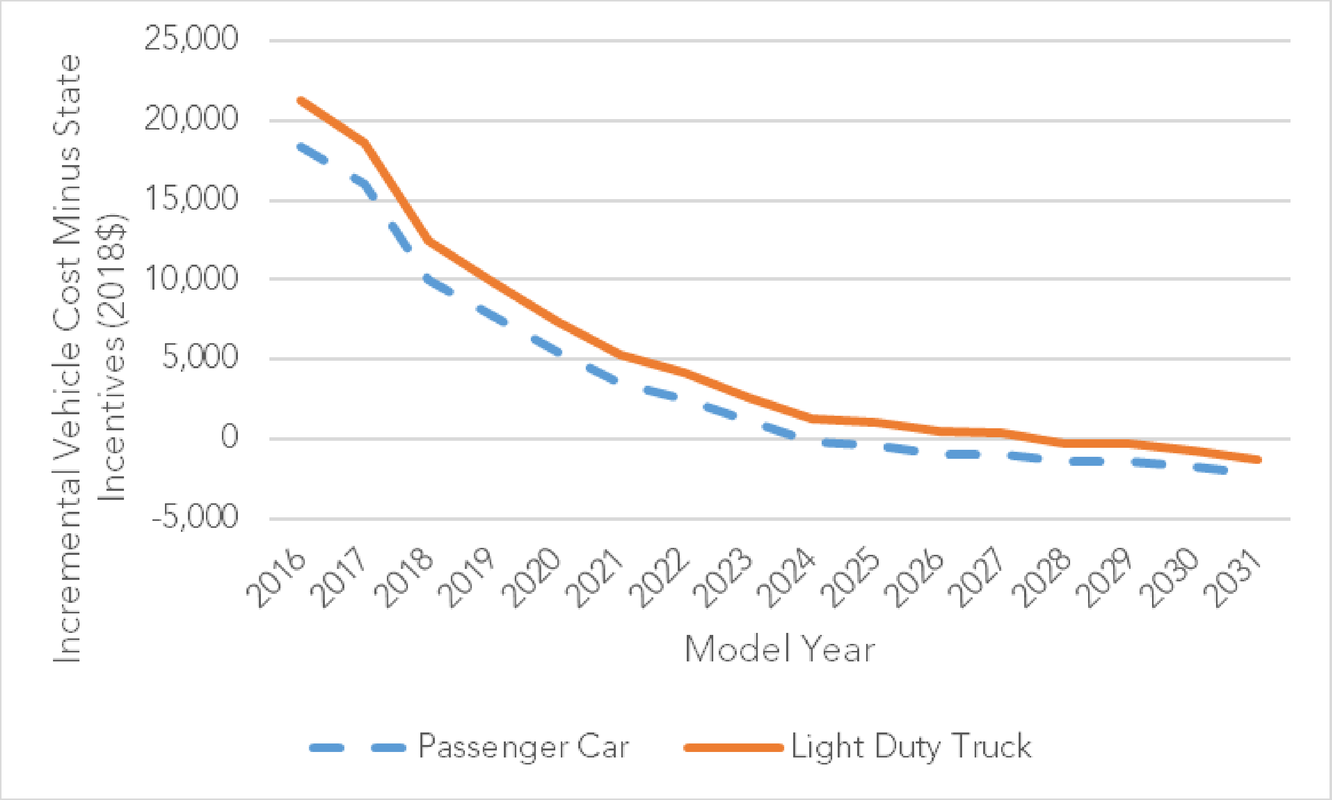
charging during TNC service hours. Refer to Technical Appendix, Percent eVMT Cost Model Methodology and Assumptions Section for more details.

Incremental new vehicle capital cost estimates come from an International Council on Clean Transportation (ICCT) study with CARB staff adjustments that reflect more conservative battery costs.[62] The estimated incremental vehicle costs for a BEV as compared to an ICE appears in Figure 8 by vehicle type. For more details on these cost estimates see the Technical Appendix, eVMT Cost Model Input Values Section.

In this analysis Staff assumes that purchasers of ZEVs would be able to take advantage of available state incentives, but no Federal incentives, and that these incentives would decline over time as ZEVs reach cost parity with gasoline vehicles (between 2028 and 2029 for passenger cars in this analysis). There are two California vehicle incentives in the eVMT Cost Model: an LCFS point of purchase rebate for future BEV owners,[63] and the Clean Vehicle Rebate Program (CVRP)[64] rebate for purchases for new ZEVs. The Federal tax incentives are not included in these figures or cost estimates. For details of the purchase incentives used and not used in the cost estimation, see the Technical Appendix, eVMT Cost Model Input Values Section.

Figure 8: Estimated Incremental Vehicle Capital Costs* of a BEV Over an ICE by Model Year



*Includes incremental vehicle purchase cost minus assumed vehicle purchase incentives

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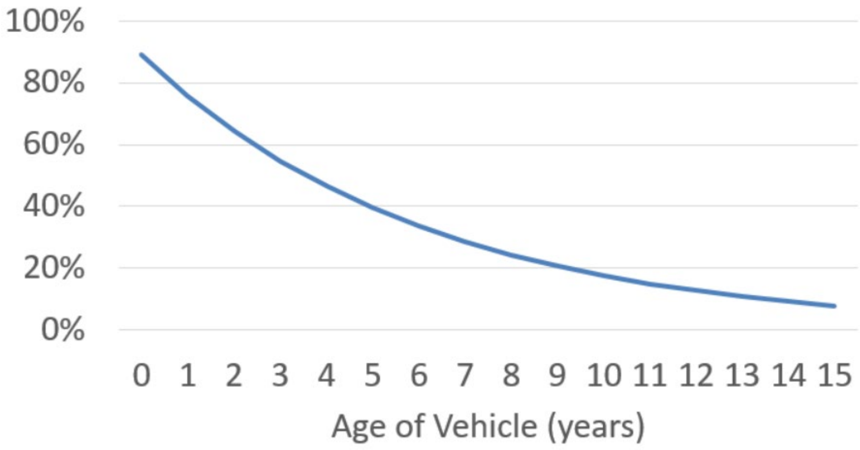
[62] Lutsey and Nicholas 2019 Update on Electric Vehicle Costs in the United States Through 2030. Note: Includes 8.5% sales tax to reflect national average.

[63] https://ww3.arb.ca.gov/regact/2019/lcfs2019/fro.pdf.

[64] https://cleanvehiclerebate.org/eng/eligible-vehicles, accessed 6/5/20.

The incremental vehicle purchase price was depreciated based on the age of the vehicle and are assumed to be the same for ICE vehicles and BEV vehicles due to the assumed range of these vehicles during the period of the regulation. The depreciation curve used is shown in Figure 9. As an example of how to use the curve, the incremental cost of a vehicle that is 15-years old would be less than 10% of the original new vehicle incremental vehicle price listed in Figure 8. Details of the depreciation curve values and data sources can be found in the Technical Appendix, eVMT Cost Model Input Values Section.

Figure 9: Depreciation Curve for Used TNC Vehicles



Operational ZEV Costs

ZEV operating costs are often different from gasoline vehicle operating costs. These include differing insurance costs, ZEV registration fees, electricity fuel costs, gasoline costs, and maintenance costs. Incremental insurance costs were estimated as 5% of the incremental vehicle purchase price. For the period of the proposed regulation, ZEVs owners also pay an additional annual registration fee of $100 per vehicle in California because they do not pay gasoline fuel taxes.

Gasoline fuel prices used in the cost model came from the California Energy Commission Integrated Energy Policy Report (or IEPR).[65] Gasoline fuel costs are based on the gasoline used by an individual driver's conventional vehicle of, which is estimated as that driver's annual VMT divided by the respective vehicle's actual U.S. EPA rated fuel efficiency, multiplied by the calendar year gasoline prices (see Technical Appendix, Cost Model Input Section for details).

Electricity charging costs are a combination of DC Fast Charger and Level 2 charger usage and their respective prices to consumers. DC Fast Charger rates were estimated from actual rates and projected, while Level 2 charger rates are a weighted average of the three largest

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[65] California Energy Commission staff. 2019. Final 2019 Integrated Energy Policy Report. California Energy Commission. Publication Number: CEC-100-2019-001-CMD. https://efiling.energy.ca.gov/getdocument.aspx?tn=232922.

electric utility providers and then also projected (see Technical Appendix, eVMT Cost Model Input Section for details on DC Fast Charger and Level 2 charger assumptions as well as costs for each of these). Electricity costs for a driver switching to a ZEV are estimated as that TNC driver's annual VMT divided by the electric vehicle's fuel efficiency, multiplied by the calendar year electricity price.[66]

Electric vehicles typically have lower maintenance costs than their gasoline counterparts, resulting in a $0.035 per mile savings associated with ZEV operation. Maintenance savings for a vehicle switching to a ZEV is estimated as the VMT multiplied by $0.035 (see Technical Appendix, Cost Model Input Section for details).

Home Charger Infrastructure

As a conservative cost assumption, this analysis assumes that each TNC ZEV operator would purchase a Level 2 home charger. Home charger costs vary over the regulation period from $1,408 in 2023 to $1,184 in 2030 and include average installation costs. For this analysis, it was assumed that each vehicle switching to a ZEV would incur an annualized cost of a home charger, regardless of the amount of DC fast charging assumed (see Technical Appendix, Cost Model Input Section for details on this assumption).

Barriers of Switching to a BEV Costs

Discussion with stakeholders revealed that there are still some barriers to seamless adoption of ZEVs for TNC services. These barriers could be related to concerns that BEVs may not have sufficient range or could reflect potential time costs due to vehicle charging during TNC service hours. CARB staff assumed that these costs start at $27.50 per week in 2023 and reduce to $10 per week by 2030 (for details, please see the Technical Appendix, Cost Model Overview Section). The costs for a vehicle switching to a ZEV are estimated as the number of weeks a BAU vehicle is active in TNC service multiplied by the BEV weekly cost of barriers.

A summary of the calendar year specific cost inputs described above is presented in Table 18.

Table 18: Summary of Calendar Year Specific Cost Inputs

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031
Gasoline Price ($/gal)	3.20	3.22	3.23	3.23	3.26	3.25	3.30	3.27	3.28
Electricity Price ($/kwh)	0.27	0.26	0.25	0.23	0.23	0.23	0.23	0.23	0.23

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[66] As the company Tesla, prohibits the use of free Supercharger use for commercial purposes, the model assumes that Tesla drivers make use of home or public L2 charging and use an adapter for public DC Fast Chargers and are therefore subject to the same rates.

Year	2023	2024	2025	2026	2027	2028	2029	2030	2031
Annualized Home Charger ($/year)	517.03	505.28	493.53	481.78	470.03	458.28	446.53	434.77	423.02
BEV Barriers ($/week)	27.50	25.00	22.50	20.00	17.50	15.00	12.50	10.00	10.00

Reporting Costs

Staff used salary information provided on Glassdoor.com for the classification of a data scientist at Uber in the San Francisco area to estimate the cost of producing the 2-year compliance plans and the annual compliance reports for each TNC. The hourly salary of $90 per hour was used for a data scientist of any level. For a senior data scientist who would conduct reviews of the compliance plan and compliance report, the hourly salary used is $120. Staff took into consideration the cost for in-house legal review of the reports, with an hourly salary of $139 for a senior legal counsel.[67]

Annual Compliance Report

The compliance report requires summarized data and information as described in Section A. For the first year of compliance, 2023, staff anticipates that more time would be required to process the data and prepare the report. For subsequent compliance years, the hours are expected to be less as the process becomes more streamlined. The hours estimate is based on time spent by CARB staff to produce similar outputs, which was done for the base year inventory analysis.

Included in the reporting costs are hours for TNC internal review of the report prior to submitting to the regulatory agency.

The estimated costs per TNC for the annual compliance report are shown in Table 19. The total annual cost to the TNC industry of the annual compliance report would be the cost of two reports, one for each large TNC.

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[67] The hourly salaries reported on Glassdoor.com are $63.58, $84.00, and $97.77 for a data scientist, a senior data scientist, and a senior legal counsel respectively.
These hourly salaries were divided by 0.7 to account for overhead and benefits, and rounded to the nearest dollar based on Bureau of Labor Statistics estimates of wages as a proportion of total compensation: https://www.bls.gov/news.release/ecec.nr0.htm (accessed July 3, 2020).

Table 19: Estimated Costs per TNC for Annual Compliance Report

Reporting years	Classification	Hourly rate	Hours	Cost
2023	Data scientist (all levels)	$90	280	$25,200
	Senior data scientist	$120	10	$1,200
	Senior legal counsel	$139	10	$1,390
	Total	$27,790		
2024-2030	Data scientist (all levels)	$90	160	$14,400
	Senior data scientist	$120	10	$1,200
	Senior legal counsel	$139	10	$1,390
	Total	$16,990		

Biennial Compliance Plan

The first compliance plan is due in 2022. The 2022 compliance plan should include how the TNC expects to meet targets for the 2023 and 2024 compliance years. The last compliance plan for meeting the 2029 and 2030 targets is due in 2028. Targets for the CMS regulation remain fixed beginning in 2030. Any additional requirements for compliance plans beyond 2030 may be determined at a later time.

The cost for a TNC data scientist to develop a 2-year compliance plan is estimated to be half of the cost of an annual compliance plan, based on CARB's experience working with TNC data. The first compliance plan is estimated to cost more than subsequent years. This cost has been scaled with the cost of the annual compliance report. The review time is anticipated to be the same for the compliance plan and for all years. Table 20 shows the estimated cost per TNC for the 2-year compliance plans. The total annual cost the TNC industry for the 2-year compliance plans would be the cost of two plans, every other year, one for each large TNC.

Table 20: Estimated Cost per TNC for Two-year Compliance Plan Submission

Reporting years	Classification	Hourly rate	Hours	Cost
2022	Data scientist (all levels)	$90	140	$12,600
	Senior data scientist	$120	10	$1,200
	Senior legal counsel	$139	10	$1390
	Total	$15,190		
2024, 2026, 2028	Data scientist (all levels)	$90	80	$7,200
	Senior data scientist	$120	10	$1,200
	Senior legal counsel	$139	10	$1,390
	Total	$9,790		

Small TNC companies are not anticipated to face an increase in reporting costs. Under the Proposed Regulation, the data they would be required to report is identical to what is already reported to the CPUC.

Total Costs to TNCs, Drivers, and Riders

Figure 10 illustrates the direct costs that would be borne by TNCs, drivers, and riders to comply with the Proposed Regulation. This includes costs associated with compliance with the GHG and electrification targets, and also includes the costs of reporting. Both costs and cost savings increase over time as more ZEVs are brought into TNC service. The total direct cost that would be borne by TNCs, drivers, and riders is $-797 million for the period from 2021 to 2031 as compared to the baseline scenario (see Table 21), a net savings.

Based on the cost analysis, increased utilization of ZEVs to comply with the proposed regulation, would decrease costs for the TNC industry. While the upfront costs of ZEVs is currently higher than traditional gasoline vehicles, the costs of ZEVs are anticipated to decline over time and reach cost parity with gasoline vehicles. With available incentives, the cost of a ZEV passenger car is anticipated to be on par with a gasoline vehicle in calendar year 2025, as shown in Figure 8. In addition, ZEVs will see savings in the form of decreased gasoline and maintenance costs. These costs savings are estimated to be larger than the additional costs of home charging equipment and electricity (for those that switch to ZEV).

Despite the fact that large cost savings arise, barriers still exist to ZEV adoption in TNC service. Although cost parity is projected, a driver's decision to purchase a ZEV can be dependent on their household income level as well as whether they drive enough miles in TNC service. Although some drivers operate full time, the average number of miles a driver operates on a TNC platform is only 7,000, which makes it difficult for drivers below the average mileage to recoup additional capital costs with fuel savings.

Although staff do not have access to socio-economic status for TNC drivers, from the 2018 base year data, staff were able to study zip codes for where the vehicles were registered. Approximately 53% of TNC vehicles were registered in AB 1550 zip codes that have low income communities, and approximately 29% of TNC vehicles were registered in AB 535 zip codes with disadvantaged communities. This data indicates that many of the drivers are low income and may not have access to capital for a vehicle purchase. There are financial programs available to low income ZEV buyers, though not all of them will be applicable.

As found in CARB's Midterm Review and recent research, awareness of ZEVs is still low, and many buyers are resistant to change.[68,69] Most buyers still think long range electric vehicles are expensive and may not be aware of the low used vehicle prices or may not want to depend on the used vehicle's shorter range. The market for long-range used BEVs, and awareness from the general public, still needs to mature. Additionally, as TNC drivers depend on driving for their income they might not know where to get a ZEV serviced or may

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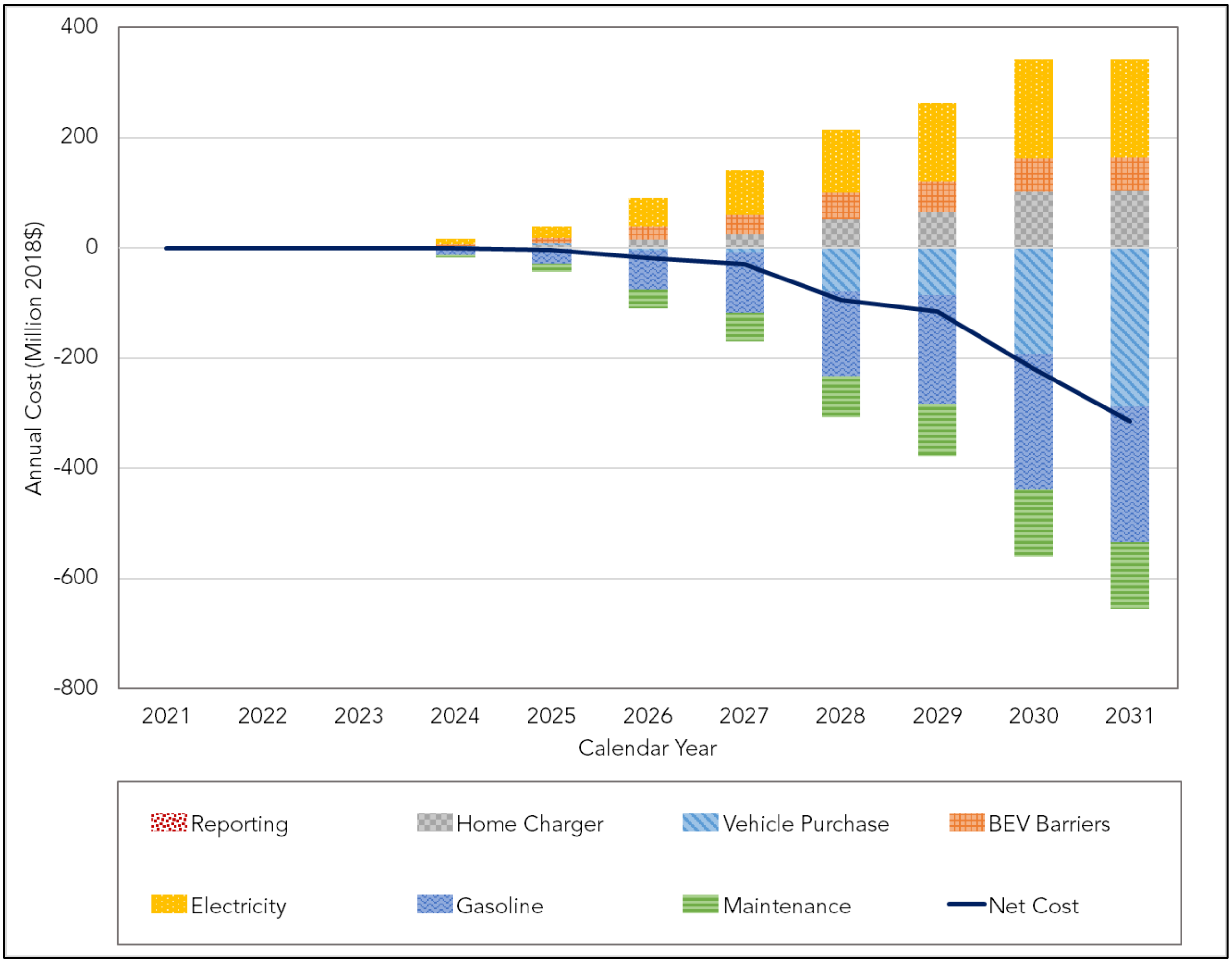
[68] CARB, 2017. "California's Advanced Clean Cars Midterm Review Appendix B: Consumer Acceptance of Zero Emission Vehicles and Plug-in Hybrid Electric Vehicles." https://ww2.arb.ca.gov/sites/default/files/2020-01/appendix_b_consumer_acceptance_ac.pdf. Accessed June 20, 2020.

[69] Kurani, K. 2018. "State of the Plug-in Electric Vehicle Market: Report I." https://escholarship.org/uc/item/4gn9x59z. Accessed June 20, 2020.

have trouble finding public charging stations (particularly relevant for lower income drivers who may not have home access to Level 2 charging).

In June 2020, Lyft announced a plan to transition to "100 percent" ZEVs by 2030.[70] However, even in their announcement, they list factors that may delay or prevent this transition, including the need for government near-term fleet incentives and continued charging infrastructure investment. CARB is encouraged by this commitment but cannot set a minimum percent eVMT threshold that all TNC companies have to meet based on an assumed financial health of governments and their ability to provide subsidies for commercial fleets and infrastructure investments (in particular after Covid-19 in which case Federal, State, and local governments are all experiencing unprecedented revenue shortfalls at the same time).

Figure 10: Costs for TNC Industry to Comply with Proposed Regulation



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[70] Lyft, 2020. "The Path to Zero Emissions: 100% Electric Vehicles by 2030." https://lyft-impact-assets.s3.amazonaws.com/images/path-to-zero-emissions.pdf. Accessed June 20, 2020.

Table 21: Costs in Millions of Dollars for TNC Industry to Comply with Proposed Regulation

Year	Vehicle Purchase	BEV Barriers	Home Charger	Electricity	Gasoline	Maintenance	Reporting Costs	Total Cost
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2023	1.2	0.6	0.2	2.0	-3.0	-1.1	0.1	0.1
2024	2.2	3.4	1.5	8.8	-12.2	-4.9	0.1	-1.1
2025	3.9	9.1	4.5	21.8	-29.8	-13.0	0.0	-3.5
2026	-4.2	24.5	14.5	51.8	-71.4	-33.7	0.1	-18.4
2027	-8.2	35.5	25.1	79.7	-109.7	-52.4	0.0	-29.8
2028	-79.0	49.0	51.7	113.1	-153.7	-75.2	0.1	-94.0
2029	-85.1	54.5	65.3	143.2	-198.0	-96.1	0.0	-116.2
2030	-192.8	60.6	101.8	179.2	-246.6	-121.4	0.1	-219.1
2031	-287.5	61.2	103.1	177.4	-247.2	-121.8	0.0	-314.7
Total	-649.3	298.3	367.9	777.0	-1071.5	-519.5	0.4	-796.7

*Note totals may differ due to rounding

Total Costs to California

As described in the BAU description (Section A.5), this regulation is not anticipated to change the population of ZEVs in California overall, but will instead shift utilization of ZEVs into TNC service. When considering costs to California as a whole, the costs associated with ZEV purchases and home charging infrastructure would also be incurred in the BAU scenario. Likewise, before a ZEV is transferred into TNC service, the BAU assumption is that the ZEV would accrue eVMT based on the average accrual rate of a household vehicle with the same characteristics and age. Therefore, when assessing the costs (and benefits) of the Proposed Regulation to California as a whole, the increase of ZEV and home charger use by TNC drivers would not be anticipated to result in additional economic activity from the ZEV and electric vehicle charging equipment manufacturing, wholesale, and retail industries. Likewise, only a portion of the TNC eVMT would be truly additional eVMT that resulted in California wide fuel savings and emission reductions.

Figure 11 illustrates the costs to California. Costs and cost savings from the purchase of ZEVs and home chargers are anticipated to be transfers between TNC drivers and typical California vehicle owners, and are not shown in the figure. Electricity, gasoline, and maintenance costs and savings are also adjusted to account for miles that these ZEVs would have been driven if not in TNC use. The BEV barriers were costs that were assumed to apply only to TNC drivers, and not a typical California ZEV owner, and as a result continue to grow over time as more vehicle are needed to switch to ZEVs.

Table 22 lists the costs to California, after accounting for the existence the Zero Emission Vehicle Regulation, which is part of the baseline. Between 2021 and 2031, the Proposed Regulation is estimated to result in additional statewide savings of $46 million.

Figure 11: All Costs to California for Compliance with Proposed Regulation

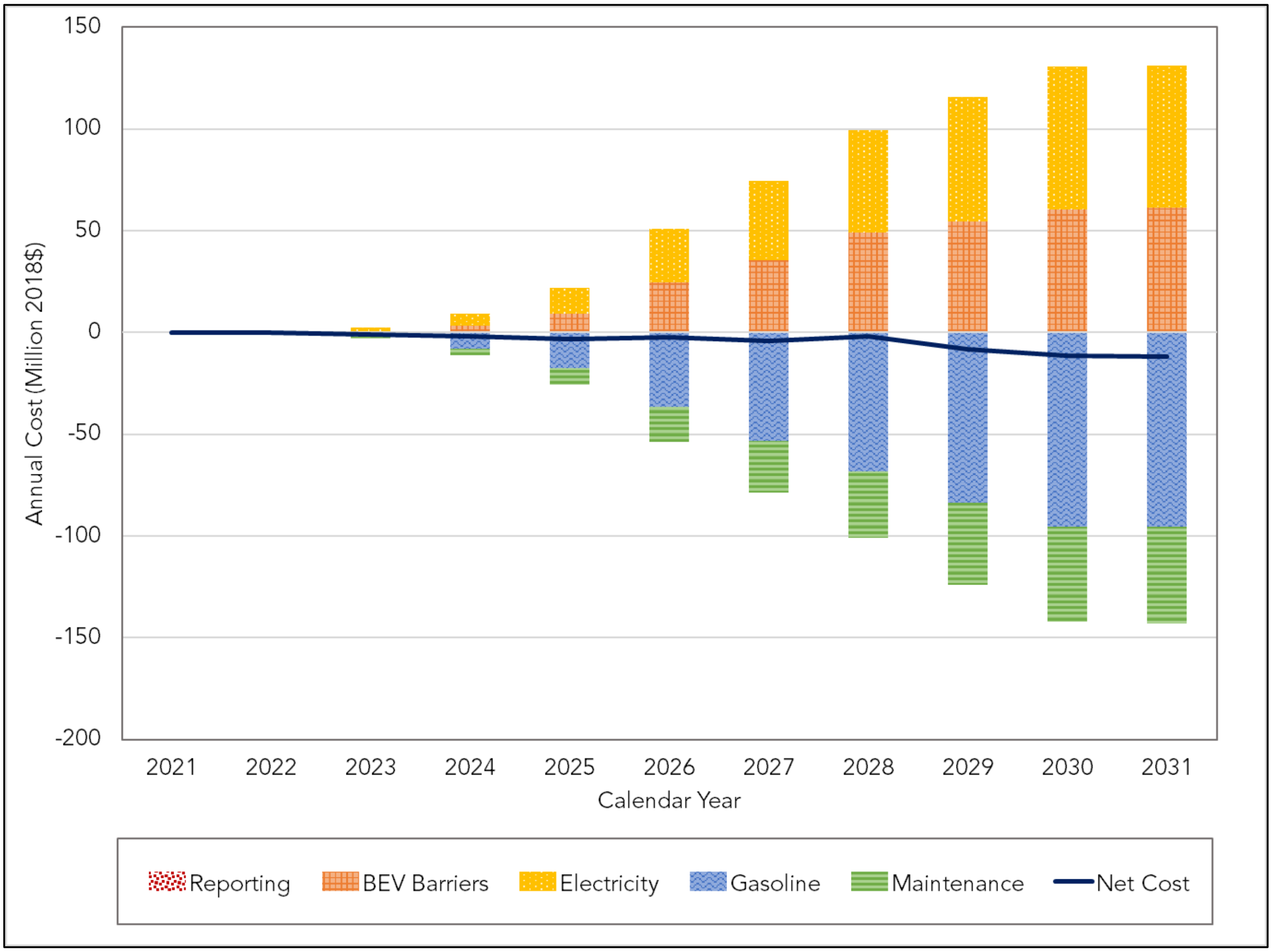

Table 22: Costs in Millions of Dollars to California for Compliance with Proposed Regulation

Year	BEV Barriers	Electricity Fueling Costs	Gasoline Fuel Costs	Maintenance Savings	Reporting	Net Costs
2021	0.0	0.0	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.0	0.0	0.0	0.0
2023	0.6	1.6	-2.2	-0.8	0.1	-0.8
2024	3.4	5.8	-8.0	-3.2	0.1	-1.9
2025	9.1	13.0	-17.7	-7.7	0.0	-3.4

Year	BEV Barriers	Electricity Fueling Costs	Gasoline Fuel Costs	Maintenance Savings	Reporting	Net Costs
2026	24.5	26.6	-36.5	-17.1	0.1	-2.5
2027	35.5	39.0	-53.4	-25.3	0.0	-4.2
2028	49.0	50.4	-68.1	-33.1	0.1	-1.7
2029	54.5	61.0	-83.6	-40.3	0.0	-8.4
2030	60.6	70.2	-95.4	-46.8	0.1	-11.4
2031	61.2	69.8	-95.7	-47.2	0.0	-11.9
Total	298.3	337.5	-460.4	-221.5	0.4	-46.1

*Note totals may differ due to rounding

Direct Costs on Typical Businesses

TNC Companies

The typical business under the Proposed Regulation is a TNC company with greater than 5 million miles annually. TNC companies are responsible for having their vehicle fleet's meet the GHG and electrification targets. Staff is expecting electrification to be a big part of compliance to meet both targets. This analysis considers compliance with both the electrification and GHG targets through increased use of ZEVs.

The majority of drivers currently bring their own personal vehicles to use on the TNC platform. However, it is unknown if a short-term rental model (e.g. weekly) will be utilized in the future if TNC companies push for higher levels of electrification. There are ZEVs available to TNC drivers through various rental programs through third party providers.[71] However, the economics of these arrangements has not yet been proven as an effective business model as evidenced by the recent closure of one of the most prominent short-term rental programs, the Maven Gig program.[72]

A more promising rental structure is where the TNCs sponsor a third party and have an integrated program (i.e. Lyft Express Drive) where capital costs may or may not be subsidized by the TNC and there are bonus incentive mechanisms built into the rental contract that reward desired behavior of drivers (such as reduced rental rate if driver hits certain performance targets).[73] Uber announced in 2018 yet another business model for London whereby each trip is charged 15 pence per mile fee, which will go towards a fund to be used to offset capital costs of the transition to the use of 100% ZEVs in London by 2025.[74] Most

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[71] https://www.envoythere.com/about-us, accessed 6/22/20. https://gigcarshare.com/, accessed 6/22/20. https://therideshareguy.com/maven-gig-review/, accessed 6/22/20.

[72] https://www.businessinsider.com/maven-gm-car-sharing-service-shutting-down-coronavirus-pandemic-2020-4 (accessed 7/3/20)

[73] https://www.lyftcolorado.com/flexdrive (accessed 6/3/20)

[74] https://www.cnbc.com/2018/10/23/uber-unveils-plan-for-london-drivers-switch-to-electric-cars-by-

recently, Lyft has announced a plan to be 100% electrified by 2030, given specific infrastructure and government incentive policies are in place.[75] Lyft intends to accomplish this with a constellation of efforts initially spearheaded by expansion of the Lyft Express Drive program.[76]

In the case of this Proposed Regulation, in particular since compliance is feasible with optimal drivers at least breaking even on costs, one possibility is that the TNCs are able to educate selected drivers that would see significant cost savings within a short time period of operating on the TNC platform and convince these drivers to take on the full costs and savings of utilizing the ZEV. In this case a TNC company might only face the costs associated with compliance reporting, and biennial compliance plans. The costs of the annual reporting was described in Section C.1 and is estimated to be $27,790 in the first year and $16,220 in subsequent years. The costs of the biennial compliance plan is estimated to be $15,190 for the first plan and $9,790 for subsequent plans.

On the other extreme, it is possible that the TNC would need to provide incentives to drivers to cover any upfront costs, but would allow operational savings to accrue to the drivers. For model years before ZEVs reach price parity with conventional vehicles, this would include incremental upfront vehicle purchase costs, along with home charger costs. If the operational savings a driver saw from switching to a ZEV did not make up for additional BEV barriers, the TNC could potentially also need to compensate the driver further. As ZEVs reach price parity and later become cheaper than conventional vehicles, TNC's many not need to provide the same level of incentives to cover the vehicle purchase costs.

Table 23 lists only the positive capital costs, associated with proposed regulation compliance, for vehicles, costs for home chargers, and BEV barriers that could be needed to compensate drivers. Based on market share, the largest TNC would likely bear 70% ($516 million) of these costs while the second largest TNC would bear the remaining 30% ($221 million) of these costs. In this scenario, it is possible that TNCs would be required to increase fares to help subsidize additional electrification.

The two largest TNCs are large publicly traded companies. The largest TNC had revenues of $14.1 billion[77] in 2019 and employs approximately 26,900 people worldwide (excluding

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2025.html#:~:text=Uber%20will%20raise%20%C2%A3200%20million%20(%24260%20million)%20to,incentive%20payments%20to%20its%20drivers., accessed 6/22/20.

[75] https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions, accessed 6/18/20. https://lyft-impact-assets.s3.amazonaws.com/images/path-to-zero-emissions.pdf

[76] Ibid.

[77] https://investor.uber.com/news-events/news/press-release-details/2020/Uber-Announces-Results-for-Fourth-Quarter-and-Full-Year-2019/

drivers).[78] The second largest TNC had revenues of $3.6 billion[79] in 2019 and employs approximately 5,500.[80] Under the extreme scenario where TNCs would need to provide incentives to drivers to cover any upfront costs, the positive capital costs in Table 23 for year 2030 are equal to approximately 1 percent and 1.5 percent of the 2019 revenues for the largest and second largest TNC, respectively. However, total TNC revenue would also be anticipated to grow so that the relative impact would be smaller.

Table 23: Positive Capital Costs for Vehicles that Switch to BEVs in Millions of Dollars

Year	Positive Incremental Vehicle Costs	BEV Cost of Barriers	Home Charger Costs	Total
2021	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.0	0.0
2023	1.2	0.6	0.2	2.1
2024	2.2	3.4	1.5	7.2
2025	4.7	9.1	4.5	18.3
2026	7.1	24.5	14.5	46.1
2027	11.8	35.5	25.1	72.4
2028	10.0	49.0	51.7	110.7
2029	14.8	54.5	65.3	134.6
2030	13.0	60.6	101.8	175.4
2031	6.7	61.2	103.1	170.9
Total	**71.56**	**298.29**	**367.87**	**737.7**

Direct Costs on Small Businesses

There is no expected direct cost on small businesses (not including TNC drivers) under the Proposed Regulation. While there are twelve TNCs operating in California, only two of them are anticipated to surpass the 5 million miles threshold which would require compliance with the electrification and GHG targets. Of the other 10 permitted TNCs, a portion of them may be considered small businesses. The Proposed Regulation exempts TNCs with 5 million or less annual miles. No additional requirements will be imposed in addition to their current annual data submittal to the CPUC. If a small TNC grows to exceed 5 million annual miles, they will become subject to the requirements of the proposed regulation with certain flexibilities afforded, as described in Section A - Flexibilities. Some TNC drivers incorporate or form an LLC and could be considered small businesses; costs to drivers is discussed in detail in the section below titled Costs to a TNC Driver.

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[78] Employment estimates from Dun and Bradstreet databases DNBi. (Accessed July 3, 2020).

[79] https://investor.lyft.com/news-releases/news-release-details/lyft-announces-record-fourth-quarter-and-fiscal-year-results

[80] Employment estimates from Dun and Bradstreet databases DNBi. (Accessed July 3, 2020).

Direct Costs on Individuals

There are no material direct costs to individuals (that are not drivers) as a result of this regulation. It is possible that individuals will see change in fares as a result of this rule if costs or cost savings are passed through to TNC riders in the state. If the potential costs to TNCs illustrated in Table 23 were passed directly on to TNC riders in the form of a Statewide fare increase, this would represent less than a $0.01 per mile increase in 2023 and approximately a $0.05 per mile increase by 2030.

Individuals may see health benefits as described in Section B.3 due to TNC eVMT replacing gasoline miles and may also see macroeconomic benefits and costs as a result of indirect and induced impacts of the regulation; these costs are discussed further in Section E.

The proposed regulation will shift the use of ZEVs from the general California population into the TNC fleet. This may lead to a reduction in eVMT for general residents. For impacts of this shift, see the Section E, Macroeconomics Impacts.

Costs to a TNC Driver

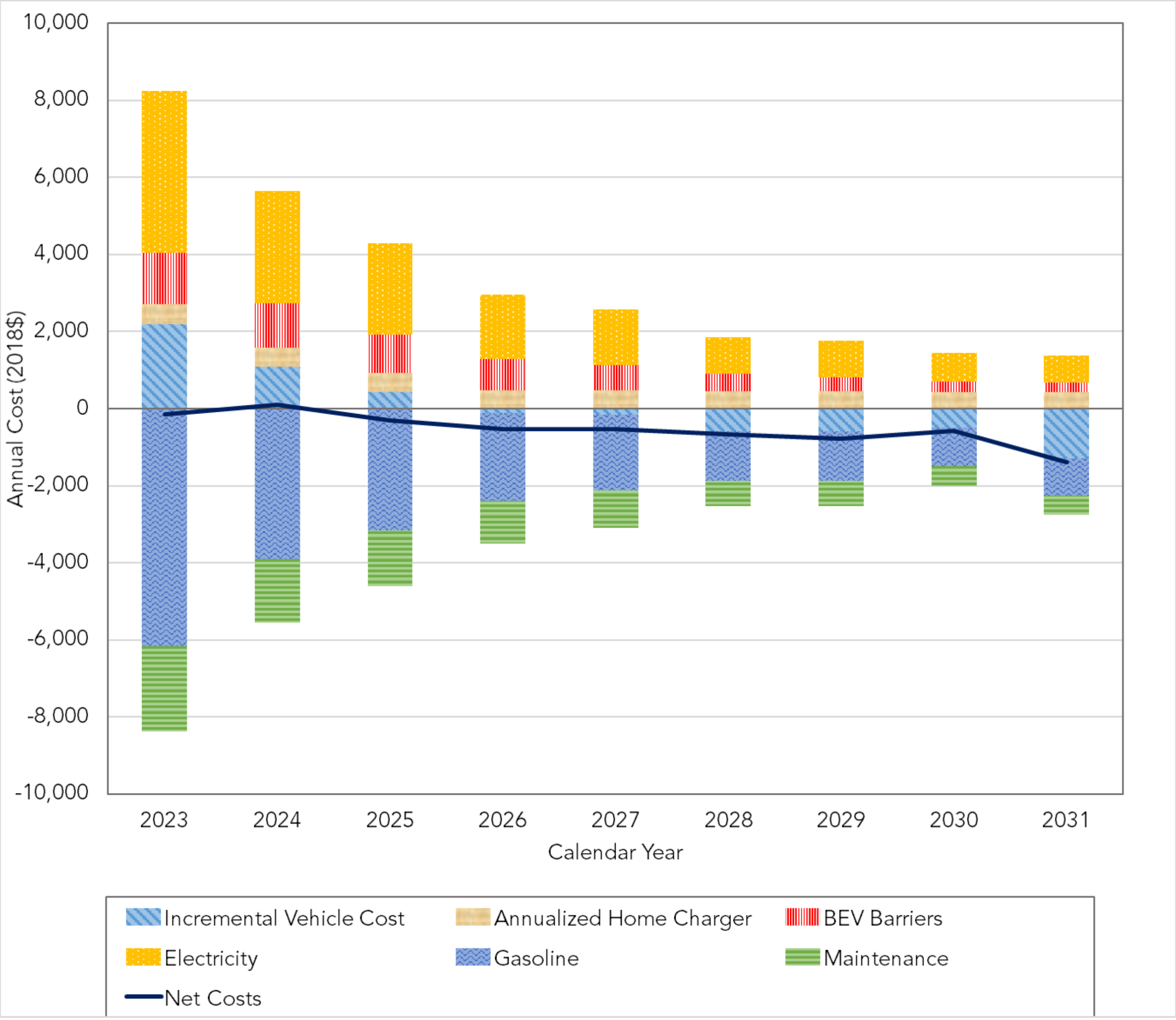
As mentioned above, there are a variety of ways in which a TNC driver may be incentivized to switch to a ZEV. Under the Proposed Regulation, TNCs could meet the eVMT targets by only targeting drivers that stand to see net cost savings during their tenure on the TNC platform. Each driver would face different costs and cost savings of switching to a ZEV based on characteristics of their BAU vehicle and the amount of miles they typically drive. For example, the incremental cost of a ZEV will decline over time, and fuel savings will vary depending on the conventional vehicle they would have been driving.

Figure 12 illustrates the costs associated with the “average” TNC vehicle that switches to a ZEV under the Proposed Regulation (described in Table 17). The incremental vehicle purchase costs are based on the average age of the vehicles that switched in the TNC fleet and adjusted for available incentives, insurance costs, registration fees, and depreciation based on the vehicle’s age. The BEV costs of overcoming barriers are based on the average number of weeks a vehicle switching to a ZEV would be driving for TNC service. Home charger costs are calculated as the annualized cost of a home charger, spread over a 3-year period with 5% interest. Electricity and gasoline fueling costs are calculated based on the average VMT of the vehicle and the efficiencies of the BAU vehicle and same model year ZEV. The costs in Figure 12 illustrate what would be borne by the driver if the costs of switching to a ZEV were placed entirely on the driver. It is possible that TNCs could provide additional incentives to drivers for them to switch to ZEVs. These additional incentives are not estimated here, making this an upper bound on the costs that a driver may incur. If TNCs bear some of these costs through incentives or other types of partnerships, there could be greater savings for TNC drivers.

Figure 12 illustrates that the average driver switching to a ZEV, under the Proposed Regulation, sees net savings over time. In early years, both the costs and cost savings are greater due to greater incremental upfront capital costs and also because vehicles switching to ZEVs in early years of the regulation have higher VMT and are in active TNC service for more weeks than in later years of the regulation. The average VMT of a driver switching to a ZEV is over 60,000 miles in 2023 compared to approximately 14,000 miles in 2030, resulting in both greater gasoline and maintenance savings and higher electricity costs for the average driver that switches to a ZEV in early years relative to the average drivers switching to a ZEV in later years. The average driver that switches to a ZEV would see savings of approximately $140 and $576 in 2023 and 2030, respectively (both inclusive of the BEV barriers).

Financial incentives are available for low-income drivers for purchase or lease of electric or hybrid vehicles. On a statewide basis, the Clean Vehicle Rebate Project and the Clean Vehicle Assistance Program provide rebates, grants and financing assistance. At the regional level, the Clean Cars for All program is available for income-eligible residents in four air districts – Sacramento, Bay Area, San Joaquin Valley, and South Coast. Additionally, The One Stop Shop provides local and regional community-based outreach to ensure that information and access to the incentive programs are shared with low-income drivers.

Figure 12: Costs Associated with the "Average" Vehicle that is Switched to a ZEV Under the Proposed Regulation



Despite the potential for significant cost savings to drivers for switching to ZEVs, there still may be additional barriers to ZEV adoption in the TNC fleet that are not directly captured through this cost analysis such as access to financial credit to purchase more expensive vehicles. While the available data does not allow for identification of individual driver income and demographics, there is a strong likelihood that a significant portion of drivers are low income or live in disadvantaged communities. Data submitted to CARB in the base year 2018 showed that approximately 56 percent of drivers resided in zip codes that included an SB 535 disadvantaged community or an AB 1550 low-income community.[81] These statistics are important as the CMS regulation is required to have minimal impact on low and moderate-income drivers.[82]

To assess the potential equity impacts of the Proposed Regulation on TNC drivers, CARB staff assessed the fraction of registered TNC vehicle owners' zip codes that included low income communities for vehicles that were assumed to switch to ZEVs. Figure 13 and Figure 14 compare the percent of registered owners' zip codes that include low-income communities and disadvantaged communities for vehicles that would switch to ZEVs and vehicles that would remain as ICEs.

Between 2023 and 2025, when the proposed electrification targets have a slower growth rate, vehicles switching to ZEVs are less likely to be registered to owners with zip codes that include low income and disadvantaged communities, suggesting that compliance with the Proposed Regulation would not disproportionately target low income drivers. This is because in the first few years, the compliance analysis resulted in ZEVs being selected for higher mileage and newer vehicles. However, even if a low-income driver did switch to a ZEV in 2023, the driver would still expect to see net savings within the first year of TNC operations. Additionally, drivers from lower income households will be able to take advantage of additional incentives for purchasing used ZEVs. To account for drivers who are only part-time and may not be motivated to consider whether an incremental vehicle cost could be recouped, the electrification targets were developed such that compliance could be achieved without targeting vehicles that drive less than 5,000 miles per year for TNCs.

Post-2026, slightly more of the vehicles switching to ZEVs having zip codes that include low income and disadvantaged communities. However, in this time period, the average incremental vehicle cost for a vehicle that switches to a ZEV is *lower* than the BAU ICE due to declining technology costs and the assumed availability of state incentives. For example, in 2026, the typical vehicle switching to a ZEV is a model year 2025 passenger car. The cost of this 1 year old vehicle is anticipated to be approximately $286 less than the BAU ICE.[83]

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[81] Disadvantaged communities are defined as the 25 percent highest scoring census tracts in CalEnviroScreen 3.0 and represent communities that are disproportionately burdened by, and vulnerable to, multiple sources of pollution. https://oehha.ca.gov/calenviroscreen
An AB 1550 low-income community is defined as any census tract with a median household income at or below 80 percent of $61,818 (i.e., $49,454) or qualifies as a low-income community based on the Department of Housing and Community Development's Low-income Limits thresholds.
https://ww2.arb.ca.gov/sites/default/files/classic/cc/capandtrade/auctionproceeds/kml/ab1550_maps_documentation.pdf

[82] SB 1014

[83] This is estimated as the incremental capital cost minus available incentives when the vehicle was new multiplied by the depreciation factor. The incremental cost of a model year 2025 passenger car is $1622, CVRP and LCFS incentives were assumed to be $1,000 each, and a 1 year old vehicle is assumed to be worth 76 percent of its new value.

Therefore, post-2026 it is less likely that upfront capital costs of acquiring a ZEV will pose a significant barrier, even for lower income drivers.

The largest cost and cost savings for the average vehicle switching to a ZEV occurs in 2023, both because of higher upfront capital costs of ZEVs and home chargers, but also because of the higher VMT of an average vehicle switching to a ZEV. In 2023, the upfront costs associated with the incremental capital costs of a ZEV and annualized home charger cost are, on average, approximately $2,500. While it is uncertain exactly how the TNC, driver, or rider would split the costs or cost savings, if these upfront cost were borne fully by the driver, this would make up approximately 5 percent of the median income of a household residing in a census tract that is designated as low income. On the other hand, if the TNC companies bore the upfront costs of the vehicle and home charging equipment, the operational cost savings from fuel and maintenance would be $4,100 on average, approximately 8 percent of the median income of a household residing in a census tract designated as low income.

Figure 13: Fraction of Registered Owners' Zip Codes that Include Low Income Communities

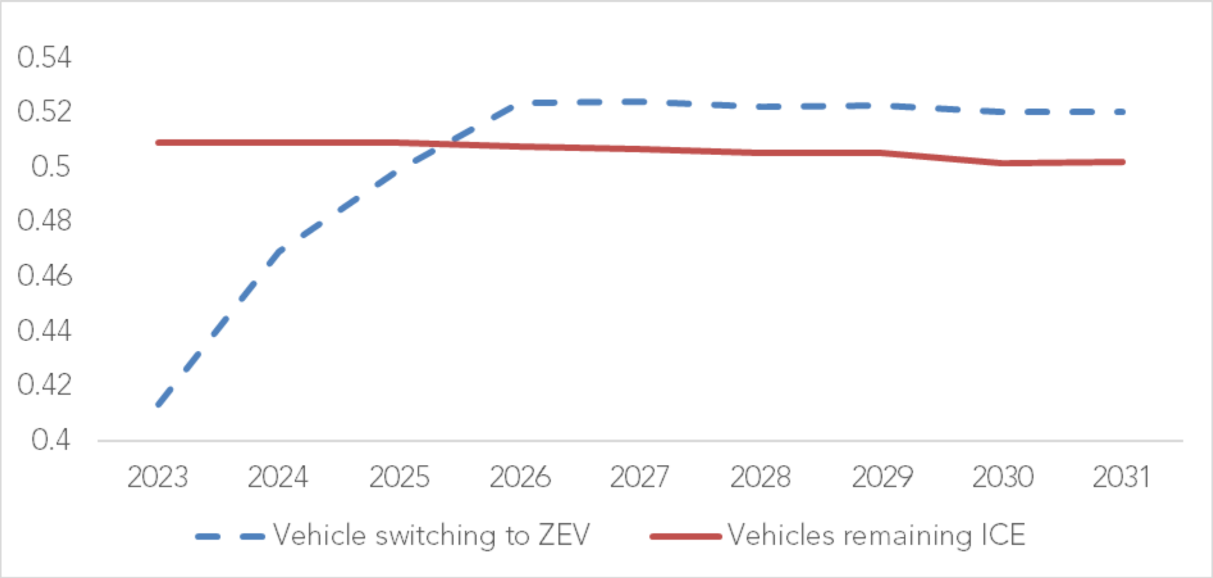
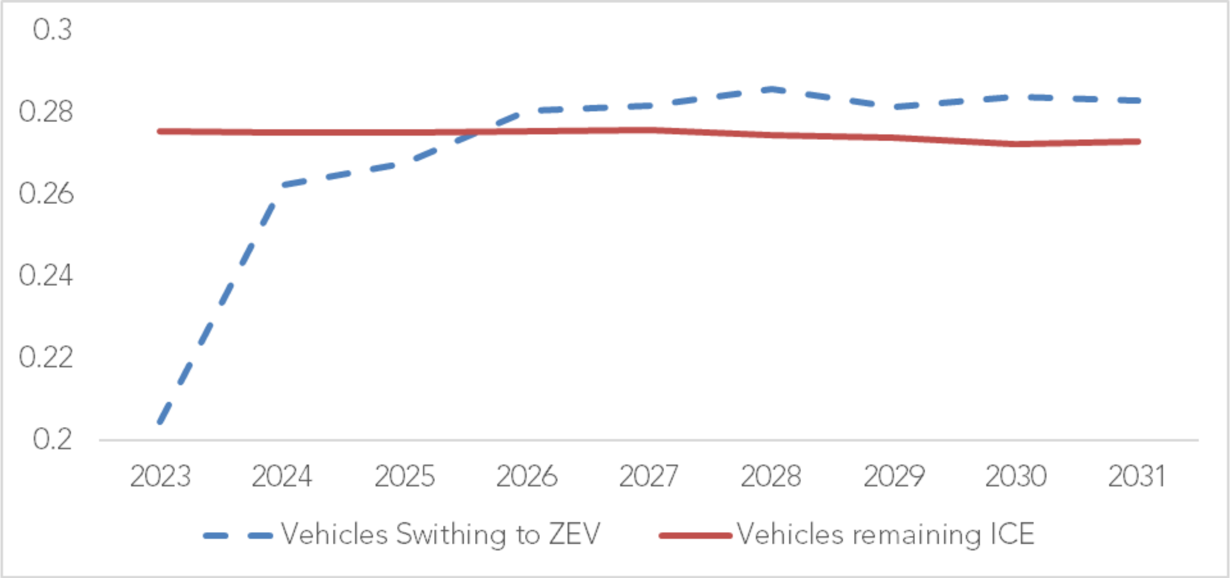


Figure 14: Fraction of Registered Owners' Zip Codes that Include Disadvantaged Communities



D. FISCAL IMPACTS

Local government

Utility Users Tax

Many cities and counties in California levy a Utility Users Tax on electricity. This tax varies from city to city and ranges from no tax to 11%. A value of 3.53% was used in this analysis, representing a population-weighted average.[84] By increasing the amount of electricity used, there will be an increase in the amount of utility user tax revenue collected by cities and counties.

Gasoline Taxes

Fuel taxes on gasoline fund transportation improvements at the State, county, and local levels. Displacing gasoline fuel with electricity will decrease the amount of gasoline dispensed in the state, resulting in a reduction in fuel tax revenue collected by local governments. Local sales tax on gasoline is set at 2.25%.

Measure D Impacts

In 2019, the City of San Francisco voters passed Measure D, a fee of 1.5% on a shared-ride fare; a 3.25% on a non-pooled fares; and 1.5% until December 31, 2024 for ZEV TNCs.[85] The

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[84] California State Controller's Office, User Utility Tax Revenue and Rates (web page: https://sco.ca.gov/Files-ARD-Local/LocRep/2017-18_Cities_TOT.pdf, last accessed June 2020).

[85] San Francisco Department of Elections, 2019a. November 5, 2019 Election Results. https://sfelections.sfgov.org/november-5-2019-election-results-summary. Accessed 7/7/20.

City would deposit the tax revenues (estimated at $30 million to $35 million annually) into a Traffic Congestion Mitigation Fund to be spent on public transit and active transportation infrastructure. [86] Approximately half of the revenues would go towards improving Muni bus and light-rail service and reliability, maintain and expand Muni vehicles and facilities, and improve Muni station access. The other half of the revenues would be spent on improving pedestrian and bicycle safety. The City of Los Angeles and the Southern California Association of Governments (SCAG) are also considering a similar measure and are expecting it to be in place by 2021.

To estimate the potential impact from increased electrification, CARB staff assumed that increased ZEV rides would replace non-pooled TNC rides and cause a decrease in Measure D fees that would be collected. The impact of increased percent eVMT would decrease fees collected by the San Francisco Municipal Transportation Agency (SFMTA) by approximately 0.3% in 2023 and between 1.5% and 1.7% in 2024.

Measure D fees could also be impacted if TNCs complied with the GHG targets, in part, through incentivizing additional pooled rides to increase occupancy. While the compliance scenario analyzed by CARB staff does not include any changes in pooled rides compared to the 2018 base year, a sensitivity analysis included in the Technical Appendix, Occupancy and Pooling, shows that revenue collected may increase by 1% if the number of pool matched rides increased by approximately 23% by 2030. There could also be a decrease in Measure D revenues collected if TNCs were to comply with the Proposed Regulation through increasing pooled-requested rides without also increasing the match rate of pooled trips or the total number of rides overall.

Fiscal Impacts to Local Government

Table 24 lists the total fiscal impact to local government. The fiscal impact to local government is estimated to be a decrease in revenue of approximately $392,000. There is no change in vehicle sales tax because there is no change in the number of ZEVs in the state.

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[86] San Francisco Department of Elections, 2019b. Initiative Ordinance – Business and Tax Regulations, Administrative Codes – Tax on Net Rider Fares of Commercial Ride-Share Companies, Autonomous Vehicles, and Private Transit Services Vehicles. https://sfelections.sfgov.org/sites/default/files/Documents/candidates/TaxOnNetRiderFares_LegalText.pdf. Accessed 7/7/20.

Table 24: Total Fiscal Impact to Local Government in Thousands of Dollars

Year	Utility User Tax Revenue	Local Gasoline Taxes	Measure D	Fiscal Impact
2021	-	-	-	-
2022	-	-	-	-
2023	53.3	(54.4)	(108.8)	(109.9)
2024	198.2	(194.1)	(561.3)	(557.2)
2025	444.5	(432.6)	-	11.9
2026	907.1	(889.6)	-	17.5
2027	1,330.8	(1,301.3)	-	29.4
2028	1,720.0	(1,659.8)	-	60.2
2029	2,080.8	(2,038.1)	-	42.7
2030	2,393.9	(2,326.6)	-	67.2
2031	2,379.3	(2,333.3)	-	46.0
Total	11,507.9	(11,230.0)	(670.0)	(392.1)

State Government

CPUC Staffing

The Proposed Regulation would require one additional CPUC Research Data Specialist III position, responsible for implementing the rule. This position would be needed starting in 2021 at a cost of $161,568 per year.[87] Enforcement is not expected to be a significant additional burden to the state government under the proposed regulation. Updated data requirements as well as biennial plans and compliance summary reports required of the TNCs should not add significant resource needs to the state government for review of these submittals. CPUC and CARB have maintained a good working relationship with the two largest TNCs throughout the development of the proposed regulation. No significant issues are expected with respect to compliance with additional data and report submittal requirements.

Gasoline Taxes

Fuel taxes on gasoline are used to fund transportation improvements at the state, county, and local levels. Displacing gasoline fuel with electricity will decrease the amount of gasoline dispensed in the state. This will result in a reduction in revenue collected by the state for use

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[87] $8800/month * 1.53 (benefits). Monthly salary from https://www.calhr.ca.gov/Pay%20Scales%20Library/PS_Sec_15.csv, benefits ratio calculated from CPUC BCP request p. 15 https://esd.dof.ca.gov/Documents/bcp/2021/FY2021_ORG8660_BCP3706.pdf

in multiple levels of government. There is a $0.505 per gallon state excise tax on gasoline.[88] In general, loss of gasoline tax revenue will be mitigated by the $100 per year registration fee for ZEVs (see Technical Appendix, Section on eVMT Cost Model Inputs for more details).

Energy Resources Fee

The Energy Resources Fee is a $0.0003/kWh surcharge levied on consumers of electricity purchased from electrical utilities. The revenue collected is deposited into the Energy Resources Programs Account of the General Fund which is used for ongoing electricity programs and projects deemed appropriate by the Legislature, including but not limited to, activities of the California Energy Commission (CEC). Increased use of ZEVs will result in increases in electricity use and increased revenue from the Energy Resources Fee.

Fiscal Impacts to State Government

Table 25 shows the estimated fiscal impacts to the state government due to the Proposed Regulation. The fiscal impact to state government is estimated to be $69.1 million over the regulatory lifetime.

Table 25: Estimated Fiscal Impacts to State Government in Thousands of Dollars

Year	CPUC Staffing and Resources	State Gasoline Taxes	Energy Resources Fee	Fiscal Impact
2021	(161.6)	-	-	(161.6)
2022	(161.6)	-	-	(161.6)
2023	(161.6)	(335.2)	1.7	(495.1)
2024	(161.6)	(1,188.5)	6.7	(1,343.4)
2025	(161.6)	(2,639.9)	15.8	(2,785.6)
2026	(161.6)	(5,429.0)	34.6	(5,555.9)
2027	(161.6)	(7,868.7)	50.9	(7,979.4)
2028	(161.6)	(10,067.0)	65.9	(10,162.6)
2029	(161.6)	(12,174.1)	79.9	(12,255.8)
2030	(161.6)	(14,024.8)	92.1	(14,094.3)
2031	(161.6)	(14,022.5)	91.6	(14,092.5)
Total	**(1,777.2)**	**(67,749.7)**	**439.3**	**(69,087.7)**

E. MACROECONOMIC IMPACTS

Methods for determining economic impacts

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[88] $0.505 per gallon state excise tax is adjusted by California Department of Finance CPI for all urban consumers and is equivalent to $0.481 in 2018 dollars. https://www.cdtfa.ca.gov/taxes-and-fees/sales-tax-rates-for-fuels.htm#note2-motor

This section describes the estimated impact of the Proposed Regulation on the California economy. The Proposed Regulation will result in changes in expenditures by TNCs and TNC drivers in order to comply with its requirements. Changes in ZEV usage from the California fleet into TNC specific use will also change overall spending on gasoline, electricity, and maintenance. These changes in expenditures will affect employment, output, and investment that supply goods and services to the TNC industry, are involved in gasoline and electricity production, and that perform maintenance services on vehicles.

These direct impacts will lead to additional indirect and induced effects, like changes in personal income that affect consumer expenditures across other spending categories. The incremental total economic impacts of the Proposed Regulation are simulated relative to the BAU using cost data described in Section C. The analysis focuses on the incremental change in major macroeconomic indicators from 2021 to 2031 including employment, growth, and gross state product (GSP). The years of the analysis are used to simulate the Proposed Regulation through 12 months post full implementation.

Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 2.4.1 is used to estimate the macroeconomic impacts of the Proposed Regulation on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies.[89] REMI Policy Insight Plus provides year-by-year estimates of the Proposed Regulation, pursuant to the requirements of SB 617 and the California DOF.[90, 91]

CARB uses the REMI single-region, 160-sector model. Several adjustments were made to the model reference case to reflect the impacts of COVID-19 and to reflect the Department of Finance conforming forecasts. First, the REMI model's National Control was updated with a short-term national forecast based on the U.S. Economic Outlook for 2020-2022 from the University of Michigan's Research Seminar in Quantitative Economics (RSQE)[92] release on April 9th, 2020, which was made available in the latest REMI model. Second, the National and Regional Controls in REMI were updated to reflect the most recent Department of Finance conforming forecasts which include population projections dated January 2020 and U.S. real GDP forecasts, and California civilian employment growth numbers Dated May 2020. Because the Department of Finance forecasts only extended to 2023, CARB staff made the assumption that post-2023, U.S. income and employment would continue to grow at the same rate as projected in the RSQE forecast, while California civilian employment would

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[89] For further information and model documentation see: https://www.remi.com/model/pi/

[90] California Legislature, Senate Bill 617, signed on October 5, 2011 (web link: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201120120SB617, last accessed June 2020)

[91] Department of Finance, Chapter 1: Standardized regulatory Impact Analysis For Major Regulations - Order of Adoption (web link: http://www.dof.ca.gov/Forecasting/Economics/Major_Regulations/SB_617_Rulemaking_Documents/documents/Order_of_Adoption-2.pdf, last accessed June 2020)

[92] https://lsa.umich.edu/econ/rsqe.html

continue to recover at the rate forecasted by the Department of Finance, until it returned to baseline levels.

Inputs of the assessment

The estimated economic impact of the Proposed Regulation is sensitive to modeling assumptions. This section provides a summary of the assumptions and inputs used to determine the suite of policy variables that best reflect the macroeconomic impacts of the Proposed Regulation. The direct costs estimated in Section C and the non-mortality health benefits estimated in Section B are translated into REMI policy variables and used as inputs for the macroeconomic analysis.[93]

The direct costs of the Proposed Regulation, as described in Section C, include costs to TNCs and drivers for acquiring and operating ZEVs, as well as cost-savings that accrue due to decreased spending of gasoline and maintenance. There is uncertainty as to how these costs and savings will be distributed across TNCs, drivers, and riders. For the macroeconomic modeling staff make the assumption that, in addition to reporting costs, that all upfront positive costs for ZEVs and costs for home chargers will also be borne by the TNC companies. TNC drivers are assumed to incur any cost savings associated with ZEVs that are less expensive than the BAU vehicle and also incur any operational costs and cost savings from operating ZEVs.

Costs borne by TNC companies are input into the economic model as an increase in production costs in the transit and ground passenger transportation industry (NAICS 485). Costs and cost savings borne by TNC drivers are input into the economic model as changes in proprietors' income in the same transit and ground passenger transportation industry. However, the BEV cost barriers discussed in Section C are not input into the macroeconomic model, as they do not represent an actual change in expenditures.

As this analysis has assumed that the total ZEV population in California remains unchanged, offsetting costs and savings from vehicle purchases and home charging equipment is input into the economic model as consumption reallocation.

The increased utilization of ZEVs in the TNC fleet will result in a statewide increase in electricity demand and a statewide decreases in gasoline demand and vehicle maintenance. These changes are input into the economic model as changes in exogenous demand in the following industries: petroleum and coal products manufacturing (NAICS 324), electric power generation, transmission and distribution (NAICS 2211), and automotive repair and maintenance (8111). The reporting and biennial compliance plan reports are assumed to be provided by the management, scientific, and technical consulting services industry (NAICS 5416).

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[93] Refer to Technical Appendix: Macroeconomic Modeling Inputs for a full list of REMI inputs for this analysis.

Table 26: Sources of Changes in Production Cost and Final Demand by Industry

Source of Cost or Savings	Direct Impacts	Industries with Changes in Final Demand
Annual reporting and biennial compliance plans	Cost to TNCs: Production cost increase for transit and ground passenger transportation (485).	Management, scientific, and technical consulting services (5416)
Home charging equipment*		No change
ZEV purchase*	Costs or savings to TNC drivers: Change in proprietors' income for transit and ground passenger transportation (485)	
Gasoline fuel		Petroleum and coal products manufacturing (324)
Electricity		Electric power generation, transmission and distribution (2211)
Maintenance		Automotive repair and maintenance (8111)

*Costs and savings of home charging equipment and ZEV purchases are offset by consumption reallocation.

In addition to these changes in production costs and final demand for businesses, there will also be economic impacts as a result of the fiscal effects. This includes the changes in gasoline and electricity tax revenue, Measure D revenue, and additional staffing costs to implement the Proposed Regulation. The changes in tax and Measure D revenue are modeled as changes in state and local government spending, assuming that this revenue is not offset elsewhere. The additional CPUC staff to implement the Proposed Regulation is modeled as an increase in government employment and decrease in government spending to reflect the opportunity costs of additional hires.

The health benefits resulting from emissions reductions of the Proposed Regulation reduce health care costs for individuals on average. This reduction in healthcare cost is modeled as a decrease in spending for hospitals, with a reallocation of the spending towards other goods and increased savings. The GHG emission reduction benefits as valued through the SC-CO_2 represent the avoided damage from climate change worldwide per MT of CO_2e. These benefits fall outside the scope of the economic model and are not evaluated here.

Results of the assessment

The results from the REMI model provide estimates of the impact of the Proposed Regulation on the California economy. These results represent the annual incremental change from the implementation of the Proposed Regulation relative to the baseline scenario. The California economy is anticipated to grow through 2031, therefore, negative impacts reported here should be interpreted as a slowing of growth and positive impacts as an acceleration of growth resulting from the Proposed Regulation.

California Employment Impacts

Table 27 presents the impacts of the Proposed Regulation on total employment in California and for the industries that are directly impacted by the Proposed Regulation. The statewide employment impacts of the Proposed Regulation are estimated to be slightly negative in all years of the assessment but there are also some industries that are estimated to have positive impacts. The changes in statewide employment represent less than a 0.01% change relative to baseline California employment.

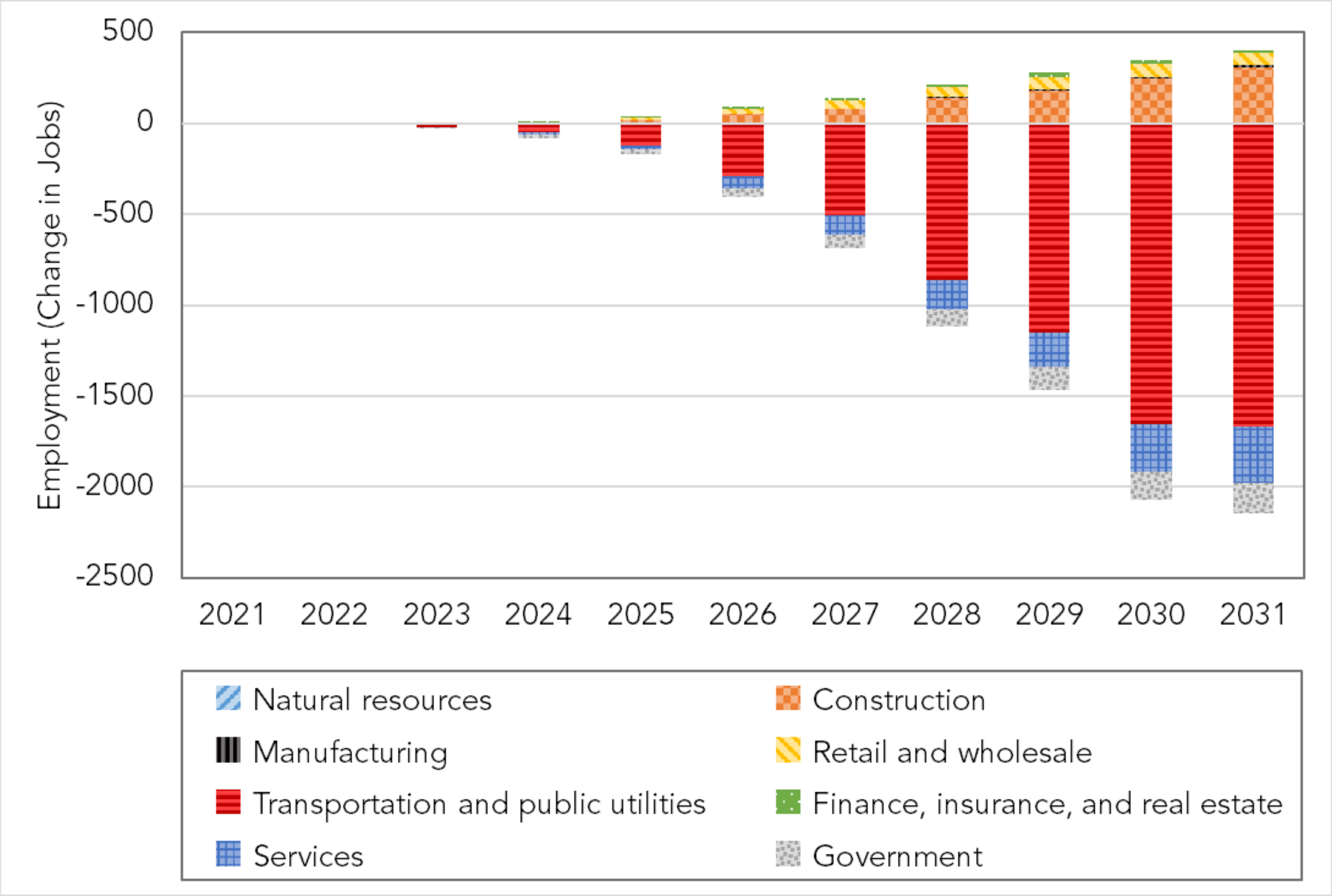
Industries that are estimated to have net costs, decreases in demand, or revenue loss such as petroleum and coal products manufacturing, transit and ground passenger transportation, automotive repair, and state and local government are estimated to see decreases in employment growth. The largest decrease in employment is estimated to come from businesses within the transit and ground passenger transportation industry. Recall, that as a conservative assumption on impacts to the TNC industry, this industry was modeled as bearing all the upfront costs of ZEV purchases and home charging equipment without incurring any of the operational savings. Within the model, these costs will cascade through the economy, impacting individuals and other industries that utilize the transit and ground passenger transportation industry. If more of the upfront costs were borne by TNC drivers, impacts to the transit and ground passenger transportation industry would be less.

Table 27: Change in California Employment by Industry

Industry	Units	2021	2023	2025	2027	2029	2031
California Statewide	Total employment	21,063,397	22,603,889	23,781,325	24,725,149	24,752,485	24,763,640
	Percent Change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change in jobs	-1	-25	-132	-545	-1,186	-1,745
Petroleum and coal products manufacturing (324)	Percent change	0.00%	0.00%	-0.02%	-0.05%	-0.07%	-0.08%
	Change in jobs	0	0	-2	-6	-9	-10
Electric power generation, transmission and distribution (2211)	Percent change	0.00%	0.00%	0.03%	0.08%	0.12%	0.13%
	Change in jobs	0	1	11	30	45	50
Transit and ground passenger transportation (485)	Percent change	0.00%	0.00%	-0.03%	-0.11%	-0.23%	-0.33%
	Change in jobs	0	-21	-132	-534	-1,189	-1,715
Management, scientific, and technical consulting services (5416)	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in jobs	0	0	0	-1	-2	-4
Automotive repair and maintenance (8111)	Percent change	0.00%	0.00%	-0.03%	-0.11%	-0.18%	-0.20%
	Change in jobs	0	-6	-57	-198	-314	-365
State and Local Government	Percent change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change in jobs	0	-4	-23	-71	-124	-167

Figure 15 illustrates the estimated employment impacts by major sector. As shown above, the greatest decreases in employment occur in the transportation and public utilities, services, and government sectors. The greatest increases in employment are estimated to occur in the construction, retail, and wholesale sectors. These increases result from overall increases in personal income that come from additional fuel and operational savings of operating ZEVs.

Figure 15: Change in California Employment by Major Sector



California Business Impacts

Gross output is used as a measure for business impacts because it represents an industry's sales or receipts and tracks the quantity of goods or services produced in a given time period. Output is the sum of output in each private industry, state, and local government as it contributes to the state's gross domestic product (GDP), and is affected by production cost and demand changes. As production cost increase or demand decreases, output is expected to contract, but as production costs decline or demand increases, industry will likely experience output growth.

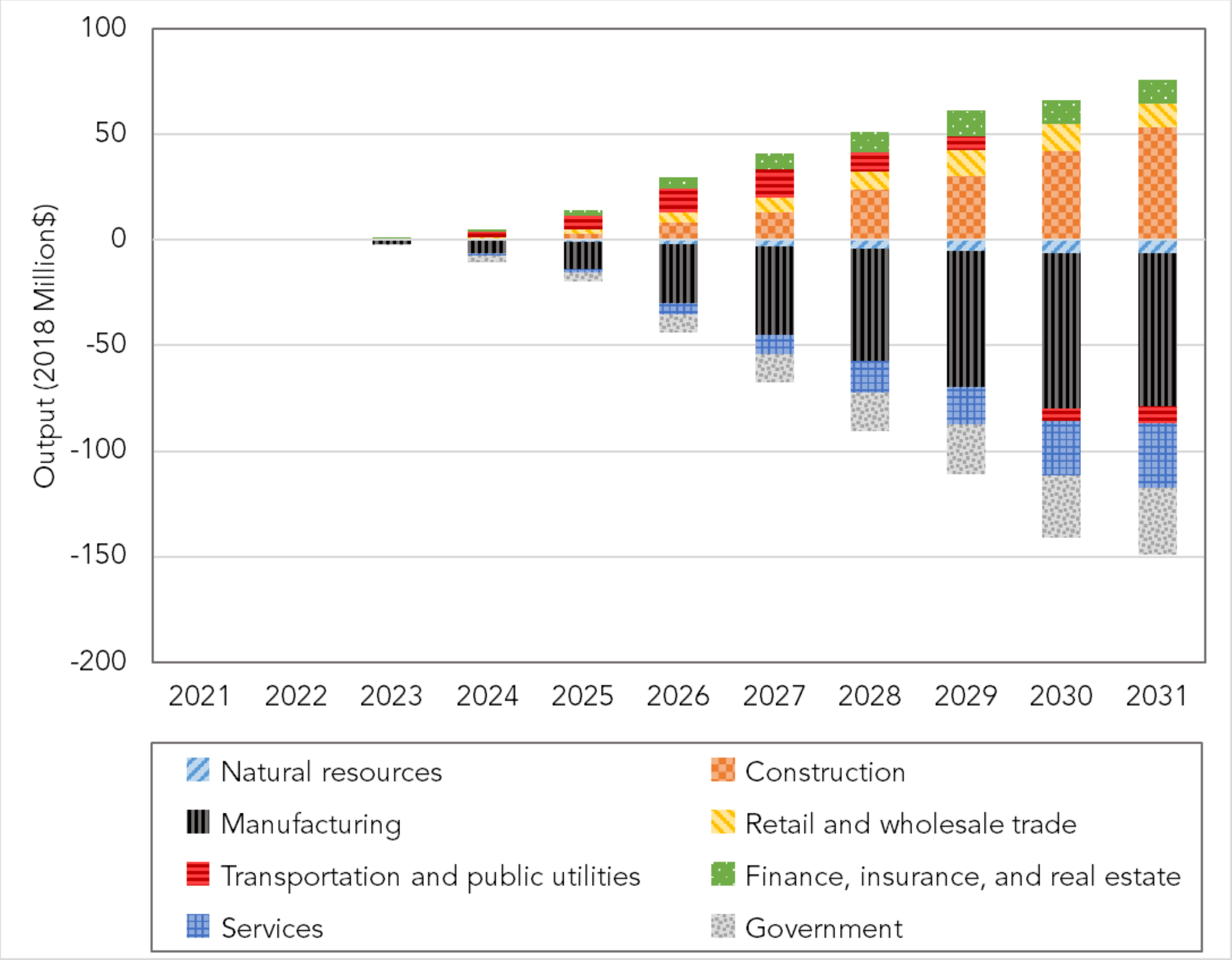
As illustrated in Table 28, the Proposed Regulation is estimated to result in a decrease in statewide output of $2 million in 2023, the first year of electrification and GHG targets, and a decrease in output of $72 million in 2031, one year after full implementation of the Proposed Regulation. In all years of the analysis, the Proposed Regulation is estimated to result in less than a 0.01% change in statewide output.

Similar to the employment impacts, all industries that are anticipated to face production cost increases, decreases in demand, or decreased revenue are anticipated to have corresponding decreases in output while industries that are anticipated to see increases in demand are estimated to have increases in output.

Table 28: Change in California Output by Industry

Industry	Units	2021	2023	2025	2027	2029	2031
California Statewide	**Total Output**	4,533,842	4,781,838	5,150,807	5,443,778	5,576,321	5,725,269
	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in Output	0	-2	-6	-26	-49	-72
Petroleum and coal products manufacturing (324)	Percent change	0.00%	0.00%	-0.02%	-0.05%	-0.07%	-0.08%
	Change in Output	0	-2	-14	-45	-71	-80
Electric power generation, transmission and distribution (2211)	Percent change	0.00%	0.00%	0.03%	0.08%	0.12%	0.13%
	Change in Output	0	1	11	32	50	57
Transit and ground passenger transportation (485)	Percent change	0.00%	0.00%	-0.03%	-0.11%	-0.24%	-0.34%
	Change in Output	0	-1	-4	-19	-42	-62
Management, scientific, and technical consulting services (5416)	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in Output	0	0	0	0	0	-1
Automotive repair and maintenance (8111)	Percent change	0.00%	0.00%	-0.04%	-0.11%	-0.18%	-0.21%
	Change in Output	0	-1	-6	-20	-31	-37
State and Local Government	Percent change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change in Output	0	-1	-4	-13	-23	-32

Figure 15: Change in California Output by Major Sector



Impacts on Investments in California

Private domestic investment consists of purchases of residential and nonresidential structures and of equipment and software by private businesses and nonprofit institutions. It is used as a proxy for impacts on investments in California because it provides an indicator of the future productive capacity of the economy.

The relative changes to growth in private investment for the Proposed Regulation are shown in Table 29 and show an increase of private investment of $97 million in 2031, an increase of approximately 0.02 percent of baseline investment.

Table 29: Change in Gross Domestic Private Investment

	2021	2023	2025	2027	2029	2031
Private Investment (2018M$)	323,535	365,613	423,691	468,404	482,365	494,864
Percent Change	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%
Change (2018M$)	0	0	7	28	59	97

Impacts on Individuals in California

As modeled, the Proposed Regulation does not impose direct costs on individuals in California. However, the costs incurred by affected businesses and the public sector will cascade through the economy and affect individuals. In addition, the operational cost savings of operating ZEVs for TNC service will increase profits for TNC drivers resulting in increases income for these drivers.

One measure of the statewide impact is the change in real personal income. Table 30 shows annual change in real personal income across all individuals in California. Total personal income increases by about $1 million in 2023 and $385 million in 2031 as a result of the Proposed Regulation. This change in personal income estimated here can also be divided by the California population to show the average or per capita impact on personal income. The increase in the personal income growth is estimated to be about $9 per person in 2031.

Table 30: Changes in Personal Income Growth

	2021	2023	2025	2027	2029	2031
Personal Income (2018M$)	2,468,200	2,568,660	2,722,315	2,861,808	2,960,462	3,076,890
Percent Change	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
Change (2018M$)	0	1	15	72	184	385
Personal Income Per Capita (2018$)	61,228	63,087	66,113	68,745	70,391	72,466
Percent Change	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
Change (2018$)	0	0	0	2	4	9

Impacts on Gross State Product (GSP)

Gross State Product (GSP) is the market value of all goods and services produced in California and is one of the primary indicators used to gauge the health of the economy. Table 31 shows the annual change in gross state product estimated as a result of the Proposed Regulation. Under the Proposed Regulation GSP is anticipated to decrease by about $1 million in 2023 and $20 million in 2031, relative to the baseline. These changes do not exceed 0.01 percent of baseline GSP.

Table 31: Changes in Gross State Product

	2021	2023	2025	2027	2029	2031
Gross State Product (2018M$)	2,680,879	2,833,581	3,058,931	3,246,315	3,342,963	3,444,702
Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Change (2018M$)	0	-1	1	-2	-9	-20

Creation or Elimination of Businesses

The REMI model cannot directly estimate the creation or elimination of businesses. Changes in jobs and output for the California economy above can be used to understand some potential impacts. The overall job and output impacts of the Proposed Regulation are very small relative to the total California economy, representing less than 0.01 percent. However, impacts to specific industries are larger as described in the previous sections. As modeled, if large TNC companies took on all upfront costs of ZEVs and home charging infrastructure, there would potentially be a decrease in business growth for TNCs. However, CARB staff does not anticipate that the Proposed Regulation would result in the elimination of any California TNC company.

The trend of decreases in demand for the automotive repair and gasoline may lead to decreases in businesses in these industries.

Incentives for Innovation

As part of the Proposed Regulation, TNC and supporting rental companies have several opportunities to innovate.

Currently, there are a small number of rental companies that supply BEVs or FCEVs for TNC drivers to rent. Typically, these are weekly rentals that only full-time drivers could earn enough income driving for TNCs in order to cover the rental fees. However, with the advent of the Proposed Regulation, a new market for hourly rentals could develop that will allow part-time drivers to also rent a vehicle and provide TNC services. This part of the market has not yet been developed due, presumably, to the low demand for such services. Were these types of new services to develop, this would assist low- to medium-income drivers in accessing ZEVs for TNC services as no capital to purchase a ZEV is required and since the vast majority of TNC drivers are part-time, this innovation would provide this access to a much larger segment of the TNC driver pool.

For TNC companies themselves, the GHG targets are designed for innovation in a myriad of ways, such as reductions in empty miles traveled, increased pooling or occupancy, development of synergies with transit and active transportation, and other forms of increased system efficiency.

Empty miles traveled comprised 40% of the total miles driven by TNCs in 2018.[94] To reduce these types of miles, TNCs could innovate in a number of ways such as incentivizing drivers to simply pull over and park for Period 1 instead of randomly driving around in circles, or create agreements with cities and counties or retail properties for places that drivers can park (and even charge their vehicles), or utilize predictive algorithms where drivers are guided during Period 1 to where the next fare is most likely to be, thus shortening both Period 1 and Period 2 miles. A simulation study found that this technique could reduce empty miles traveled from approximately 50 to 80%.[95]

Pooling is the process where strangers share a TNC vehicle at the same time. This increases average occupancy rates and reduces GHG emissions per passenger mile. Currently, pooling is only offered in California for limited markets that are extremely dense. For example, San Francisco is a market where pooling is offered, but Sacramento, is not. However, the Proposed Regulation would provide incentive for innovation in this area. Currently, TNCs raise prices during periods of high demand for rides such as when it suddenly rains, when a sporting event ends, during commute hours to downtown, or when a transit train suddenly discharges hundreds of passengers at a station all at the same time. This is known as "peak pricing". These situations are the exact same situations where pooling could be offered temporarily as there are many potential passengers or fares who are either starting at the same location (sporting event ending or transit stop passengers all exiting at the same time) or ending at the same location (commute hours going downtown, or to a sporting event, or to a transit stop). However, a TNC at this time is not motivated to offer temporary pooling at these times and the peak pricing offers the best profit for TNCs and their drivers. The Proposed Regulation could tip the incentives for TNCs to forgo some of the profits for reductions in GHG emissions per passenger mile.

Incentives with the Proposed Regulation, in the form of credits for zero emission passenger miles, could lead to innovations in partnerships with transit agencies or motivating passengers to walk a block or two to meet a TNC ride instead of simply waiting for the ride. Partnerships with transit could make the transportation system more efficient, more accessible to low- and moderate-income citizens, and bolster transit utilization if passengers are able to use both TNCs and transit for longer trips and not just use the TNC the entire way. And, if a passenger is incentivized to walk a block or two, often the TNC vehicle can use a more direct route (deviate less) to meet a passenger and get them to their destination. These opportunities are particularly beneficial in city centers (where majority of TNC business is located) with one-way streets, large wide roadways where a driver may have to circle an entire block in heavy traffic just to get to the correct side of a street, and where a large building/facility or causeway may block access to a passenger for a vehicle, but a pedestrian could transcend quite easily.

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[94] CARB 2019. *2018 Base-Year Emissions Inventory Report*

[95] Kontou, Garikapati, Hou, and Wang. 2020 Reducing ridesharing empty vehicle travel with future travel demand prediction. *WSTLUR*.

System-wide efficiencies are another potential innovation that TNCs may choose to employ. Without the Proposed Regulation, TNCs are optimized only for highest profit and best quality of service (travel and wait times minimized). With the Proposed Regulation, some of these optimizations can begin to be balanced with other outcomes such as energy consumption and pooling occupation increases, for example. There are many ways that efficiencies can be worked into ordinary TNC operations including all of those mentioned above. Additional possibilities includes more optimal trip routing that balances energy consumption reduction with travel time minimization (instead of only optimizing for travel time), or lengthening the pooling window of opportunity a few more minutes so that the ride matching rate increases.

Competitive Advantage or Disadvantage

The Proposed Regulation may create some competitive advantages or disadvantages for TNCs, drivers, or other companies, while other issues are mitigated.

In the past, a high percentage of TNC drivers provided services for multiple TNC services at the same time.[96] TNC companies more recently have been able to structure driver incentives to reduce this practice. With the recent implementation of Assembly Bill 5, this practice could potentially be reduced further if drivers are considered employees to one specific TNC.[97] To the extent that drivers can operate for both companies at the same time, the Proposed Regulation presents a competitive advantage to the largest of the TNCs (as determined by relative number of riders requesting trips). In this situation, a driver is accumulating empty miles traveled for both Uber and Lyft (for example) during the period where they have no fare or passenger assigned. But, once the passenger is assigned, the TNC that did not get the assignment will not have passenger miles accrued as a result that would offset the accrued empty miles traveled emissions. This presents an advantage to the TNC that has the higher probability of matching the driver to a rider. The magnitude of the advantage or disadvantage is proportional to the magnitude of the discrepancy in number of riders requesting trips for each TNC within a similar region, if there are a significant number of drivers working for more than one TNC at the same time.

Given that AB 5 may reduce opportunities for TNC drivers to work for more than one TNC company at a time, competitive advantages or disadvantages created by the Proposed Regulation between the specific companies of Uber and Lyft do not appear to be material. Both companies' drivers exhibit similar vehicle types, average passenger miles per trip, and exist in similar markets. The economics of one of these companies meeting GHG emission and electrification targets appears to be very much the same as the other.

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[96] In the Clean Miles Standard 2018 Base-year Emissions Inventory Report, CARB staff found that approximately 11 percent of P1 VMT overlaps between at least two companies.

[97] Assembly Bill 5: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201920200AB5, accessed 6/30/20.

The Proposed Regulation does not present any overt or direct advantages other than this common phenomenon and in fact, both of the proposed targets are relative and specifically designed to be independent of the size of a company's operations or cash flow. The GHG emissions target is adjusted by the number of passenger miles so that emissions restrictions are on a per ride basis, which doesn't give larger companies any advantage. And, the electrification target is in percent eVMT, which is also relative to the total number of miles provided by a given TNC. In this way, the Proposed Regulation is designed to mitigate any competitive advantage or disadvantage to any particular TNC as a result of its relative size in the market.

The Proposed Regulation creates a competitive disadvantage for TNCs relative to other businesses in the transportation and passenger ground support industries that are explicitly excluded under SB 1014. Specifically, the Proposed Regulation excludes from electrification targets taxi, limousine, and some charter party carrier companies. However, other charter party carriers are subject to other emissions regulations such as the Zero-emission Airport Shuttle Regulation, and the Truck and Bus Regulation.

The Proposed Regulation may provide a competitive advantage to TNC drivers that have electric vehicles or relatively more fuel efficient vehicles than other nearby drivers. All else equal, TNCs could potentially favor these more efficient vehicles when matching passengers to drivers, as miles traveled in these vehicles could increase eVMT or have lower GHG per passenger mile.

The Proposed Regulation may also provide a disadvantage to California drivers near the state border. For example, a TNC driver in Nevada could potentially be chosen over a California driver to respond to a ride request that occurred near the border as some of the miles from the driver located on the Nevada side of the border would not be counted towards the TNC's GHG emissions.

Summary and Agency Interpretation of the Assessment Results

As analyzed here, CARB estimates the Proposed Regulation is unlikely to have a significant impact on the California economy. Table 32 provides a summary of the statewide macroeconomic impacts on the California economy. Overall the changes in growth of jobs, output, private investment, income, and GDP are projected to not exceed 0.01 percent of the baseline. The Proposed Regulation results in increased costs to TNC companies and decreases in demand for gasoline and automotive repair, but also results in increased income for TNC drivers and additional demand for electricity as a transportation fuel. The analysis also shows the negative impact estimated for state and local government output and employment due to tax revenue decreases, without any offsetting revenues.

Table 32: Summary of Macroeconomic Results

		2021	2023	2025	2027	2029	2031
GSP	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (2018M$)	0	-1	1	-2	-9	-20
Personal Income	Percent Change	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
	Change (2018M$)	0	1	15	72	184	385
Employment	Percent Change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change	-1	-25	-132	-545	-1186	-1745
Output	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (2018M$)	0	-2	-6	-26	-49	-72
Private Investment	Percent Change	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%
	Change (2018M$)	0	0	7	28	59	97

F. ALTERNATIVES

CARB Staff analyzed two regulatory alternatives. In keeping with the requirements of SB 1014, both alternatives propose an electrification and GHG target. Table 33 provides a summary of the electrification and GHG targets under Proposed Regulation and regulatory alternatives and the following sections give more detail.

Table 33: Proposed and Alternatives 1 and 2 Targets for GHG and Electrification Targets

Year	Alt. 1: 100% eVMT by 2030		Proposed Regulation		Alt. 2: 40% eVMT by 2030	
	%eVMT	gCO$_2$/PMT	%eVMT	gCO$_2$/PMT	%eVMT	gCO$_2$/PMT
2023	4%	250	2%	255	2%	254
2024	17%	213	4%	240	2%	245
2025	34%	167	8%	222	4%	231
2026	52%	122	18%	193	8%	215
2027	70%	77	27%	168	12%	200
2028	81%	49	38%	140	20%	179
2029	91%	24	48%	116	27%	161
2030	100%	0	60%	88	40%	131

Alternative 1: The 100% Electrification by 2030 Alternative

This first of two alternatives is the case where TNCs achieve 100% Electrification by 2030. For this, CARB staff used a trajectory across the period of the regulation from the BAU case to a 100% eVMT target in 2030. This alternative was selected for many reasons, one of which is that Board directed staff to consider this alternative in the January 2020 Board Hearing.[98] This is also the most stringent target that other stakeholders have proposed. Lyft has announced independently, a company goal of achieving this target by 2030, but also clearly indicates barriers and additional supporting government policies needed to achieve the goal.[99] At 100% eVMT any drivers who wish to earn money driving for TNC companies would only be able to drive for the platform if they own, rent, or otherwise acquire a zero emission vehicle, and this may push some drivers out of this business.

To estimate compliance with Alternative 1, the economic cost model switched the vehicles with the lowest net costs until the electrification target in each year was met.[100] Table 34 illustrates the total number of vehicles that would switch to ZEVs and characteristics of the average vehicle that would switch to a ZEV under Alternative 1. Compared to the Proposed Regulation, Alternative 1 would require many more vehicles to be switched to ZEVs in each year. In the first half of the regulatory lifetime, 2023 through 2027, the Alternative 1 eVMT targets would require approximately 7 times more vehicles be switched in each year, than under the Proposed Regulation. In 2030, Alternative 1 would require approximately 3 times as many ZEVs than the Proposed Regulation.

Table 34: Characteristics of the Average Vehicle Switching to a ZEV under Alternative 1

Year	Number of Vehicles	Average VMT	Average Active Weeks	Average BAU Vehicle MPG	Average Vehicle age
2023	2,914	50,298	46.7	36.9	1
2024	29,481	30,158	38.7	44.1	1
2025	72,098	25,941	36.8	46.8	1
2026	158,338	18,497	30.0	47.8	1

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[98] CARB Resolution 20-4. https://ww2.arb.ca.gov/board-resolutions-2020, accessed July 3, 2020.

[99] https://www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions, accessed 6/18/20. https://lyft-impact-assets.s3.amazonaws.com/images/path-to-zero-emissions.pdf

[100] When the net costs are negative (i.e. net savings), the economic cost model switches vehicles with the lowest net costs first. When net costs are positive, the economic cost model switches vehicles with the lowest cost per mile.

2027	226,021	17,682	30.5	48.1	2
2028	323,710	14,364	27.0	48.1	2
2029	404,224	13,004	26.0	47.6	3
2030	751,024	7,742	17.8	45.4	4
2031	752,247	7,748	17.8	45.8	4

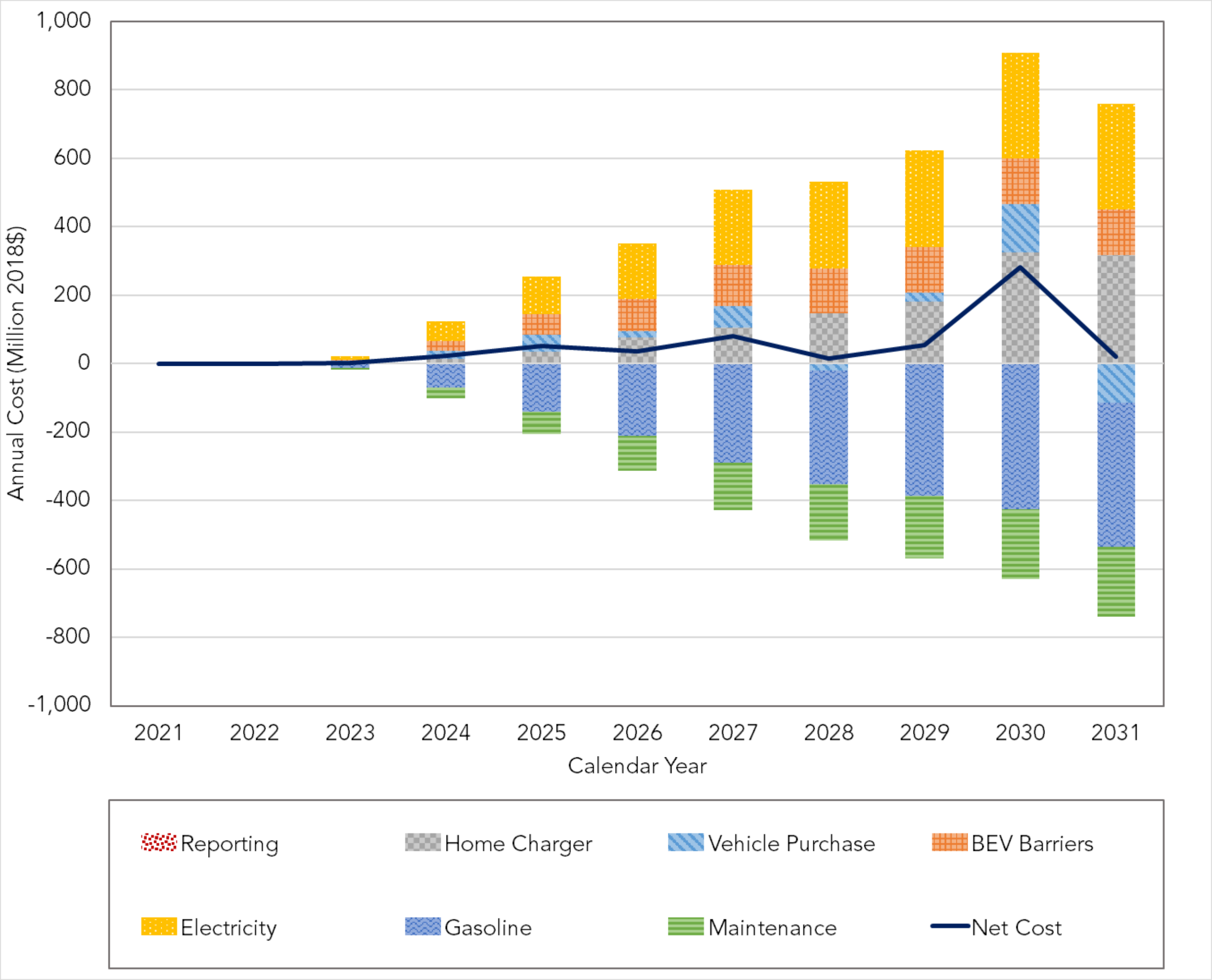
Costs

Total Costs to TNCs, Drivers, and Riders

Alternative 1 would increase the number of ZEVs used in TNC service relative to the Proposed Regulation. This would result in greater impacts to TNCs, drivers, and riders due to more vehicle purchases, home chargers, electricity, and BEV barriers, but would also result in greater cost savings associated with gasoline and maintenance savings. The direct costs that would be distributed among TNCs, drivers, and riders would total $564 million between 2021 and 2031, versus a savings of $797 million under the Proposed Regulation. The cost differences between Alternative 1 and the Proposed Regulation are a direct result of the number of vehicles that would need to be switched to ZEVs. The vehicles needing to switch to ZEVs under Alternative 1 would, on average, have VMT that is 36 percent lower than those needing to switch under the Proposed Regulation. In addition, Alternative 1 would require all of the older model year vehicles to switch to a ZEV. Older model year vehicles have higher incremental capital costs of switching to ZEVs, relative to a similar aged newer model year vehicle. The fuel and maintenance savings from the relatively low mileage of vehicles that need to be switched to ZEVs under Alternative 1 do not make up for the incremental vehicle purchase costs, BEV barriers, and home charger costs.

Figure 16 illustrates the difference in costs to TNCs, drivers, and riders between Alternative 1 and the BAU scenario.

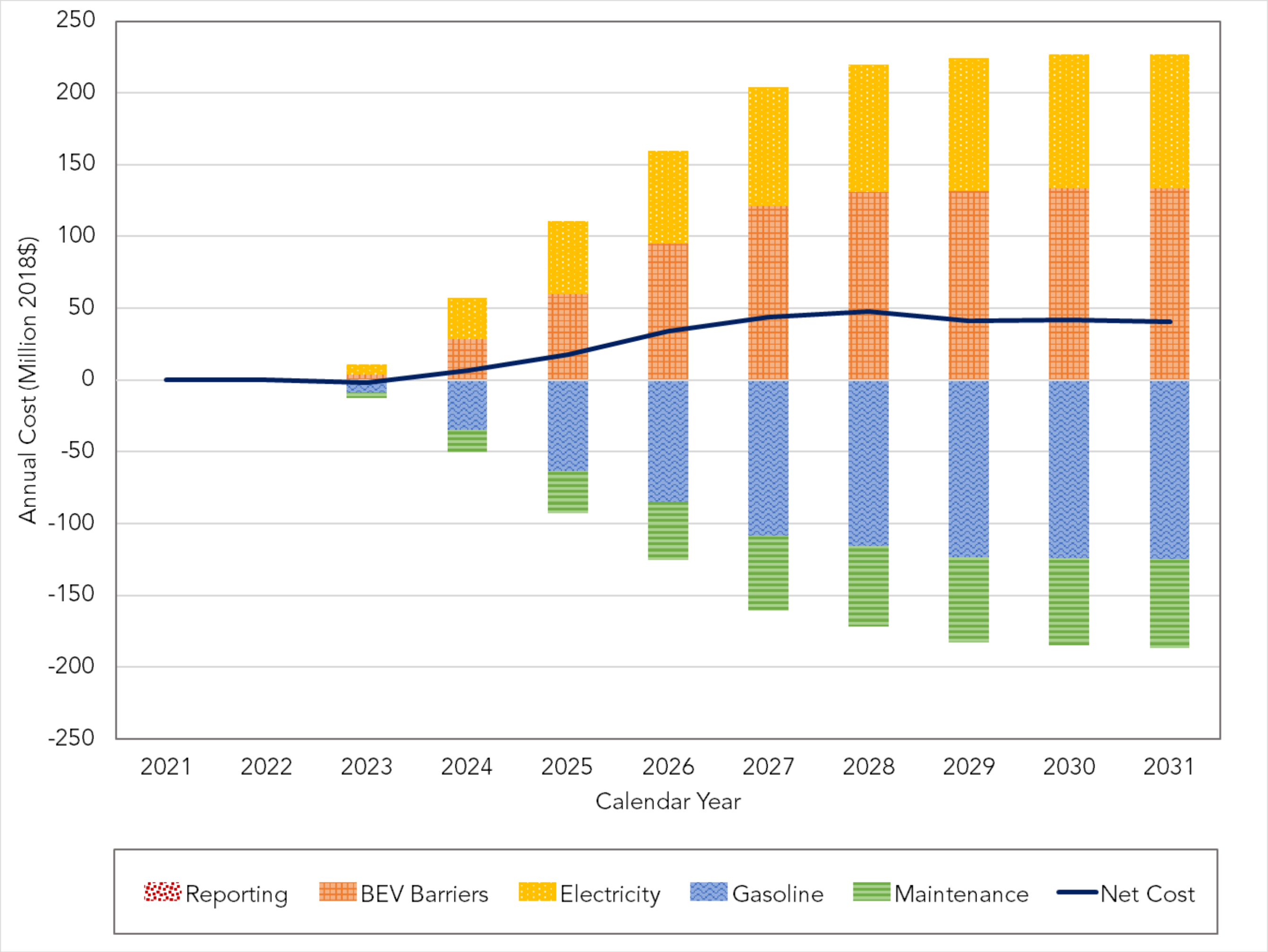
Figure 16: Differences in Costs to TNCs and Drivers between Alternative 1 and BAU Scenario



Total Costs to California

Figure 17 illustrates the costs to California. As described above, because of the Zero Emission Vehicle Regulation, costs and cost savings from the purchase of ZEVs and home chargers are anticipated to be transfers between TNC drivers and typical California vehicle owners, and are not shown in the figure. In addition, the figure takes into account eVMT that would have occurred in the BAU ZEVs. Under Alternative 1, the net cost to California would be $272 million between 2021 and 2031, relative to a net savings of $46 million under the Proposed Regulation.

Figure 17: All Costs to California for Compliance with Alternative 1



Benefits

Criteria Pollutants and GHG Emission Benefits

Alternative 1 results in higher levels of eVMT and greater criteria and GHG emission benefits relative to the Proposed Regulation. Table 35 summarizes the expected annual NOx, $PM_{2.5}$, and CO_2 reductions in Alternative 1 in 2031 when compared to the BAU.

Table 35: Alternative 1 WTW NOx, PM2.5 and GHG Emission Benefits Relative to BAU

Calendar Year	NOx(tpd)	$PM_{2.5}$ (tpd)	CO2(MMT/yr)
2031	0.17	0.10	0.37

The NOx and PM2.5 emissions impact of the Alternative 1 scenario are presented relative to the BAU in Figure 18and Figure 19 respectively and are shown in short tons per day (tpd).

Figure 18. Projected WTW NOx Emission Reduction from Alternative 1

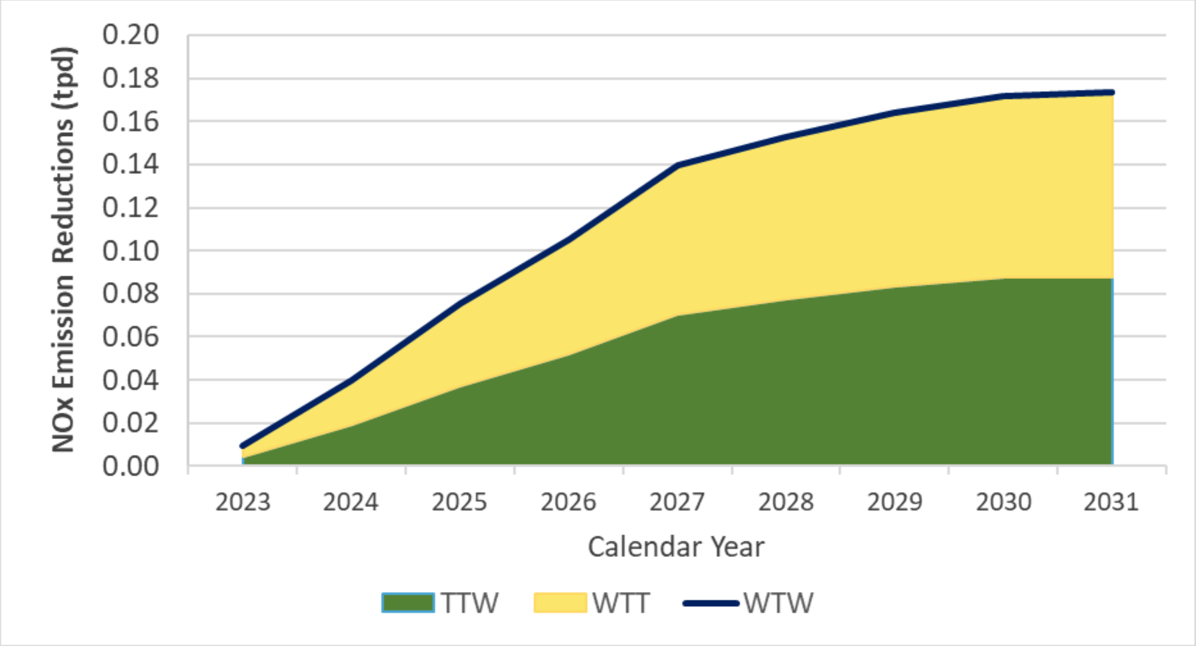


Figure 19: Projected WTW PM2.5 Emission Reduction from Alternative 1

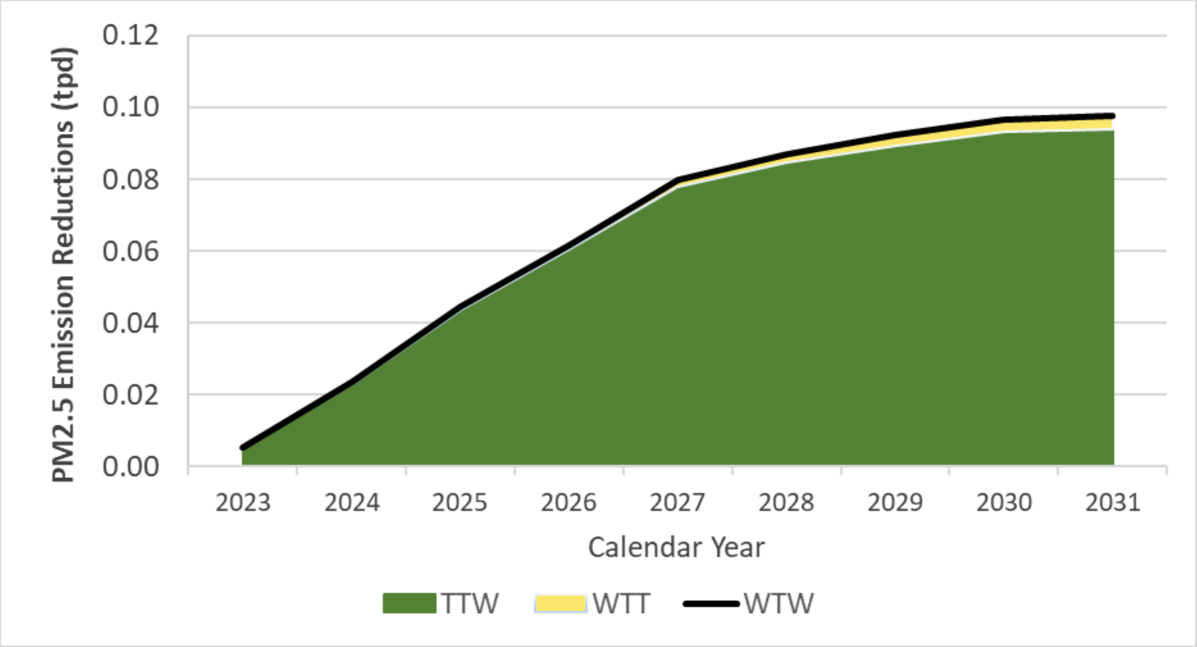
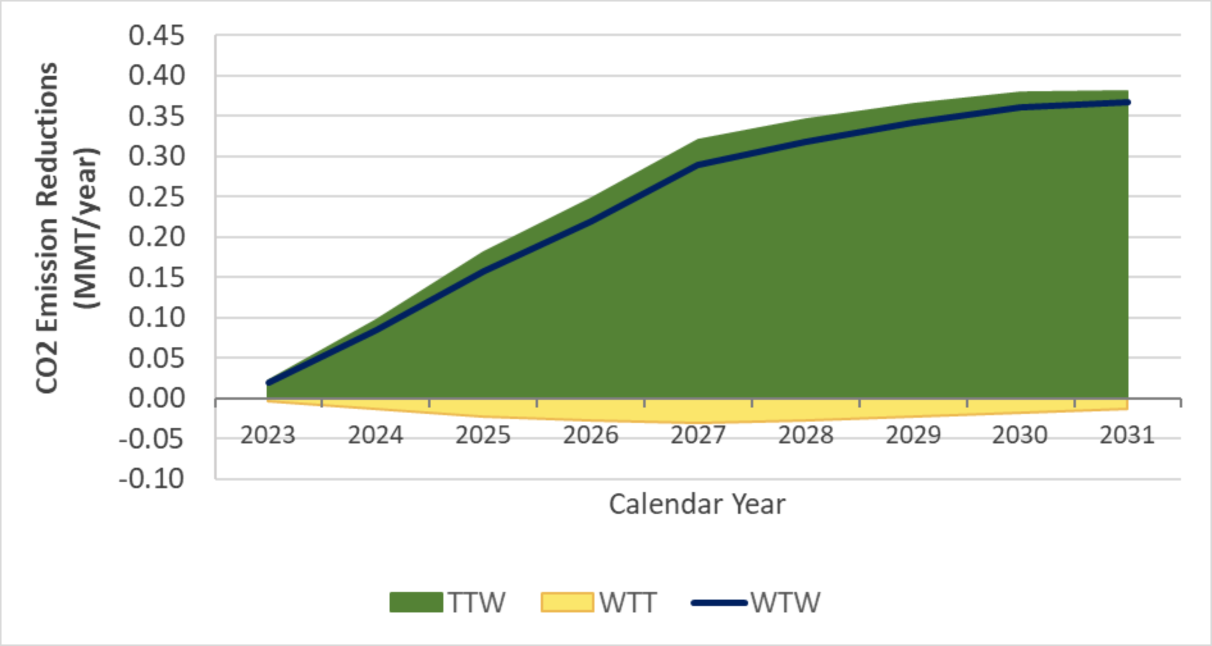


Figure 20 presents the TTW, WTT and WTW GHG emission reductions in million metric tons per year (MMT/year). From 2023 to 2031, the estimated GHG benefits would be valued between $33 million and $154 million, depending on the discount rate used.

Figure 20: Projected WTW CO2 Emission Reduction from Alternative 1



Health Benefits

Alternative 1 results in emission reductions relative to the BAU leading to health benefits as shown in Table 36. The health benefits are greater than those of the Proposed Regulation (Table 16) due to greater emission reductions estimated for this alternative.

Table 36: Statewide Valuation from Avoided Health Outcomes for Alternative 1

Outcome	**Avoided Incidents**	**Valuation (Million 2018$)**
Avoided Premature Mortality	36	$348.10
Avoided Cardiovascular Hospitalizations	5	$0.31
Avoided Acute Respiratory Hospitalizations	6	$0.32
Avoided Emergency Room Visits	19	$0.02
Total		**$348.74**

Economic Impacts

Alternative 1 would impose electrification targets that reach 100 percent by 2030. As modeled, this would result in greater costs to TNC companies, as well as larger impacts from reduced gasoline and automotive repair demand. This would be offset by greater demand for electricity and savings for TNC drivers as they spent less on fuel and maintenance. As shown in Table 37, the macroeconomic impacts analysis results show that this alternative would result in larger economic impacts than the Proposed Regulation. Alternative 1 is estimated to have a 7 times greater impact on GSP, a 5 times greater impact on employment, and a 13 times greater impact on output relative to the Proposed Amendments by 2031.

However, this impact is never greater than 0.01 percent of California's GSP or output. Similar to the Proposed Amendments, Alternative 1 is estimated to result in increases in personal income and private investment. However, the increases in personal income and private investment are also lower under Alternative 1, relative to the Proposed Amendments.

Figure 21 illustrates the impact of Alternative 1 on California employment by major sector and Figure 22 illustrates the impact of Alternative 1 on California output by major sector. Like the Proposed Regulation, the greatest negative impacts occur within the transportation and public utilities sector.

Table 37: Summary of Macroeconomic Impacts of Alternative 1

		2021	2023	2025	2027	2029	2031
GSP	% Change	0.00%	0.00%	0.00%	0.00%	0.00%	-0.01%
	Change (2018M$)	0	0	-15	-62	-127	-275
Personal Income	% Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (2018M$)	0	2	24	61	83	98
Employment	% Change	0.00%	0.00%	-0.01%	-0.01%	-0.02%	-0.04%
	Change in Jobs	-1	-107	-1,307	-3,318	-5,428	-9,607
Output	% Change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change (2018M$)	0	-4	-52	-152	-270	-527
Private Investment	% Change	0.00%	0.00%	0.01%	0.01%	0.01%	0.00%
	Change (2018M$)	0	2	20	43	50	22

Figure 21: Changes in Employment Growth by Major Sector Under Alternative 1

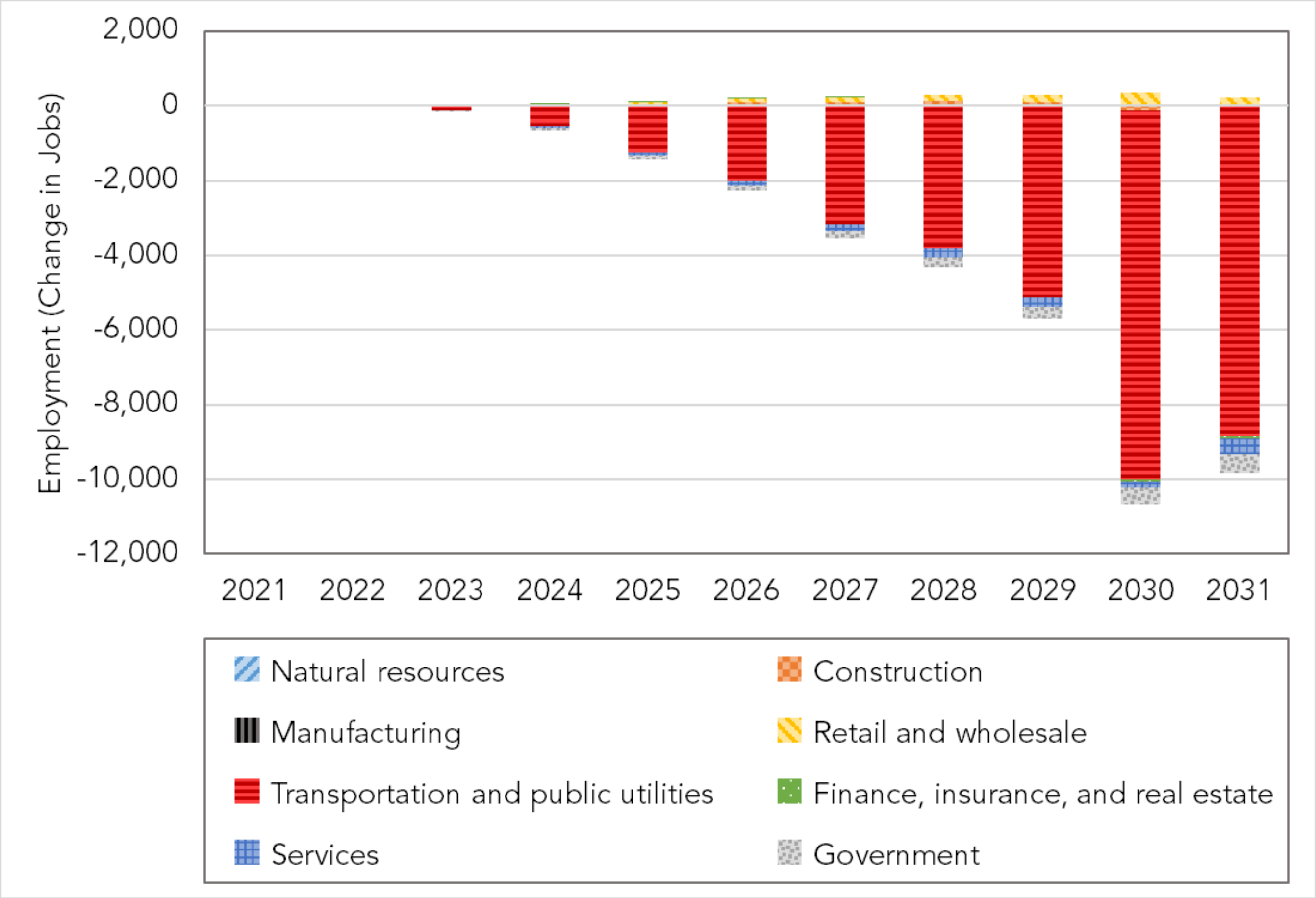
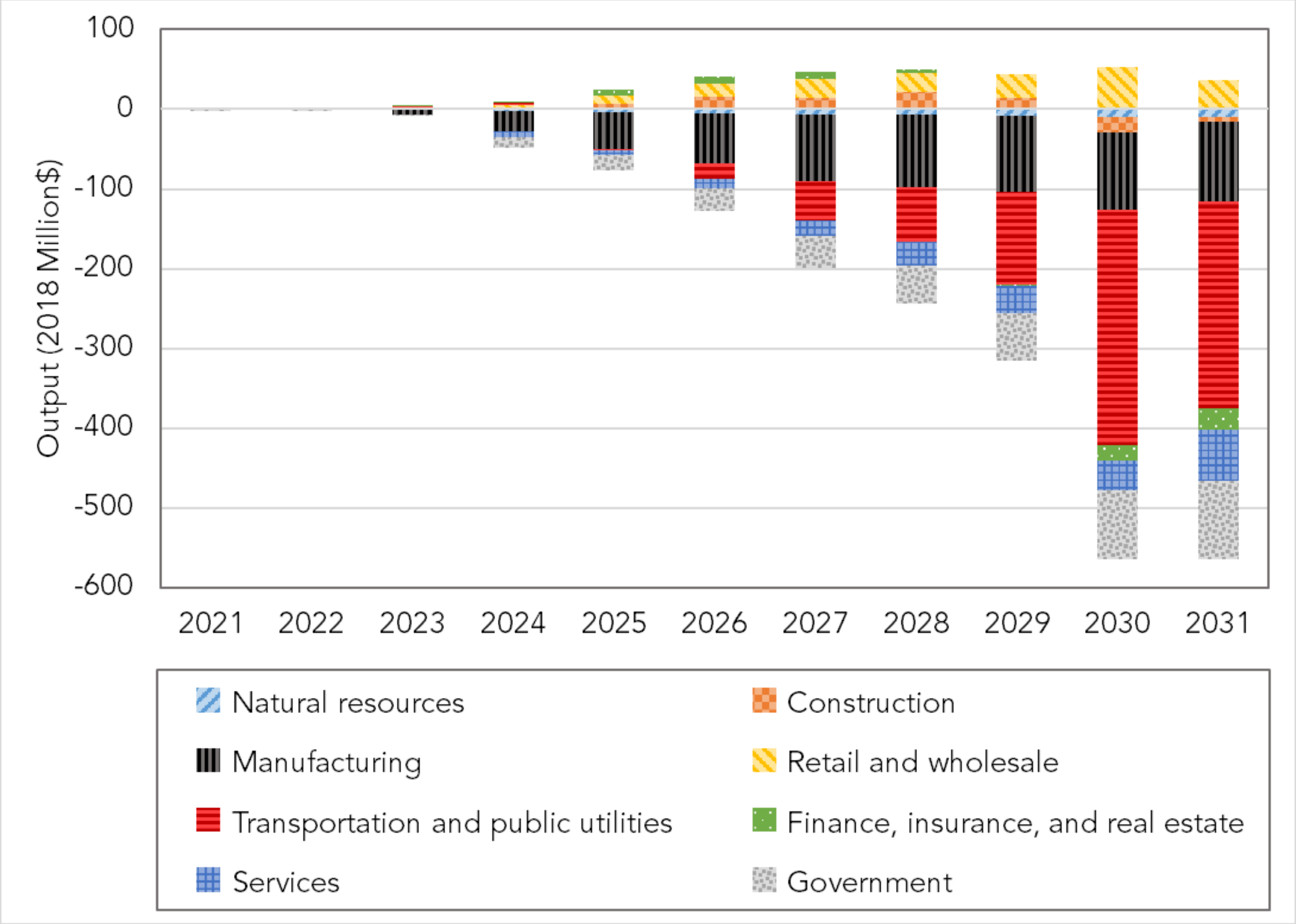


Figure 22: Changes to Output Growth by Major Sectors Under Alternative 1



Cost-Effectiveness

The metric to quantify cost-effectiveness of the Proposed Regulation and Alternatives is the ratio of total monetized benefits divided by total monetized costs. A comparison of this type is an appropriate cost-effectiveness measure if the harm associated with increased emissions is fully captured in the estimates of monetized health impacts. A benefit-cost ratio greater than 1 implies that a regulation's benefits are higher than its costs. Benefits include both health benefits and cost savings after subtracting tax impacts to State and local governments.

Table 38 presents a comparison of total costs, benefits, and benefits-cost ratio for the Proposed Regulation, Alternative 1. The costs and benefits presented are the California statewide impacts; those that would occur beyond the Zero Emission Vehicle Regulation. It indicates that the Proposed Regulation has a cumulative net benefit close to $171 million and a benefit-cost ratio of 1.27, meaning the benefits are more than the costs during the analysis period between 2021 through 2031. While Alternative 1 has greater total benefits than the Proposed Regulation, it also has significantly greater total costs. These costs are primarily caused by the large number of drivers that would need to switch to a ZEV under a 100 percent electrification target and the costs associated with the BEV barriers. As a result, Alternative 1 has net benefits of approximately $-41 Million, and a lower benefit-cost ratio of 0.97, compared to the Proposed Regulation.

Table 38: Cost Effectiveness Comparison of Proposed Regulation and Alternative 1

Scenario	Total Costs	Health Benefits	Cost Savings (Benefit)	Taxes	Total Benefit	Net Benefit	Benefits-Cost Ratio
Proposed Regulation	636.2	194.9	681.9	-69.5	807.4	171.2	1.27
Alternative 1	1,440.0	348.7	1,168.3	-118.4	1,398.6	-41.4	0.97

Reason for Rejecting

Relative to the Proposed Amendments, Alternative 1 has lower net benefits and a lower benefit-costs ratio. In addition, CARB would not be able to ensure that a 100 percent electrification target could be achieved without significant impacts to TNC drivers. Drivers, particularly those with lower household income, that have a short tenure in TNC service or drive very few miles would not be able to continue to drive for TNCs if they didn't own or acquire a zero emission vehicle. Although there are business models supported by TNCs that provide short-term (e.g. weekly) electric vehicle rentals to drivers, these services are not currently operating in California and it is unclear when, and how fast, they will return and expand in the state. Further, lower income drivers commonly drive older vehicles and will not be able to take advantage of the cost parity of electric and conventional vehicles closer to 2030.

SB 1014, in the modified language to Section 5450 of the PUC code, includes two sections with clear direction to the agencies to carefully consider impacts to lower income drivers. Section 4 (b)(4) allows the PUC to delay implementation of the regulation if unanticipated barriers arise from low income drivers gaining access to electric vehicles. Section 4 (d)(1) states the PUC, in implementation of the regulation, shall ensure minimum negative impact to low income drivers. Several factors that staff have assessed but cannot be assured include the rate of infrastructure investment/buildup, continued funding for incentive programs, as well as reductions over time in electricity rates for vehicles. CARB staff are not confident a full electrification requirement could be met by lower income drivers in the years up to 2030.

There are low-income drivers that do not drive for a TNC very often and will never recuperate the costs of switching as their current ICE vehicle has little residual value. According to Lyft's 2020 Economic Impact report, 86% of Lyft drivers in California drive less than 20 hours per week.[101] CARB staff observed in the 2018 base year data that a large portion of drivers drive on the platform for a temporary amount of time. Staff are continuing to evaluate whether it is feasible to account for non-TNC household vehicle activity in order to assess if a driver would

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[101] Lyft 2020 Economic Impact Report: https://www.lyftimpact.com/stats/states/california

recoup electric vehicle costs over larger mileage. This could enable moderate income, part time, drivers to recoup electric vehicle costs. However, for the portion of drivers who work for only a few months on the platform, *and* are lower income with a need for older vehicles, the switch to a ZEV does not make economic sense.

Beyond the impacts to low income drivers of acquiring an electric vehicle, a 100 percent electrification target would not allow for other avenues of compliance such as reducing empty miles and increasing pooled services. This is because electrification would become the only mechanism for compliance in the greenhouse gas requirement. However, SB 1014 was clear in its intent to enable multiple forms of compliance by TNCs to help address transportation land-use challenges and congestion. Specifically, Section 4 (d)(2) states that the PUC shall ensure the program complements and supports sustainable land-use objectives. Further, Section 1 (m) of the approved statute highlights current state policy objectives to advance sustainable land-use and increase access to clean mobility options to low and moderate income individuals. Clean mobility options include pooling of TNC rides, access to active transportation services, and quality traditional transit that currently is facing competition from TNCs in some markets competing for passengers.

While this analysis analyzed compliance with the Proposed Regulation and Alternatives entirely through electrification, there may potentially be other cost effective methods to reach the GHG targets that would create additional benefits such as reduction in congestion. Alternative 1 is rejected because it may hurt certain drivers without providing significant benefits.

Alternative 2: The 40% eVMT by 2030 Alternative

The second Alternative considered reduces the proposed percent eVMT target to 40% by 2030. (See Table 33). This was chosen as a gradual increase in electrification over time as a lower bounds for stringency.

Table 39 illustrates the number of vehicles and characteristics of the average vehicle that would be switched to ZEVs under Alternative 2. Compliance with the electrification and GHG targets in Alternative 2 could be achieved by switching fewer vehicles to ZEVs, relative to the Proposed Regulation; approximately 50 percent fewer vehicles would need to be switched in 2030. The vehicles that switched over to ZEVs could on average have higher VMT, leading to greater net savings for the average driver that switched to a ZEV. Relative to the Proposed Regulation, the average vehicle that switched to a ZEV under Alternative 2 would have 40 percent higher VMT.

Table 39: Characteristics of Vehicles Switched To ZEVs Under Alternative 2 in the Model

Year	Number of Vehicles	Average VMT	Average Active Weeks	Average BAU Vehicle MPG	Average Vehicle Age
2023	479	63,413	48.6	32.9	1.2

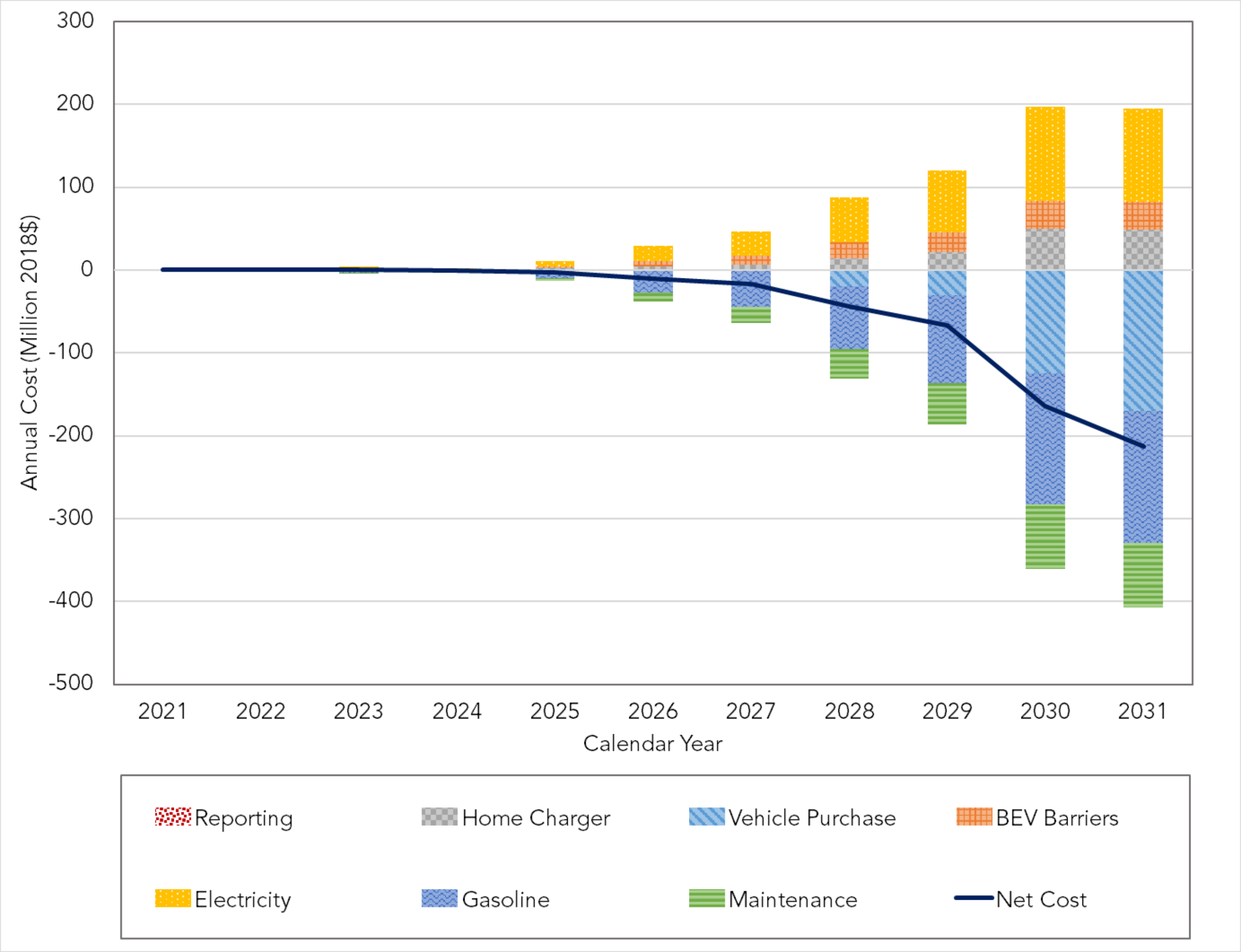
Year	Number of Vehicles	Average VMT	Average Active Weeks	Average BAU Vehicle MPG	Average Vehicle Age
2024	212	65,198	49.7	32.2	1.0
2025	2,140	52,560	47.5	38.9	1.0
2026	7,529	44,429	45.5	42.4	1.1
2027	13,719	40,809	44.4	43.6	1.2
2028	31,402	32,638	40.6	45.7	1.1
2029	49,112	29,245	38.5	46.7	1.3
2030	114,882	19,272	29.2	48.0	1.1
2031	115,437	19,179	29.1	48.0	1.1

Costs

Total Costs to TNCs, Drivers, and Riders

Alternative 2 would increase the number of ZEVs in TNC service relative to the BAU scenario, but would require fewer ZEVs than the Proposed Regulation. This would result in lower costs to TNCs and drivers associated with vehicle purchase, home chargers, and electricity, but would also decrease the amount of savings associated with gasoline fuel and maintenance. Relative to the baseline, the total costs to TNCs and drivers between 2021 and 2031 is $-517 million, versus a cost of $-797 million in the Proposed Regulation. Figure 23 illustrates the differences in costs between Alternative 2 and the BAU.

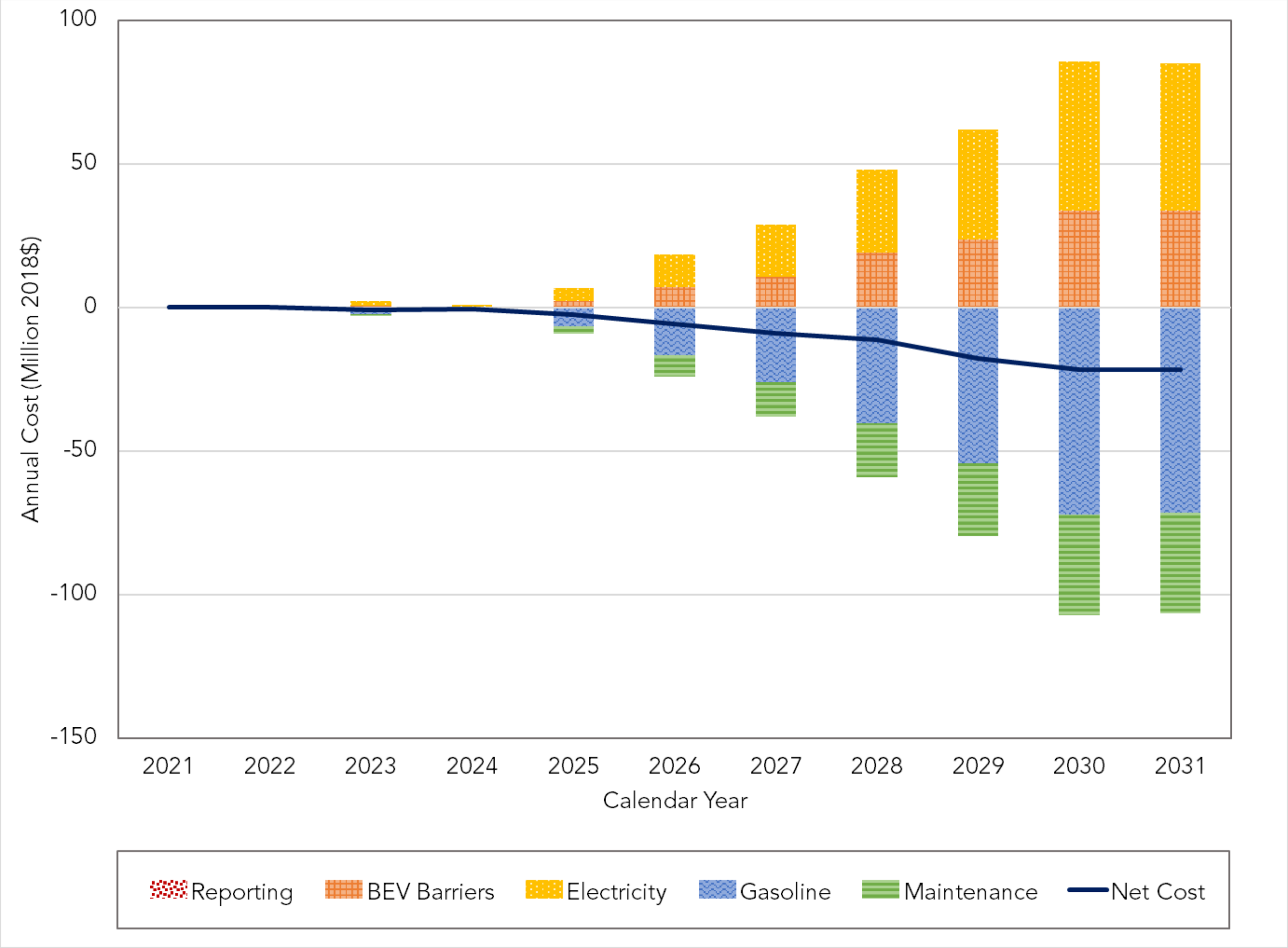
Figure 23: Differences in Costs to TNCs and Drivers between Alternative 2 and BAU



Total Costs to California

Similar to the Proposed Regulation, Alternative 2 would not be anticipated to increase the total number of zero emission vehicles in California beyond what is anticipated from the Zero Emission Vehicle Regulation. Rather, the impact of Alternative 2 would be shifting the use of ZEVs to TNCs. Relative to the baseline, Alternative 2 would result in a cost to California of $-91 million, versus a cost of $-46 million under the Proposed Regulation. Figure 24 shows the net impact to California.

Figure 24: All Costs to California for Compliance with Alternative 2



Benefits

Criteria Pollutants and GHG Emission Benefits

Alternative 2 results in lower levels of percent eVMT and increase criteria and GHG emission relative to the Proposed Regulation. Table 40 summarizes the expected annual NOx, $PM_{2.5}$, and CO_2 reductions in Alternative 2 in 2031 when compared to the baseline. From 2023 to 2031, the estimated GHG benefits would be valued between $11 million and $52 million, depending on the discount rate used.

Table 40: Alternative 2 WTW NOx, PM2.5 and GHG Emission Benefits Relative to BAU

Calendar Year	NOx(tpd)	$PM_{2.5}$ (tpd)	CO2(MMT/yr)
2031	0.09	0.05	0.19

The NOx and PM2.5 emissions impact of Alternative 2 relative to the BAU are presented in Figure 25 and Figure 26 respectively and are shown in short tons per day (tpd). The GHG emissions impact of Alternative 2 relative to the BAU is presented in Figure 27.

Figure 25: Projected WTW NOx Emission Reduction From Alternative 2

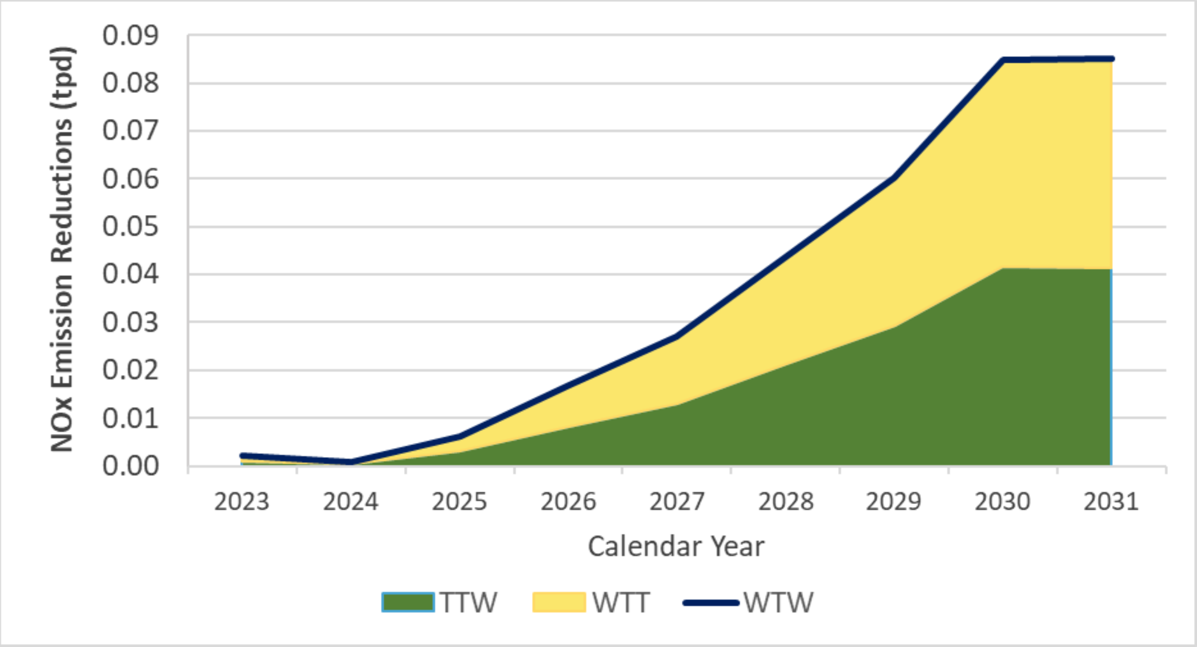


Figure 26: Projected WTW PM2.5 Emission Reduction from Alternative 2

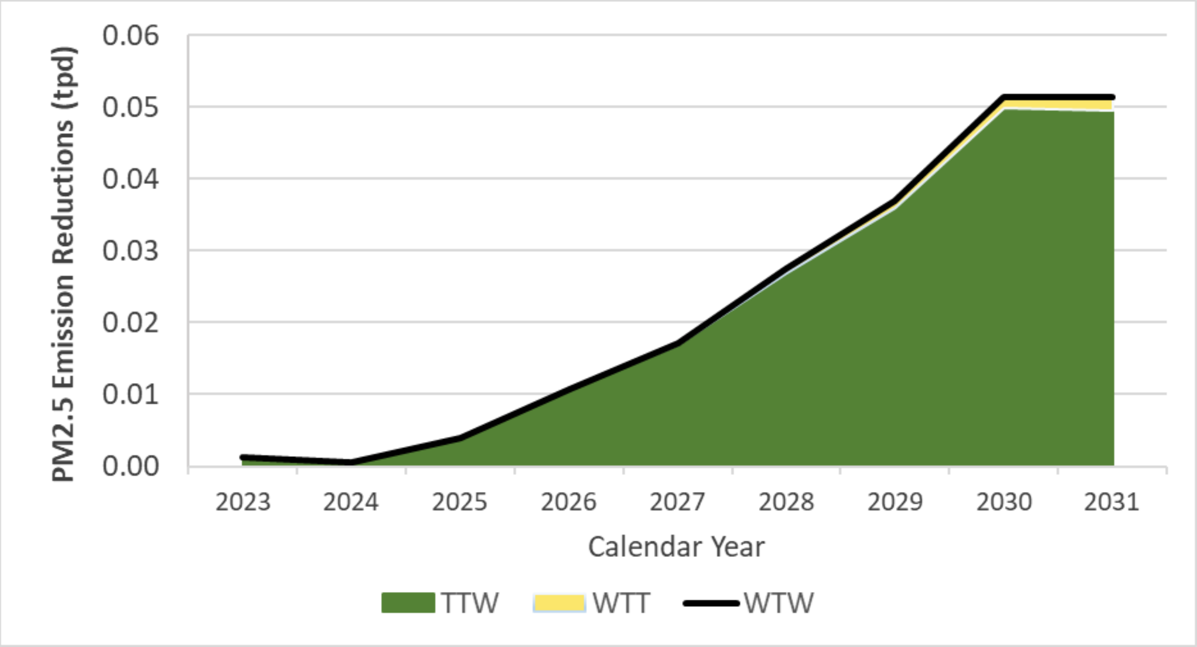
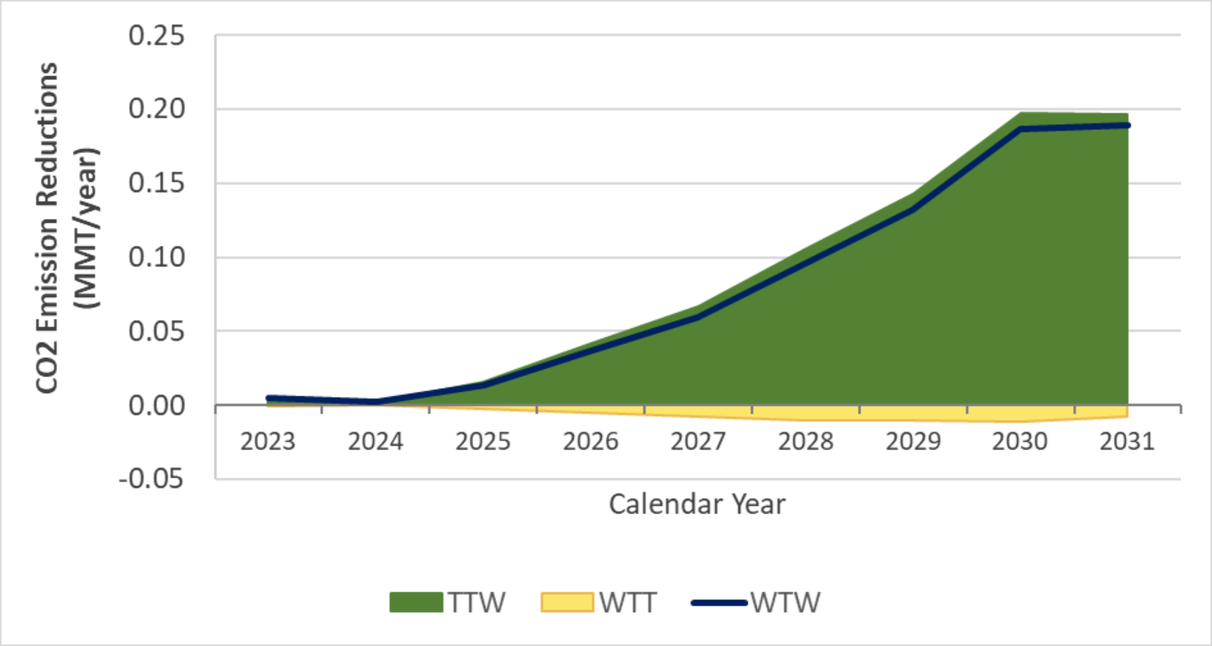


Figure 27: Projected WTW CO2 Emission Reduction from Alternative 2



Health Benefits

Alternative 2 results in emission reductions relative to the BAU leading to health benefits as shown in Table 41. The health benefits are less than those of the Proposed Regulation (Table 16) due to greater fewer reductions estimated for this alternative.

Table 41: Statewide Valuation from Avoided Health Outcomes for Alternative 2

Outcome	Avoided Incidents	Valuation (Million 2018$)
Avoided Premature Mortality	12	$118.81
Avoided Cardiovascular Hospitalizations	2	$0.11
Avoided Acute Respiratory Hospitalizations	2	$0.11
Avoided Emergency Room Visits	6	$0.01
Total		**$119.03**

Economic Impacts

Alternative 2 would impose less stringent eVMT and electrification targets than the Proposed Regulation. As shown in Table 42, the macroeconomic impacts analysis results estimate slightly smaller impacts to the California economy when compared to the Proposed Regulation. Relative to the BAU, there would be slight decreases in employment and output and slight increases in GSP, personal income, and private investment. The changes in these indicators is never greater than 0.01 percent.

Table 42: Change in Economic Indicators for Alternative 2 Relative to BAU

		2021	2023	2025	2027	2029	2031
GSP	% Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (2018M$)	0	-1	0	0	1	4
Personal Income	% Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
	Change (2018M$)	0	1	5	30	96	259
Employment	% Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in Jobs	-1	-25	-36	-151	-402	-737
Output	% Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (2018M$)	0	-2	-2	-10	-20	-22
Private Investment	% Change	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
	Change (2018M$)	0	0	2	12	32	70

Figure 28 illustrates the impacts of Alternative 2 on employment, by major sectors. Similar to the Proposed Amendments, Alternative 2 is estimated to have a small negative impact on employment growth in the transportation and public utilities industry, the service industry, and on government. This is a result of increased costs to the TNC industry, decreases in demand for automotive repair, fiscal impacts to government. The positive impacts to the construction, retail and wholesale, and finance, insurance, and real estate industries results from overall increased personal income within California.

Figure 29 illustrates the impacts of Alternative 2 on output, by major sectors. Similar to the Proposed Amendments, there is anticipated to be a slight overall decrease in output growth as a result of Alternative 2. However, Alternative 2 would be expected to result in slight *increases* in output in the transportation and public utilities industry, relative to the BAU. Under Alternative 2, the average vehicle switching to a ZEV sees greater net savings than under the Proposed Regulation. As a result, the positive impacts of the increases in proprietors' income in the transit and ground passenger transportation industry outweigh the impacts of increased costs to the TNCs.

Figure 28: Job Impacts of Alternative 2 by Major Sector

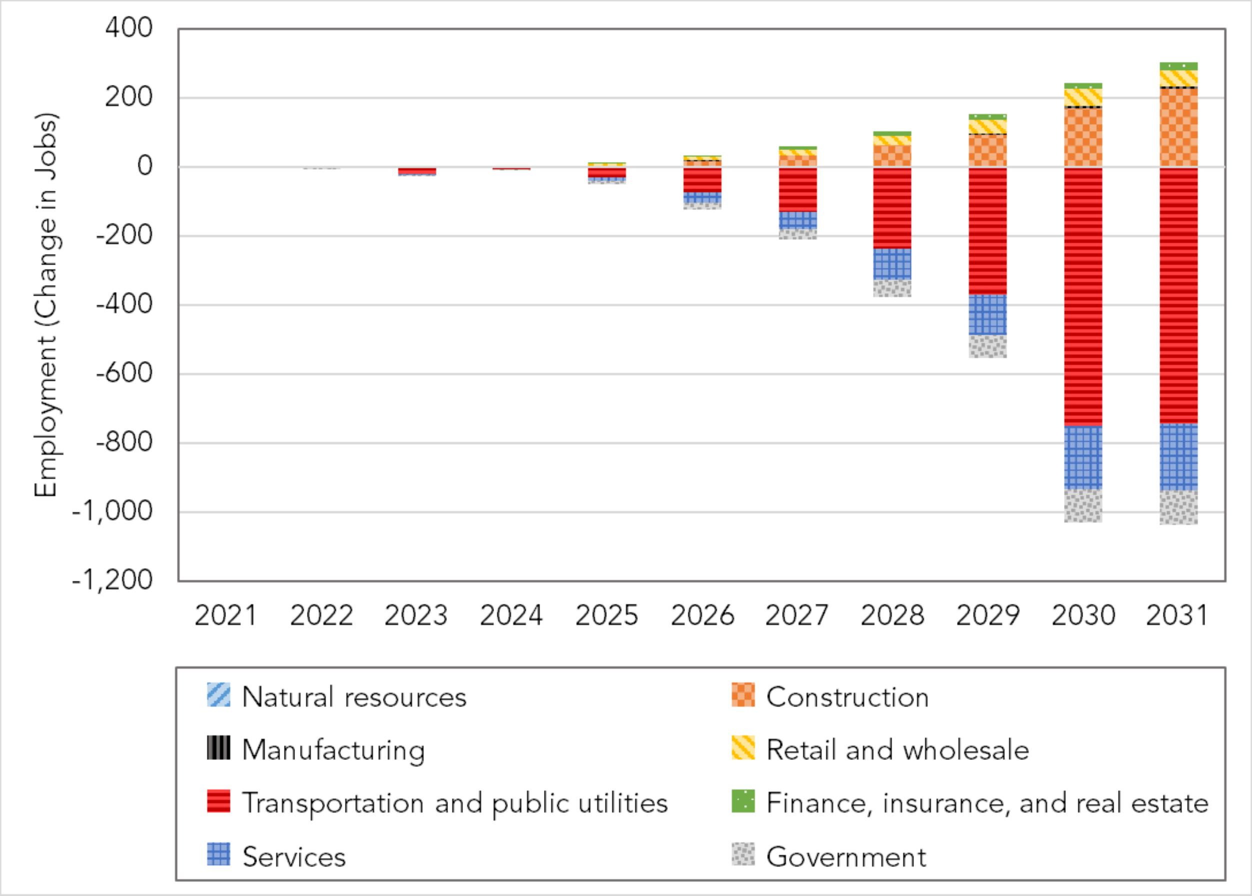
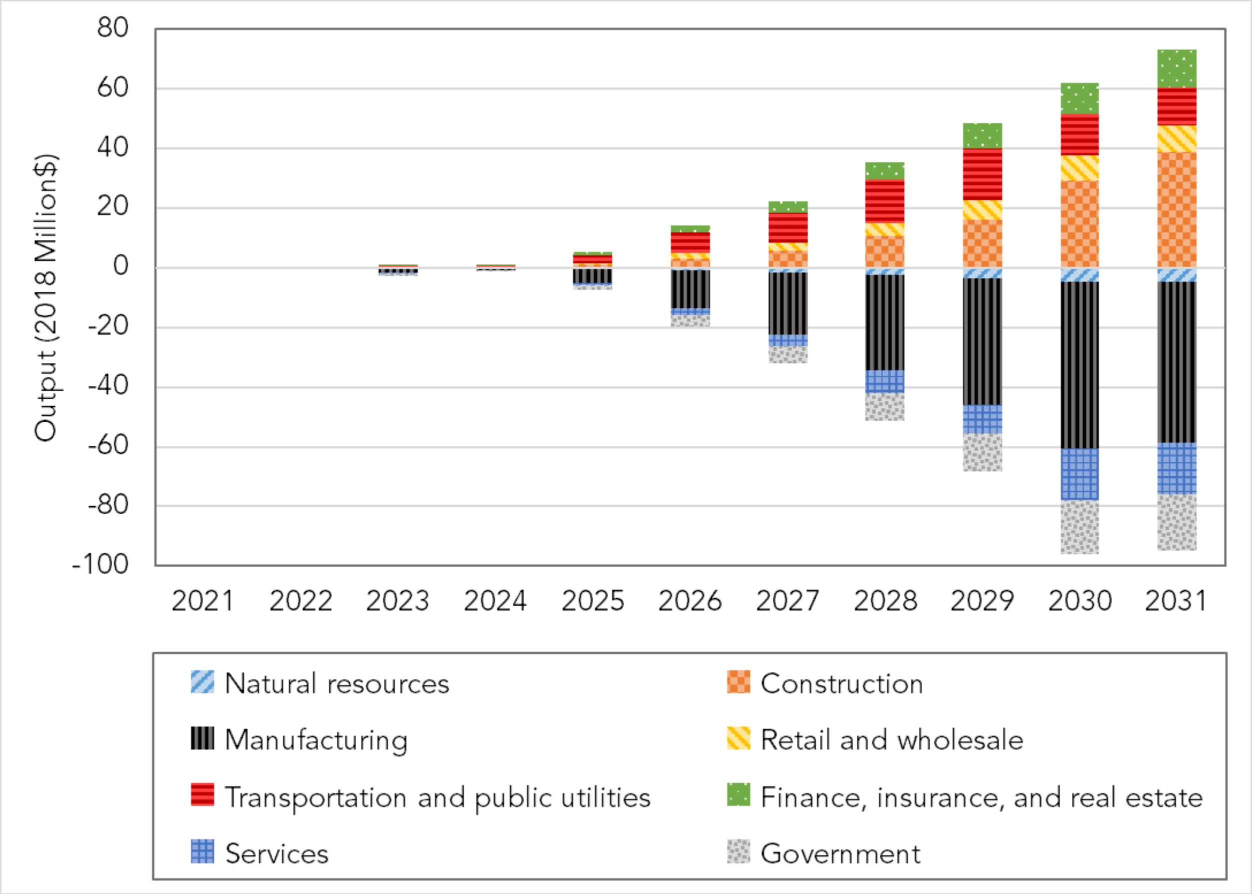


Figure 29: Changes in Economic Output from Alternative 2 by Major Sector



Cost-Effectiveness

Table 43 provides a comparison between the California statewide costs of the Proposed Regulation and Alternative 2. Alternative 2 is estimated to have net benefits of approximately $165 million compared to net benefits of $171 million for the Proposed Regulation. The benefits-cost ratio of Alternative 2 is 1.49 compared to 1.27 under the Proposed Regulation.

Table 43: Cost Effectiveness Comparison of Proposed Regulation and Alternative 2

Scenario	Total Costs	Health Benefits	Cost-Savings (Benefit)	Taxes	Total Benefit	Net Benefit	Benefits-Cost Ratio
Proposed Regulation	636.2	194.9	681.9	-69.5	807.4	171.2	1.27
Alternative 2	337.5	119.0	428.3	-44.5	502.8	165.3	1.49

Reason for Rejecting

While the benefits-cost ratio of the Proposed Regulation is slightly lower than Alternative 2, the magnitude of health benefits and the total net benefits of the Proposed Regulation are greater than those that would occur under Alternative 2. The proposed regulation would result in health benefits that are approximately 64 percent greater than Alternative 2 and net benefits approximately 4 percent higher than Alternative 2. As described in the 2017 Scoping Plan, substantial additional GHG emission reductions are needed to achieve the 2030 SB 32 requirements. Maximum feasible GHG emission benefits from the Clean Miles Standard should be pursued.

Alternative 2 is rejected because it does not make use of the opportunities presented for this regulation. The total emissions benefit is almost 40% less than the Proposed Regulation (or Proposed Regulation has 60% more total emissions benefit). This is not a small difference in the same time frame. Given that Lyft has volunteered to strive for 100% eVMT during the regulation period, staff only need to account for future incentives, infrastructure, and market uncertainties in setting the GHG and eVMT targets. The proposed regulation already takes these uncertainties, along with protections for low- to medium-income TNC drivers into account.

G. TECHNICAL APPENDIX

Percent eVMT Cost Model

Cost Model Overview

This section will describe the basic structure of the eVMT cost model and the logic in how it selects TNC vehicles to switch to ZEVs. The section will include details of the varying input assumptions to the cost model, and example outcomes.

The economic assumptions of the Cost Model govern how the model makes use of the input values. To begin with, a TNC vehicle population is constructed in a simulation for each year of the regulation. Specifically, the actual TNC 2018 base year fleet is sampled with replacement. This means that vehicles from the 2018 base year TNC fleet are randomly selected to represent future TNC fleet vehicles, and vehicles already selected could potentially be selected more than once in the case where future TNC fleets are assumed to grow in scale. Future year TNC fleets inherit the same vehicle age and VMT distributions given the model assumes driver behavior will be approximately the same. However, for the purposes of the BAU scenario, electric vehicle populations in California scale at the same rate as the EMFAC2017 projected ZEV growth.[102] Additionally, future vehicle fuel efficiency values are adjusted to reflect new vehicles in compliance with the light-duty vehicle regulations.[103]

An illustrative example of a projected vehicle is shown in Table 44. In this example, a one-year old model-year 2017 gasoline passenger car is sampled from the 2018 base year TNC fleet. The vehicle has 31 miles per gallon fuel efficiency and travels 6,000 miles in that year performing TNC services. This same vehicle is used to represent a model-year 2022 vehicle for the 2023 TNC fleet. All assumptions are the same, except that the efficiency of the vehicle is adjusted to reflect a later model year vehicle, which now achieves 40 miles per gallon.

The Cost Model has a typical economic structure relying on cost based purchase decisions. As applied in this analysis, TNC drivers with the lowest net cost to switch to a ZEV do so first. For example, the model assumes a perfect market or that drivers can liquidate vehicles at market rate and purchase vehicles at market rate. Additionally, the model assumes that TNC drivers make vehicle purchasing decisions rationally strictly based on economic factors. Thus, those who can best switch to a ZEV do so first, and those who would benefit little, do not switch.

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[102] CARB LEV III Program. https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/lev-program/low-emission-vehicle-lev-iii-program

[103] Ibid.

Table 44: Example Projected Vehicle for the TNC Fleet in 2023

Example	In 2018	In 2023
Model Year	2017	2022
Vehicle Age	1	1
Vehicle Type	Passenger car	Passenger car
Efficiency	31 mpg	40 mpg
Technology	ICE	ICE
VMT per year	6,000 mi	6,000 mi

A number of operation cost factors are included. Fuel expenditures are estimated based on the actual number of miles driven, for each driver, in 2018, and are dependent on the improving vehicle efficiency in future model years. Individual vehicle efficiency assumptions used in the model came from CARB's EMFAC 2017[104] fleet inventory projections, and vary by vehicle type, classification, and age. Gasoline fuel prices used in the cost model came from the California Energy Commission IEPR analysis.[105] Electricity charging costs are a function of DC Fast Charger and Level 2 usage and their respective retail prices. The hydrogen costs are from current retail prices in California blended with future U.S. Department of Energy targets.[106] The maintenance and insurance costs came from the ICCT study cited earlier and a UC Davis 2018 study.[107] Annual ZEV registration fees are also included in the analysis.

A number of upfront purchase cost factors are included. Incremental vehicle purchase cost estimates used in the model came from an ICCT study with CARB staff adjustments to battery cost assumptions.[108] The costs of installing a home Level 2 charger is amortized over three years (average length of equipment warranty),[109] and applied to each driver even though

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[104] CARB LEV III Program. https://ww2.arb.ca.gov/our-work/programs/advanced-clean-cars-program/lev-program/low-emission-vehicle-lev-iii-program

[105] California Energy Commission staff. 2019. Final 2019 Integrated Energy Policy Report. California Energy Commission. Publication Number: CEC-100-2019-001-CMD. https://efiling.energy.ca.gov/getdocument.aspx?tn=232922.

[106] CARB 2019 Annual Evaluation of Fuel Cell Electric Vehicle Deployment and Hydrogen Fuel Station Network Development: https://ww2.arb.ca.gov/sites/default/files/2019-07/AB8_report_2019_Final.pdf

[107] Fulton 2018 Ownership Cost Comparison of Battery Electric and NonPlugin Hybrid Vehicles

[108] Lutsey and Nicholas 2019 Update on Electric Vehicle Costs in the United States Through 2030.

[109] ChargeHub. How to Choose the Right Home Charging Station. Accessed June 3, 2020. https://chargehub.com/en/how-to-choose-home-charging-station.html

many drivers may not have a place to charge at home.[110] This assumption is included to be cautious without knowing which specific TNC ZEV drivers in the fleet would be able to install a home charger. ZEV purchase incentive values used in the model begin with current state incentive values[111], and then adjust downwards to synchronize with future incremental vehicle costs. Other model inputs include the depreciation schedule for used electric vehicles.

An example cost model input value is illustrated in Figure 31. Incremental vehicle costs for 250-mile range battery electric passenger cars are shown.[112] Light duty truck assumptions are also in the cost model but that vehicle classification only represents 20% of the TNC 2018 base year fleet, and therefore has less of an effect on the model results. The Incremental vehicle cost is the additional cost of purchasing a BEV instead of a gasoline powered passenger car. The figure shows that incremental passenger car costs start at almost $14,000 in 2018 and decline to cost parity before 2029. At the beginning of the regulation in 2023, average incremental passenger car costs are approximately $3,600.

These cost projections are validated by estimations from industry, and may be conservative as several vehicle manufacturers predict BEV cost parity earlier than 2029 for certain vehicle classifications and battery sizes.[113] BloombergNEF estimates cost parity in the U.S. for small and medium size passenger vehicles in 2024, and large size passenger vehicles or SUVs in 2022.[114] At this time, the cost model switches drivers to BEVs but not FCEVs given the higher projected hydrogen fuel and vehicle capital costs. However, fuel cell vehicles do exist in the model in that FCEVs are already in the 2018 base year TNC population and are thus propagated forward in the BAU scenario.

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[110] Sanguinetti and Kurani UCD 2020 Characteristics and Experiences of Ride-Hailing Drivers with Plug-in Electric Vehicles

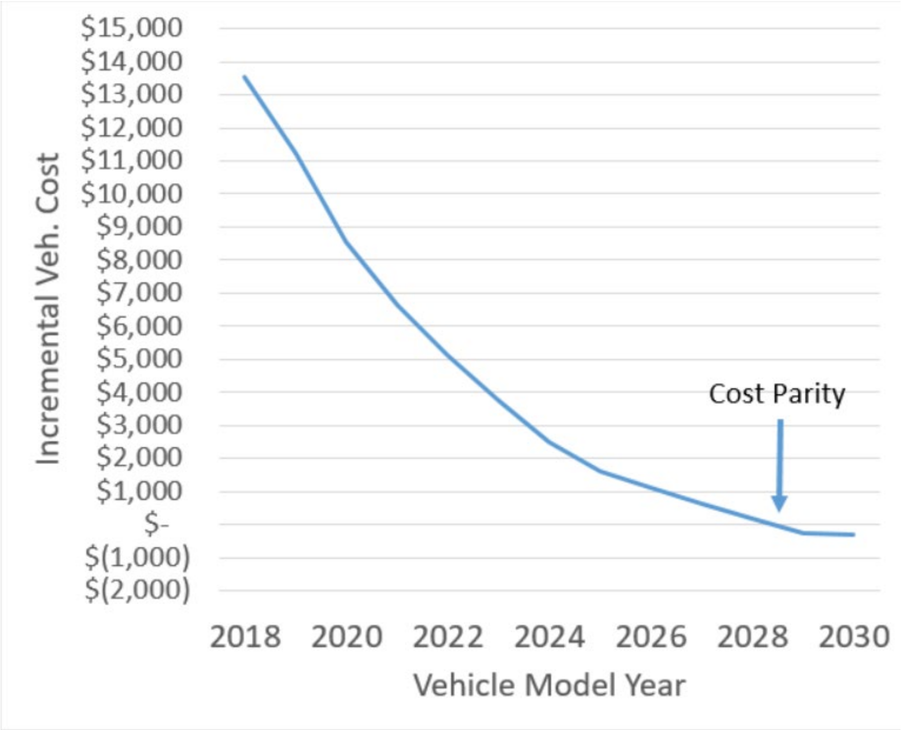
[111] https://cleanvehiclerebate.org/eng/eligible-vehicles, accessed 6/5/20

[112] Lutsey and Nicholas 2019 Update on Electric Vehicle Costs in the United States Through 2030 with CARB Staff Adjustments

[113] https://cleantechnica.com/2019/08/09/ev-price-parity-coming-soon-claims-vw-executive/, accessed 6/8/20; https://www.thedetroitbureau.com/2019/06/evs-will-reach-cost-parity-with-gas-cars-sooner-than-people-think-says-gms-reuss/, accessed 6/8/20.

[114] BloombergNEF 2020 Electric Vehicle Outlook 2020; EIPR Docket Number 20-IEPR-02, Presentation by Nick Albanese of BloombergNEF, submitted 6/9/20.

Figure 30: Incremental Vehicle Cost Projections for BEVs Example of 250 Mile Passenger Cars



The model assumed drivers face additional inconvenience or barriers to ZEV costs of $27.50/week in 2023 and reducing linearly to $10/week in 2030.[115] This cost is intended to reflect the gradual reduction in barriers for acquiring and operating a ZEV. Barriers to operating a ZEV for a TNC driver could include time waiting for the vehicle to charge, driving further than a gas station to find a charger, having to not accept a fare or passenger due to not enough battery charge at the time. All of these barriers are mitigated by longer-range vehicles and a more ubiquitous and available charger network, which is expected in the future.

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[115] An Uber study in 2017 in London estimated that BEV drivers, most having short range vehicles, would require an additional 10 hours a week of driving to equate the additional logistics and demands of BEV driving for a TNC as compared to an ICE driver: Lewis-Jones and Roberts 2017 Electric Private Hire Vehicles in London; On the road, here and now, *Uber*. Additionally, charging speeds were Level 2 or Level 1 60% of the time and DC Fast Charger at 50kW 40% of the time. As most of this time was for charging time, by 2023 standards of likely 150kW charge rates most of the time, in combination with vehicles that have typically four times the range, 10 hours is reduced to 1.5 (10hrs/wk * (40% * 50kW + 25% * 1.4kW + 35% * 7kW)/150 kW = 1.52 hours/week. As newer ZEVs need to charge one-third as many times to get the same range, added flexibility of charging such as opportunistic charging reduces the number of extra hours per week needed even further. $35 per week translates to more than 1 to 1.5 hours of extra driving a week.

Percent eVMT Cost Model Input Values

Home Charging Electricity Rate

Home charging electricity prices are reflective of a combination of existing and forecasted residential electricity rates in California and of electric vehicle specific time-of-use rates using the three largest investor owned electric utilities in California as a surrogate. This mixing accounts for lower enrollment in EV specific rates in the earlier years of the regulation and accounts for drivers that are not able to take advantage of optimal off-peak rates.

The CEC's IEPR documents forecasted electricity prices for statewide residential rates. The CEC's 2018 *Revised Transportation Energy Demand Forecast* indicates that projected residential electricity prices for light-duty transportation in a mid-case scenario will maintain at about $0.19 per kWh through 2030.[116] This projected rate assumes no change in charging behavior, special tariffs for EV customers, or time-of-use rates. For this analysis, an IEPR residential rate of $0.19 per kWh through 2030 is mixed in with other applicable EV-specific residential rates over the regulation period to determine the actual home charging electricity price in the model.

To account for the impact of specific EV tariffs and a transition to default time-of-use (TOU) rates, current EV-specific or TOU rates offered by the large investor-owned utilities in California were used to establish both a baseline rate and a more optimal EV rate. The following rates were used as a California surrogate to determine the EV-specific rates: EV2-A from Pacific Gas & Electric,[117] TOU-D-PRIME from Southern California Edison,[118] and EV-TOU-2 from San Diego Gas and Electric.[119] Using each of these rates, the hours per day and per year available at each pricing tier were applied, resulting in a baseline EV-TOU rate statewide of $0.213 per kWh. This assumes that drivers are on the rate, but do not make any behavioral changes to charge at more price optimal times of the day. To account for these behavioral changes, a more optimal rate was also determined by assuming that drivers are able to charge primarily at times that are not on-peak. In this case, only 5% of the charging is assumed to be on-peak, while 95% is either during off-peak or partial peak times. The optimal EV-TOU rate statewide is $0.096 per kWh.

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[116] Bahrenian, Aniss, Jesse Gage, Sudhakar Konala, Bob McBride, Mark Palmere, Charles Smith, and Ysbrand van der Werf. 2018. *Revised Transportation Energy Demand Forecast, 2018-2030*. California Energy Commission. Publication Number: CEC-200-2018-003. Figure 4-18. https://efiling.energy.ca.gov/GetDocument.aspx?tn=223241.

[117] Pacific Gas & Electric. Exploring EV Fundamentals. Retrieved December 03, 2019. https://www.pge.com/en_US/residential/solar-and-vehicles/options/clean-vehicles/electric/explore-ev-fundamentals.page.

[118] Southern California Edison. Time-of-Use Rate: TOU-D-PRIME. 2019. https://www.sce.com/sites/default/files/inline-files/TOU-D-PRIME%20Fact%20Sheet_WCAG%20(1).pdf

[119] San Diego Gas & Electric. Schedule EV-TOU-2. 2019. http://regarchive.sdge.com/tm2/pdf/ELEC_ELEC-SCHEDS_EV-TOU-2_2019.pdf

The three potential rates to apply to home charging – the IEPR general residential rate of $0.19 per kWh, the baseline EV-TOU rate of $0.213 per kWh, and the optimal EV-TOU rate of $0.096 per kWh – were then mixed together over time to determine the singular home charging price in the model. This mixing assumes that drivers will transition to TOU rates and behave more optimally in response to price signals. The IEPR residential rate accounts for 55% of the EV drivers in 2023 and reduces to 20% in 2030. In contrast, the optimal EV-TOU rate is assumed to be 35% in 2023 and 70% in 2030. Meanwhile, the baseline EV-TOU rate accounts for 10% of the home charging rate. This mixing and the resultant overall statewide home charging rates for electricity applied in the model is shown in Table 45.

Table 45: Statewide EV Home Charging Rate Assumptions

	Rate ($/kWh)	Calendar Year							
		2023	2024	2025	2026	2027	2028	2029	2030
Baseline EV-TOU	0.213	10%	10%	10%	10%	10%	10%	10%	10%
Optimal EV-TOU	0.096	35%	40%	45%	50%	55%	60%	65%	70%
IEPR Residential	0.19	55%	50%	45%	40%	35%	30%	25%	20%
Statewide Home Charging Rate ($/kWh)		$0.16	$0.15	$0.15	$0.15	$0.14	$0.14	$0.13	$0.13

Overall, home charging rates are assumed to be applied consistently across the state, with a slight decrease in prices over the regulation calendar years from $0.16 per kWh in 2023 to $0.13 per kWh in 2030. Residential electricity prices from home charging used in total cost of ownership modeling by the ICCT researchers also indicates that $0.13-$0.14 per kWh is reasonable through the 2030 time period given TOU pricing.[120] Home charging electricity prices used in the model align with current research, while accounting for lower enrollment in EV-specific rates and less optimal price-based decisions in earlier years of the regulation.

Level 2 Home Charging Station Cost

Plug-in electric vehicles require charging, which can take place at home using conventional household plugs or by using upgraded equipment. Level 1 charging uses a standard 120-volt outlet, (e.g., a typical wall outlet), and a charging cord set provided with most plug-in electric vehicles at the time of vehicle purchase. Level 2 charging is faster than Level 1, with a variety of power outputs from 16 to 40 amps at 240-volts. The higher power output results in faster

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[120] Pavlenko, N., Slowik, P., Lutsey, N. When does electrifying shared mobility make economic sense? The International Council on Clean Transportation. January 2019. https://theicct.org/sites/default/files/publications/Electric_shared_mobility_20190114.pdf

charging, with 14 to 35 miles of electric range provided per hour of charging. Level 2 chargers are therefore common solutions for residential, commercial, and workplace settings.[121] To ensure vehicles are sufficiently refueled during off-shift hours from TNC service, it is assumed that all drivers will purchase and install Level 2 charging equipment.

The overall project cost of a residential Level 2 charging station (including installation) varies significantly due to site-specific factors, such as the existing home electric panel capacity, installation location, and regional labor costs, as well as personal decisions, such as the electric vehicle supply equipment (EVSE) purchased and the type of mounting of the EVSE. Residential Level 2 BEV charging stations according to Fixr, a resource on home project costs and contractors, cost a national average of $1,200.[122] This includes a Level 2 EVSE, the necessary 240-volt outlet, and wall-mounted installation. The installation cost itself typically ranges from $420 to $800 on average.[123] Other home project sources indicate that residential Level 2 EVSE installation may cost around $720,[124] while a recent utility program review suggests residential installation costs closer to $1,200 on average.[125]

Similar to the variability in the installation costs, Level 2 EVSE for residential use available on the market today have a variety of different features and power ratings resulting in purchase price variability. Given a lack of market data on individual purchase decisions relative to networked (wireless communication) versus non-networked EVSE, both types of EVSE units are assumed available to drivers based on individual purchase decisions. Recent pricing data from PlugStar's online inventory of Level 2 EVSE indicates that costs range from $300 for a basic unit to $1,100 for an EVSE with many features.[126]

After evaluating cost information and recognizing that home installation and Level 2 EVSE costs are highly variable by household, the Level 2 residential EVSE costs (including installation) were assumed to be about $1,500 on average in 2020. As done in other modeling efforts, a technology cost improvement factor was applied over the regulation period resulting in an approximate 2.1% - 2.6% cost reduction per year.[127] It is anticipated that EVSE purchase costs decrease over time with increased market competition and higher production volumes; however, installation costs may increase or decrease depending on labor and

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[121] CALeVIP. Electric Vehicle Charging 101. Accessed June 2, 2020 at https://calevip.org/electric-vehicle-charging-101.

[122] Fixr. Home Electric Vehicle Charging Station Cost. Accessed May 27, 2020. https://www.fixr.com/costs/home-electric-vehicle-charging-station.

[123] Ibid.

[124] HomeAdvisor. Electric Car Charging Station Installation Cost. Accessed June 3, 2020. https://www.homeadvisor.com/cosUgarages/install-an-electric-vehicle-charging-station/#calc

[125] Avista Corporation. Electric Vehicle Supply Equipment Pilot Final Report. Submitted to the Washington Utilities and Transportation Commission, October 18, 2019. https://www.myavista.com/-/media/myavista/content-documents/energy-savings/electricvehiclesupplyequipmentpilotfinalreport.pdf?la=en.

[126] PlugStar Shopping Assistant. Level 2 Home Chargers. Accessed June 3, 2020. https://plugstar.com/chargers.

[127] Avista, 2019.

material costs and building code improvements that may reduce overall project costs. The resulting home EVSE total project costs assumed over the regulation period are provided in Table 46.

Table 46: Residential Level 2 EVSE Cost Assumptions

Year	2023	2024	2025	2026	2027	2028	2029	2030
Residential Level 2 Cost	$1,408	$1,376	$1,344	$1,312	$1,280	$1,248	$1,216	$1,184

Using the residential Level 2 costs as shown in Table 46, an assumed amortization of 3 years is then applied with a 5% interest rate. Based on research of available Level 2 EVSE warranties from the inventory listed on the PlugStar website and as noted by electric vehicle information site ChargeHub, the typical warranty period of residential Level 2 EVSEs available on the market today is about 3 years, with a range from 1 year to 5 years.[128] The amortization period is therefore aligned with the average warranty period to ensure that equipment is useable for drivers. The short amortization period and assumption that this charging equipment is not also used for personal benefit ensures that the cost of home charging equipment is not devalued in the model, recognizing that drivers may have to make this investment upfront and will likely need to recover costs relatively quickly.

DC Fast Charger Equipment Cost

DC fast charging is the fastest charging option for plug-in electric vehicles, where a vehicle with a 100 mile range can obtain a full charge in approximately 30 minutes.[129] New DC fast chargers (DCFCs) capable of charging at even faster rates (with 150-350 kilowatts of power) are continuing to be installed and will significantly reduce charging times. DC fast chargers are used along major travel corridors and in urban environments where slower charging and overnight charging opportunities are less convenient.

Several efforts are underway to support the installation of DC fast chargers to meet the demand for BEVs statewide. Near-term DC fast charger targets are illustrated by Executive Order B-48-18, which set a target to install 10,000 DC fast chargers in California by 2025.[130] Funding and investment programs, including the CEC's Clean Transportation Program,[131]

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[128] ChargeHub. How to Choose the Right Home Charging Station. Accessed June 3, 2020. https://chargehub.com/en/how-to-choose-home-charging-station.html

[129] CALeVIP. Electric Vehicle Charging 101. Accessed June 2, 2020 at https://calevip.org/electric-vehicle-charging-101.

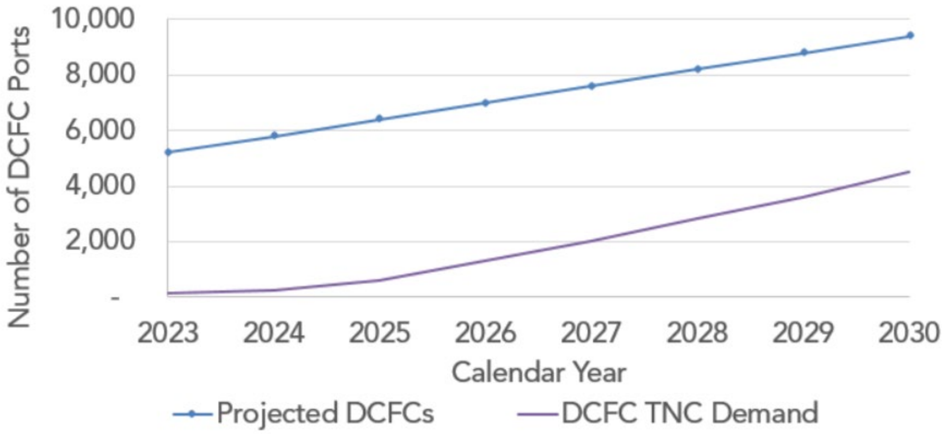
[130] Governor Brown, E. G. (2018, January 26). Executive Order B-48-18. Retrieved from https://www.ca.gov/archive/gov39/2018/01/26/governor-brown-takes-action-to-increase-zero-emission-vehicles-fund-new-climate-investments/index.html.

[131] Brecht, Patrick. 2020. 2020-2023 Investment Plan Update for the Clean Transportation Program. California Energy Commission. Publication Number: CEC-600-2020-001-SD. https://efiling.energy.ca.gov/getdocument.aspx?tn=232280

CARB's Low Carbon Fuel Standard DC Fast Charging Infrastructure Pathway,[132] Electrify America investments,[133] and electric utility investments,[134] are aimed at helping California reach this goal. Based on these and similar programs to accelerate the deployment of charging infrastructure in the state, combined with private investments, it is likely that DC fast charging ports deployed will exceed projections that are based solely on historical data.

To apply a baseline methodology, however, in projecting the number of public DC fast charging ports in the state over the regulation period, a linear historical deployment trajectory is used. This assumes that roughly 600 public DC fast charging ports will be deployed annually over the regulation period. The resulting projection aligns with similar estimates of likely DC fast charging ports in California by 2025 without additional measures to accelerate deployment.[135] The number of estimated public DC fast charging ports available based on a low or historical deployment is shown in Figure 31.

Figure 31: DC Fast Charging Port Deployment Projections and Estimates of TNC Driver DC Fast Charging Port Demand



Public DC fast charging is important for facilitating the use of electric vehicles in TNC service. Additionally, BEVs used for TNC service provide an opportunity to enhance the business case for DC fast chargers, as drivers are likely to increase the utilization of stations. While work is

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[132] California Air Resources Board. Low Carbon Fuel Standard. January, 2019. https://www.arb.ca.gov/regact/2018/lcfs18/frolcfs.pdf?_ga=2.231122911.1326245745.1591231160-1965078090.1582755576

[133] Electrify America, 2018. California ZEV Investment Plan: Cycle 2. https://elam-cms-assets.s3.amazonaws.com/inline-files/Cycle%202%20California%20ZEV%20Investment%20Plan.pdf

[134] Pacific Gas & Electric. EV Fast Charge. 2019. https://www.pge.com/pge_global/common/pdfs/solar-and-vehicles/your-options/clean-vehicles/charging-stations/ev-fleet-program/ev-fast-charge/ev-fast-charge-fs.pdf.

[135] Brecht, 2020.

underway to assess TNC demand for DC fast chargers by research under contract with the CEC,[136] existing research and methodologies are used to estimate the potential DC fast charging needs of TNC battery electric vehicle drivers.

Research from the ICCT suggests that the number of DC fast charge points needed to support TNC electrification varies significantly by the number of hours TNC drivers use a charge point.[137] Higher utilization of a given charge point will result in fewer overall charge points needed; however, the highest utilization scenarios also likely need to be dedicated TNC DC fast charging stations to achieve the utilization assumption. To account for other public use of this charging infrastructure in a shared environment, a 6-hour TNC utilization is assumed at DC fast chargers for this analysis. This allows for an additional 3.5 to 4 hours of utilization from non-TNC electric vehicles, as reports by EVgo Services indicate that fast charger congestion may occur at about 40% utilization (or 9.6 hours of utilization).[138] While dedicated TNC DC fast charging ports may be deployed, here it is assumed that TNC drivers can use existing and future public charging ports.

Using a function derived from ICCT researcher ratios reported for the number of DC fast chargers needed per TNC BEV at a 6-hour utilization,[139] additional adjustments are made in this analysis to account for modeling assumptions and eVMT model outputs. These adjustments include: the number of BEVs associated with the percent eVMT target in each year, the average annual mileage of those BEVs, and year-by-year assumptions on the percent of residential charging used. One factor that contributes significantly to the demand for DC fast chargers is the availability of overnight or home charging and other public Level 2 charging, such as at workplaces. Since a large portion of current TNC drivers are not working full-time, it is possible that the slower charging speeds of public Level 2 chargers would be sufficient for refueling; however, to simplify charging scenarios, it is assumed that only residential and DC fast charging is used. Adjustments to the number of DC fast charger ports needed account for overnight charging assumptions as described in *Projected Percent of TNC Driver Charging Done at Home, Public or Workplace L2 Chargers, or Public DC Fast Chargers*. Adjustments to the number of ZEVs in each calendar year and their annual mileage account for cost model-specific outputs as shown in Table 47.

Results of this DC fast charging port assessment are shown in Table 47. Assuming that TNC drivers can utilize public DC fast chargers about 60% of the time, the demand added is likely

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[136] California Energy Commission. Business Meeting Agenda. July, 2019. https://www.energy.ca.gov/sites/default/files/2020-01/2019-07-15_agenda_revised_ada.pdf

[137] Slowik, P., Wappelhorst, S., Lutsey, N. How Can Taxes And Fees On Ride-Hailing Fleets Steer Them To Electrify? September, 2019. https://theicct.org/sites/default/files/publications/EV_TNC_ridehailing_wp_20190919.pdf.

[138] EVgo Services LLC. 2018 Annual Report: Electric Vehicle Charging Station Project (Public Facing Version). Settlement Year 6 Progress Report to California Public Utilities Commission. March, 2019. https://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442461480.

[139] Slowik, 2019.

capable of being met by existing and anticipated infrastructure. DC fast charger costs are only accounted for in a cost per kWh charged to TNC BEV drivers.

Table 47: DC Fast Chargers to Support TNC Electric Vehicles and Percent eVMT Targets

Year	Number of TNC ZEVs	Average Annual Miles per ZEV	DC Fast Charger Demand
2023	10,504	11,060	120
2024	15,466	15,752	269
2025	23,905	20,641	578
2026	45,795	23,482	1,331
2027	71,888	22,921	2,039
2028	133,178	17,366	2,862
2029	168,267	17,360	3,614
2030	257,485	14,189	4,521

Direct Current Fast Charging Refueling Price

Due to higher capital and operating costs, DC fast charging rates are typically more expensive than residential or public Level 2 charging rates. Additionally, electric vehicle service providers (EVSPs) or site hosts operating the DC fast chargers set the prices for charging, and therefore prices of electricity service to the site cannot be used solely for establishing these refueling prices.

DC fast charging prices used in the model are based on recent data of DC fast charging prices as provided by the U.S. Department of Energy's (DOE) Alternative Fuels Data Center (AFDC) and are projected based on research indicating a decrease in these refueling prices.[140] The AFDC database details the total number DC fast charging stations currently installed in California for public use, and provides public downloads of this infrastructure data, including a data field on charger pricing or the price charged to consumers.[141] Based on data from the end of 2019, staff analysis indicates a statewide average of $0.41 per kWh for DC fast

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[140] U.S. Department of Energy. Alternative Fuels Data Center: Electric Vehicle Charging Stations. Accessed June 3, 2020. https://afdc.energy.gov/fuels/electricity_stations.html

[141] U.S. Department of Energy. Alternative Fuels Data Center: Electric Vehicle Charging Station Locations. Accessed June 3, 2020. https://afdc.energy.gov/fuels/electricity_locations.html#/analyze

charging.[142] Similar values are used in total cost of ownership models by the ICCT researchers.[143]

The 2019 DC fast charging price of $0.41 per kWh is used in the initial year, with subsequent years showing decreased prices to eventually reach $0.24 per kWh in 2026. CARB staff used a linear interpolation between 2019 and 2026 to align with similar ICCT research indicating that a rate of $0.24 per kWh may be possible in the 2025 timeframe.[144] Decreased DC fast charging prices in future years are likely due to increases in charger utilization and reduced costs of non-hardware components such as site preparation, grid upgrades, and installation costs. After reaching the $0.24 per kWh price point in 2026, this rate is assumed to remain the same through 2030. The resultant calendar year DC fast charging prices assumed over the regulation period are shown in Table 48.

Table 48: DC Fast Charging Price Assumptions

Year	2023	2024	2025	2026	2027	2028	2029	2030
DCFC Rate ($/kWh)	$0.31	$0.29	$0.26	$0.24	$0.24	$0.24	$0.24	$0.24

Gasoline Prices

Gasoline prices for conventionally fueled vehicles from the years 2023 to 2030 rely on the CEC's 2019 IEPR fuel price forecast.[145] The CEC forecasts gasoline fuel price cases based on price trends to develop California-specific fuel price forecasts. The mid-case gasoline prices (in 2018 dollars per gallon) are directly used in the model with no modifications. The gasoline prices are depicted in Table 49.

Table 49: Gasoline Fuel Price Assumptions

Year	2023	2024	2025	2026	2027	2028	2029	2030
Gasoline Price ($/gal)	$3.20	$3.22	$3.23	$3.23	$3.26	$3.25	$3.30	$3.27

The costs of gasoline and electricity displayed above includes fuel taxes. Assumed state and local taxes on gasoline and electricity are listed in Table 50.

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[142] U.S. Department of Energy. Alternative Fuels Data Center: Electric Vehicle Charging Station Locations Advanced Filter, Download Results. Accessed December 6, 2019.

[143] Pavlenko, N., Slowik, P., Lutsey, N. When does electrifying shared mobility make economic sense? The International Council on Clean Transportation. January 2019. https://theicct.org/sites/default/files/publications/Electric_shared_mobility_20190114.pdf

[144] Ibid.

[145] California Energy Commission staff. 2019. Final 2019 Integrated Energy Policy Report. California Energy Commission. Publication Number: CEC-100-2019-001-CMD. https://efiling.energy.ca.gov/getdocument.aspx?tn=232922.

Table 50: State and Local Taxes on Gasoline and Electricity

Fuel Type	Local Tax	State Tax
Gasoline	2.25% sales tax	$0.493/gal excise tax
Electricity	3.53% utility users tax*	$0.0003/kWh

*Statewide population-weighted average

Proportion of BEV Charging using Varying Types of Chargers

The Cost Model for switching TNC drivers to ZEVs assumes a given percentage of the drivers use home charging, DC fast charging, and Level 2 home/workplace or Level 2 public chargers for each year of the regulation. For 2018, the assumed percentage of each is 50%, 50%, and 0% respectively as a UC Davis study estimated that 58% of TNC BEV and PHEV drivers charge at home.[146] These values quickly change to 10%, 90%, and 0% respectively, and flat line with these values to 2030. As costs are favorable for drivers who can charge at home, these changes are designed to be conservative. Although there is some evidence that public or workplace L2 charging may be a viable option for TNC drivers, there is no supporting data for this assertion and so the assumed percent remains at 0%. In recent survey research, over half (54%) of PEV TNC drivers who do not charge at home indicated they *cannot* charge at home, whereas 39% said that they could.[147] Less than half of survey respondents in the UCLA study had a 120v outlet available at their parking spot. This study further found that the average income of a TNC driver is $35-50k, and that more than half rent their housing (not likely to have L2 home charging access).[148]

Incremental Vehicle Costs

The additional costs of purchasing a BEV above and beyond the costs of purchasing an equivalent ICE are the incremental vehicle costs. Values of these costs were projected for each year of the regulation for passenger cars and light-duty trucks. Projected values used in the percent eVMT cost model were first obtained from an ICCT Study,[149] and then adjusted by CARB staff. The ICCT BEV battery costs were revised upward by roughly 7% in 2017 ($200/kWh), 25% in 2025 ($125/kWh), 40% in 2030 ($100/kWh) to represent a more conservative battery cost reduction trajectory. CARB staff then linearly interpolated costs between those years and used the negative growth rate from 2025 to 2030. When included

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[146] Sanguinetti and Kurani 2020 Characteristics and Experiences of Ride-Hailing Drivers with Plug-in Electric Vehicles. Institute of Transportation Studies, University of California at Davis. https://escholarship.org/uc/item/1203t5fj Accessed 20200406.

[147] Ibid.

[148] Rajagopal and Yang UCLA 2020 Electric Vehicles in Ridehailing Applications: Insights from a Fall 2019 Survey of Lyft and Uber Drivers in Los Angles

[149] Lutsey and Nicholas 2019 Update on Electric Vehicle Costs in the United States Through 2030 with CARB Staff Adjustments

in the full electric vehicle cost estimates, the actual incremental capital costs for BEVs used in the eVMT Cost Model appear in Figure 30.

Used Vehicle Depreciation Scale

In order to estimate the incremental cost of used BEVs, a depreciation scale was used that specifies the relative value of the used vehicle based on the vehicle age, ranging from 0 to 15 years of age. For years 0 to 5, Edmunds depreciation values were used.[150] For years 6 to 15, a simple 15% value loss was applied to each year. The actual values used in the eVMT Cost Model are shown in Table 51.

Table 51: Used Vehicle Depreciation Scale

Veh. Age (yrs.)	Depreciation %
0	89.0
1	75.7
2	64.3
3	54.7
4	46.5
5	39.5
6	33.6
7	28.5
8	24.3
9	20.6
10	17.5
11	14.9
12	12.7
13	10.8
14	9.1
15	7.8

The incremental used ZEV purchase costs were estimated by depreciating the new vehicle costs, after having subtracted any vehicle rebate amounts. Thus, this method assumes that any savings from rebates that a new vehicle purchaser benefits from are passed on to the used buyer but in proportionately a smaller amount. The depreciation scale used is described in the prior section on eVMT Cost Model Input Values.

Vehicle Fuel Efficiency

The vehicle fuel economy values are specific to vehicle size classification, vehicle age, and technology type. The values assumed and how they were determined are explained in the Emissions Rates Sub-Section of the Baseline Information Section.

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[150] https://www.edmunds.com/car-buying/how-fast-does-my-new-car-lose-value-infographic.html, accessed 12/5/2019

Vehicle Incentives

There are two California vehicle incentives in the eVMT Cost Model: an LCFS point of purchase rebate for future BEV owners,[151] and the CVRP[152] rebate for purchases for new ZEVs. The federal tax benefit for BEVs is not applied to the eVMT Cost Model given several prominent automakers no longer qualify with potentially more automakers hitting the federal cap between 2023 or 2030.[153] For all years of the regulation, a $1,000 Clean Fuel Reward point of purchase LCFS rebate was applied to each new vehicle. This value is estimated using a weighted average of previous LCFS rebate amounts offered by the three largest investor owned utilities in California.[154,155,156] The CVRP rebate amount for a typical BEV in 2020 is $2,000.[157] For future years in the cost model, the CVRP amount was slowly reduced in increments of $500 over time so that it becomes zero at the same point at which the incremental vehicle costs also becomes zero (CVRP amount for 2023 is $1,500). This assumption was made to avoid some used ZEVs costing more than new ones in certain situations, and is an assumption only used for the eVMT Cost Model and in no way implies what the actual rebate amounts for the CVRP will be in future years.

Incremental Cost of Insurance

The main factor that influences vehicle insurance costs, after a baseline for liability, is the value of the vehicle insured. Thus, incremental insurance costs for a BEV over that of an ICE were estimated as 5% of the incremental capital costs.[158]

Incremental Cost of Maintenance

The incremental cost of maintenance for a BEV from a conventional gasoline vehicle is a negative value (a savings). An ICCT study[159] estimates the maintenance costs for gasoline and

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[151] https://ww3.arb.ca.gov/regact/2019/lcfs2019/fro.pdf.

[152] https://cleanvehiclerebate.org/eng/eligible-vehicles, accessed 6/5/20.

[153] https://www.irs.gov/newsroom/plug-in-electric-vehicle-manufacturer-crosses-200000-sold-threshold-tax-credit-for-eligible-consumers-begins-phase-down-on-april-1, accessed 6/19/20

[154] https://www.pge.com/en_US/residential/solar-and-vehicles/options/clean-vehicles/electric/clean-fuel-rebate-for-electric-vehicles.page, accessed 12/10/19

[155] https://www.sce.com/residential/electric-vehicles/ev-rebates-incentives/cfrp, Accessed 12/10/19

[156] https://www.sdge.com/residential/electric-vehicles/electric-vehicle-climate-credit, accessed 12/10/19

[157] https://cleanvehiclerebate.org/eng/eligible-vehicles, accessed 6/5/20

[158] Fulton 2018 Ownership Cost Comparison of Battery Electric and NonPlugin Hybrid Vehicles

[159] Pavlenko, Slowik, and Lutsey ICCT 2019 When Does electrifying shared mobility make economic sense?

BEVs. The savings are approximately \$0.035/mi or 3.5 cents per mile, which was used in the eVMT Cost Model for both vehicle types and for all years of the regulation.

California ZEV Registration Fee

In the State of California, as established by SB 1 (2017), each ZEV must pay an additional \$100 per year in vehicle registration fees (except in the first year the vehicle was purchased) to replace the lost revenue from not contributing to gasoline taxes.[160], [161] Thus, each TNC driver who switched to a ZEV also is assumed to pay an additional \$100 per year.

Percent eVMT Cost Model Rental Costs

The eVMT cost model used for the analysis in setting the proposed targets relied on a driver purchase economic model, as described earlier. However, CARB staff additionally evaluated the short-term (weekly) TNC BEV rental business model. Costs for Lyft rentals in the City of Denver were used as data as they rented to TNC drivers only and had different rates for each of the vehicle technology types.

Shown below are the rental prices that do not include taxes or fees:[162]

Midsize conventional vehicle (ICE)
\$179/week, 250 weekly personal miles
\$209/week, 350 weekly personal miles
No unlimited personal miles plan

Hybrid electric vehicle (no plug)
\$199/week, 250 weekly personal miles
\$229/week, 350 weekly personal miles
\$299/week, unlimited weekly personal miles

Battery Electric Vehicles (BEVs)
\$229/week, 250 weekly personal miles
\$259/week, 350 weekly personal miles
\$329/week, unlimited personal miles

From these rental rates in Colorado, a 10% upward adjustment was applied for the additional cost of doing business in California, where there are increased costs for permitting and new

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[160] https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=VEH&sectionNum=9250.6., accessed 6/5/20.

[161] SB 1 version 5/1/17: https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1.

[162] https://www.lyftcolorado.com/flexdrive (accessed 6/3/20)

business startup costs. An additional 14% was applied for estimated taxes and fees.[163] Together, these represent a 25.4% increase above the prices in Colorado for a total of approximately $325/week for a BEV. Note that the BEV rental rates all include unlimited free DC fast charger access for fueling, so if the eVMT cost model were to account for this rental business structure, the electricity prices would have been adjusted accordingly.

Percent eVMT Cost Model Methodology and Assumptions

This section elaborates on how the model functions and how it manages the input assumptions.

The cost model was developed based on the economic principles that the TNC driver market is perfect (drivers can liquidate vehicles at market rate, and purchase vehicles at market rate at will), and that drivers could be encouraged to make decisions based on economics. Thus, the first in the model to switch to a ZEV are those drivers who would benefit the most: drivers generally with the least fuel efficient vehicles and the highest mileage on TNC services. Under the proposed electrification targets, any particular driver who is switched to a ZEV, with his or her annual weeks of TNC service, vehicle's associated fuel economy and age, would be able to recoup at a minimum, the entire incremental vehicle capital cost of a comparable ZEV, a significant portion of home charger costs, and additional costs associated with barriers to ZEV adoption through fuel and maintenance savings within a year.

The following algorithm below describes the logic of the cost model process, making use of assumptions described further in the subsequent sub-sections.

For each given year of the regulation period, the model loops through all of the vehicles in the California TNC fleet and applies this logic:

- If individual vehicle being considered for switching is currently <u>not</u> a ZEV, then test criteria for switching to a ZEV. Switching criteria includes:
    - If vehicle has < 5,000 TNC VMT for year, then don't switch to ZEV,
    - If vehicle model year < 2016 and the vehicle full weekly cost of ZEV rental, plus extra savings to overcome ZEV barriers, minus fuel savings < 0, then switch to ZEV, otherwise do not switch to ZEV.
    - If vehicle model year > 2016 and incremental <u>upfront costs</u> of obtaining a ZEV of the same model year as the currently owned ICE (vehicle purchase, purchase incentives, Level 2 equipment purchase), and <u>operation costs</u> (fuel savings, maintenance savings, insurance savings, ZEV registration fees, plus extra savings to overcome ZEV barriers) <u>combined is < 0, then switch to ZEV,</u> otherwise do not switch to ZEV.
- If vehicle is already a ZEV, then leave it as a ZEV and associate no costs.

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[163] https://www.autoslash.com/blog-and-tips/posts/rental-car-taxes-and-fees-explained-the-fee-detective-visits-sunny-california, accessed 6/16/20 indicates 10.75% in sales tax and a tourism fee plus local sales taxes and fees is estimated at 14% overall.

Assumed Range for BEV

For the CMS regulation period of 2023 to 2030, it is assumed that a typical BEV will have a 250-mile range. For model year 2019, 44% of available ZEVs have a 250-mile range or more.[164] Examples of such electric vehicle models include: General Motors Bolt EV with 259 miles of range, Tesla Model 3 with 215 to 330 miles of range, Hyundai Kona with 258 miles of range, and the Toyota Mirai FCEV with 312 miles of range.[165] More recently, Tesla has announced a new 2020 long-range plus Model S that will get 402 miles of range on a single charge.[166] Other research supports this assumption such as the recent ICCT study that assumes 250-mile range ZEVs in 2025.[167] An electric vehicle analyst estimates that the average range of new vehicles in 2030 will be approximately 330 miles.[168] CARB staff expect that ZEVs used for TNC service, both new and used, will typically have a range of 250 miles for the period 2023 to 2030.

Ability to Provide Full TNC Service Using a ZEV

CARB staff are assuming that a ZEV with a range of 250 miles or more can provide full TNC services. In the 2018 base year data, 95% of TNC drivers traveled less than 250 miles per day, with 90% traveling less than 200 miles per day. The full distribution of average miles driven by all TNC drivers in 2018 is shown in Figure 32. These estimates are corroborated by an independent academic study that found a more conservative result where 90% of TNC driving can be done with one charge using only a 200-mile range vehicle.[169]

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[164] https://www.fueleconomy.gov/feg/pdfs/guides/FEG2020.pdf

[165] EPA vehicle fuel economy ratings: https://www.fueleconomy.gov/feg/findacar.shtml, accessed 6/20/20.

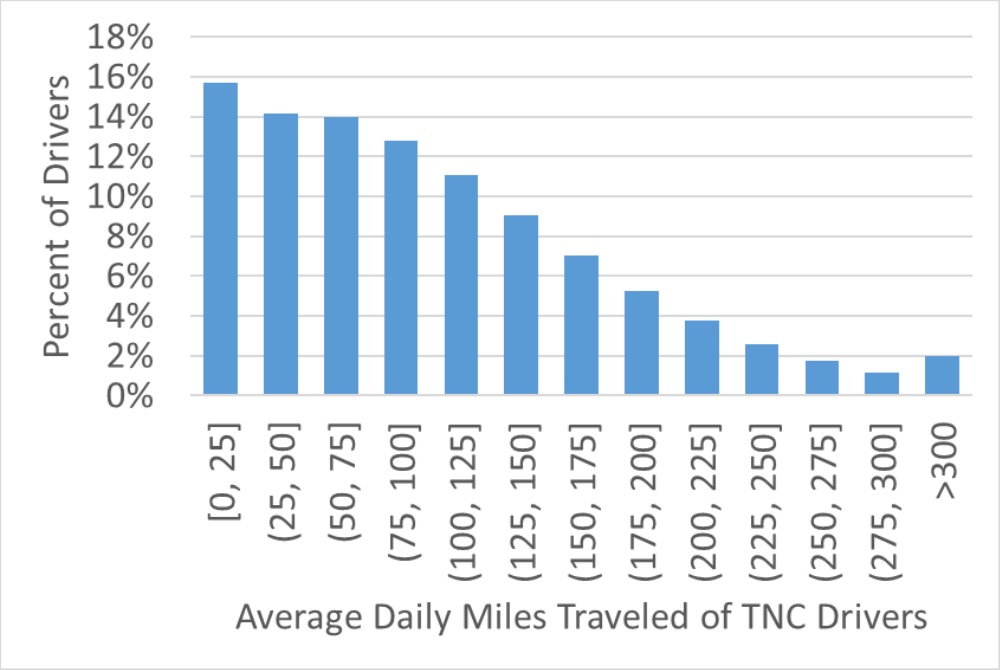
[166] https://www.greencarreports.com/news/1128506_tesla-model-s-long-range-plus-400-mile-range-an-electric-car-first, accessed 6/16/20.

[167] Pavlenko, Slowik, and Lutsey ICCT 2019 When Does electrifying shared mobility make economic sense?

[168] https://www.greencarreports.com/news/1128626_why-you-really-don-t-need-your-ev-to-go-500-miles, accessed 6/25/20.

[169] Wenzel, T., Rames, C., Kontou, E., & Henao, A. (2019). Travel and energy implications of ridesourcing services in Austin, Texas. TRR Part D, Transp. Environ., 70(2019), pp. 18-34, 10.1016/j.trd.2019.03.005

Figure 32: Average Daily Miles Traveled of TNC Drivers in 2018



Surveyed TNC drivers charged at a DC fast charger an average of 2.5 times during a shift (for drivers with prepaid charging plans).[170] This demonstrates feasibility of meaningful opportunistic charging during typical TNC service activity. Additionally, research finds TNC drivers are willing to wait for charging up to 60 minutes per day on average.[171] This indicates the total amount of time a driver is willing to spend charging during a shift indicating the amount of electricity that can be gained during a shift. If using an average of 150 kW DC fast charger, which is likely during the regulation period, then a TNC driver can cumulatively refuel approximately 150 kWh of electricity during a shift, which is enough for over 400 additional miles.[172] For those 5% of drivers who drive more than 250 miles in one day, they can easily charge throughout the day to gain an additional 400 more miles of range.

In another 2020 study, all TNC drivers who use ZEVs missed, at most, one fare in 5 charges. Of these drivers, 76% missed, at most, one fare every 10 charges, and 54% never missed a fare due to charging.[173] In later years of the regulation, these estimates will be even more favorable as current TNC ZEV drivers have shorter range vehicles and must take more time to

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[170] Jenn 2019 Emissions Benefits of Electric Vehicles in Uber and Lyft Services

[171] Rajagopal and Yang UCLA 2020 Electric Vehicles in Ridehailing Applications: Insights from a Fall 2019 Survey of Lyft and Uber Drivers in Los Angles

[172] Based on a Chevy Bolt having a 60kWh battery that can go over 200 miles on a single charge. EPA vehicle fuel economy ratings: https://www.fueleconomy.gov/feg/findacar.shtml, accessed 6/20/20.

[173] Sanguinetti and Kurani 2020 Characteristics and Experiences of Ride-Hailing Drivers with Plug-in Electric Vehicles. Institute of Transportation Studies, University of California at Davis. https://escholarship.org/uc/item/1203t5fj Accessed 20200406.

recharge. For these reasons the Cost Model assumes that the time needed to charge a BEV while providing TNC service can be done opportunistically between passenger assignments and when taking a break or meal.

However, in spite of this estimation, there may be unforeseen barriers to using a ZEV that includes having to make special arrangements to charge overnight or for a long period at least during the day. For this reason, the Cost Model assumes that each individual driver will have to earn an additional amount of money on fuel savings as compared to an ICE vehicle before they make the switch to a ZEV (see Section A, Electrification Targets (Percent eVMT) for details).

Level 2 Home Charger Costs Partial Attribution to Personal Benefit

Staff chose to attribute all of the Level 2 installation costs to the TNC drivers as compared to apportioning some of the capital costs to personal use benefits from home charging. This simplifies the issue of cost attribution for various lengths of driver turnover, which are difficult to characterize, as well as the challenges of determining which drivers already had a BEV and which bought a BEV primarily to drive for a TNC.

5,000 Annual Miles Traveled Minimum for Switching to ZEV

CARB staff determined that TNC drivers who travel a small number of annual miles per year may not be able to rationalize switching to a ZEV. For context, a full-time TNC driver typically drives 40,000 miles per year, [174] and as an example in 2026, the most common mileage of the drivers who switched to a ZEV was 30,000 miles per year. Since the average California 2018 base year TNC driver travels 7,000 miles per year,[175] staff chose 5,000 miles per year would as a good threshold for a minimum (for those TNC drivers who would switch to a ZEV). Note that 5,000 miles in a year is approximately equivalent to 1.5 months of driving full-time.

ZEV Rentals For Model Year 2016 and Older Vehicles

The eVMT Cost Model considers switching TNC drivers from an ICE to a ZEV by assuming a rental mechanism if the driver's ICE is model year 2016 or older, and they are not in a ZEV already. This is to accommodate the lack of available ZEV models on the market prior to 2016 with sufficient drive range on a single charge to meet TNC driver needs. Thus, when the eVMT Cost Model considers a TNC driver with an ICE vehicle of 2016 or older, the costs of switching to a ZEV for that individual are assumed to be by virtue of renting a newer model year ZEV. To support this assumption, available ZEV models for 2016 are shown in Figure 33:

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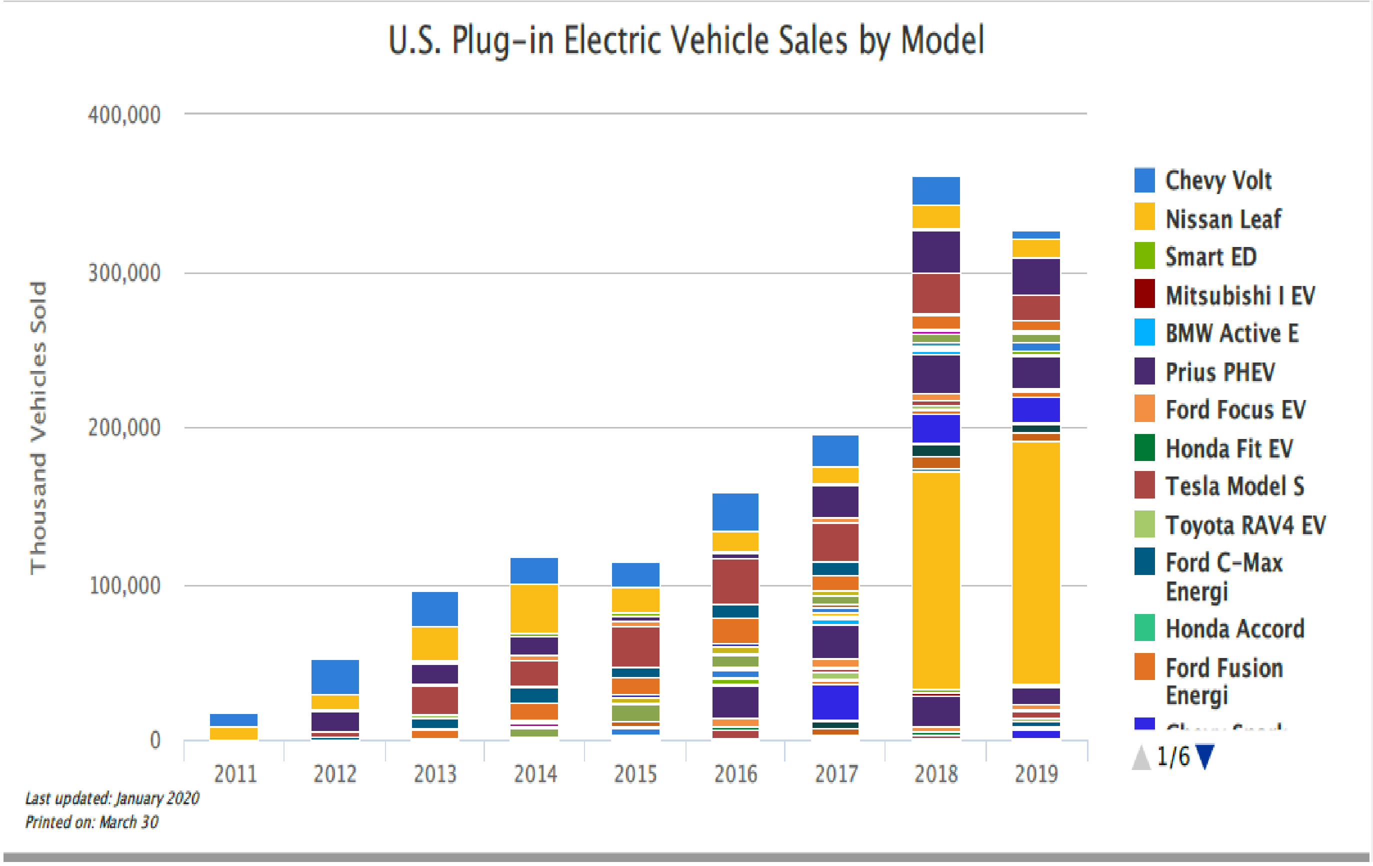
[174] Pavlenko, Slowik, and Lutsey ICCT 2019 When Does electrifying shared mobility make economic sense?

[175] CARB, 2019. Clean Miles Standard 2018 Base-year Emissions Inventory Report. Technical Documentation. https://ww2.arb.ca.gov/resources/documents/2018-base-year-emissions-inventory-report.

U.S. Plug-in Electric Vehicle Sales by Model.[176] Additionally, TNC drivers with significantly older vehicles may not have access to financial capital to buy a newer vehicle and therefore will likely need to rent a vehicle.

Figure 33: U.S. Plug-in Electric Vehicle Sales by Model[177]



Automated Vehicles

SB 1014 directs CARB to consider automated vehicles (AVs) as part of the CMS regulation development.[178] The CPUC has authority over AVs in passenger services. Companies that

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[176] US DOE Alternative Fuels Data Center: https://afdc.energy.gov/data/ Accessed 3/30/2020.

[177] Ibid.

[178] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1014, accessed 6/22/20.

currently have permits in the CPUC Passenger Service pilot programs operate test AVs and cannot collect fares for these services in California.[179] The CPUC requested comments regarding the autonomous vehicle regulatory framework,[180] however there is no indication as to when the CPUC will reconsider or alter the current rulemaking to allow companies testing AVs for passenger service to operate commercially.

Existing studies and reports anticipate AVs to be introduced in the early 2020s through limited deployment and applications,[181] continuing with trial advancements through the mid-2020s.[182] Full autonomy is projected to arrive by 2030,[183] with conservative timelines projecting that this may be not happen before 2030.[184] Given this anticipated timeline for AV deployment, AVs are not included in the CMS regulatory compliance and cost analysis. However, if AVs do enter into commercial use, and operate in TNC services for passengers, they may be subject to the CMS regulation.

Definition of Urbanicity

Urbanicity, in the context of SB1014, is a geographical designation of areas based on the unique characters of the region such as socioeconomics, TNC activity, and transportation infrastructure. Currently, there are no existing geographical boundary that serve the purpose of performing TNC activity analysis and modeling regulation scenarios. In addition, the existing datasets are in different geographical levels which necessitated the need for Urbanicity. The defined Urbanicity helps CARB to form reasonable assumptions (i.e. eVMT, pooling, and deadhead miles) for business as usual and regulatory scenarios assessment by Urbanicity.

To develop Urbanicity, CARB staff collected data in categories of land use, socioeconomics, transportation infrastructure, ZEV infrastructure, and TNC activity. Then, staff explored several approaches, and developed a framework of dividing the State of California into multiple levels

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[179] CPUC. Order to Adopt. Autonomous Vehicles. 2018. https://www.dmv.ca.gov/portal/wcm/connect/a6ea01e0-072f-4f93-aa6c-e12b844443cc/DriverlessAV_Adopted_Regulatory_Text.pdf?MOD=AJPERES&CVID=

[180] CPUC. Administrative Law Judge's Ruling Ordering Parties to Comment on Questions Regarding the Commission's Regulation Of Autonomous Vehicles. 2019. https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M322/K210/322210404.PDF

[181] S&P Global. The Road Ahead For Autonomous Vehicles. May 2018. https://www.ibtta.org/sites/default/files/documents/SP%20Global%20Ratings%20-%20Road%20Ahead%20For%20Autonomous%20Vehicles-Enhanced%20May-14-2018.pdf

[182] LMC Automotive. The outlook for Autonomous Vehicle sales and their impact to 2050. November 2018. https://lmc-auto.com/wp-content/uploads/2018/10/AV-Brochure-Nov-2018.pdf

[183] Litman, T. Autonomous Vehicle Implementation Predictions: Implications for Transport Planning. Victoria Transport Policy Institute. March 2020. https://www.vtpi.org/avip.pdf

[184] Simpson, C., Ataii, E., Kemp, E., Zhang, Y. Mobility 2030: Transforming the mobility landscape. KPMG International. February 2019. https://assets.kpmg/content/dam/kpmg/xx/pdf/2019/02/mobility-2030-transforming-the-mobility-landscape.pdf

of Urbanicity by Census Tract. The socioeconomic, land use, and transportation attributes are also collected from American Community Survey/census at Census Tract level. To remove the correlations within the attributes of the census tracts, a Principal Component Analysis (PCA) is performed as an attribute selection process. After the PCA, only the most meaningful attributes were kept for the clustering analysis. A k-means clustering is then applied. The optimum number of clusters were determined after a few trials and comparisons. Thus, each of the Census Tracts was assigned to an Urbanicity level.

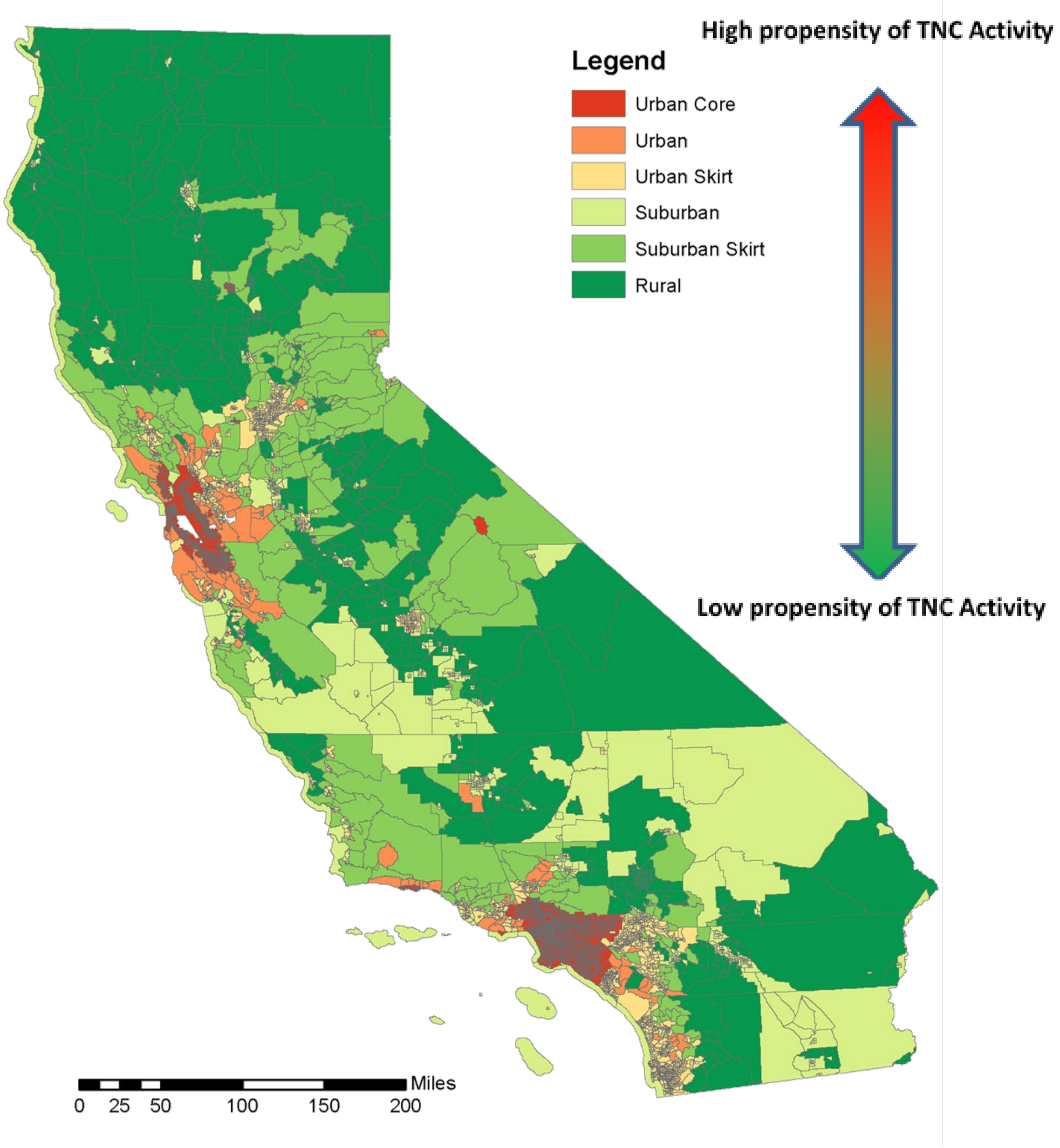
The output from PCA provided basis on which attributes should be kept for clustering. The redundant attributes were removed based on the correlations, either positive or negative, and significance. The selected attributes are listed in Table 52.

Table 52: Selected Attributes for Clustering

Attribute		Description
Land Use		
1	Geographical area size	Total square miles of geographical area
2	Single Family Housing	Population weighted average for % of homes that are single unit detached
Socioeconomic		
3	Household Income	Median income
4	Percent employed	Percent of people over 16 that are employed
5	Population density	Total population/geography size
6	Age group percentage (20~44)	Percent of people between the ages 20 and 44
Transportation Infrastructure		
7	Roadway density	Road miles/geography size
8	Per capita roadway length	Road miles/population
9	Percent using public transportation	Percent of people commuting to using public transportation
10	Commute time to work	Time spent on traveling to work
Electric Vehicle Infrastructure		
11	EV Station Count	Total number of EVSE (assuming this is public) in the geography
TNC Activity		
12	Total Number of Trips	Total number of trips summed at Zip Code level
13	Total P3 VMT	Total VMT and P3 summed at Zip Code level
14	Percentage of Deadhead Miles	Percentage of P1 and P2 miles divided by total miles at Zip Code level

A sample map as an outcome of the Urbanicity is shown in Figure 34. For the convenience of naming, the clusters of Urbanicity were named as Urban Core, Urban, Urban Skirt, Suburban, Suburban Skirt, and Rural.

Figure 34: Sample Clustering Map Showing Urbanicity



Occupancy and Pooling

Occupancy factors are based on default occupancy values of 1.5 for non-pooled and pool-requested unmatched trips and 2.5 for pool-requested matched trips, which are expected to be the middle values for pool unmatched and pool matched occupancies. Table 53 shows the year by year occupancy values consistent with meeting the GHG targets with minimum compliance with the electrification targets and additional increases in occupancy.[185] In 2023, staff assumed occupancy would go back the same level as in the 2018 base year, allowing for several years for the TNC industry to revert to pre-COVID pooling levels. Continued compliance with the GHG targets through minimum compliance with the electrification targets and additional pooling would require a 10 percent increase in occupancy in 2024, followed by year-over-year increases of occupancy of approximately 1 percent.

Table 53: Statewide Occupancy for Meeting GHG Targets with Minimum Compliance with Electrification Targets

Year	Occupancy
2023	1.55
2024	1.70
2025	1.72
2026	1.74
2027	1.77
2028	1.79
2029	1.81
2030	1.83

Based on the 2018 base year TNC data submitted to CARB, staff identified three pooling markets within California: Los Angeles, San Diego, and San Francisco metropolitan areas. A pooling analysis was performed for each of these three markets. For 2018, two ratios were assumed based on the derived 2018 base year TNC data and public references: 1) the ratio of pool-requested trips to total TNC trips or $N_{\text{pool requested}}/N_{\text{total}}$ in each pooling market, and 2) the ratio of matched trips to pool-requested trips or $N_{\text{matched}}/N_{\text{pool requested}}$, as presented inTable 54.[186] Although there are limited public references related to pool request and match ratios, the two sources found were used. One study based on three-months of Lyft data in Los Angeles County in 2016 found approximately a third of all trips were pool-requested.[187] Using publicly available TNC data from Chicago[188] from November 2018 through December 2019, staff derived an overall average pool-request ratio of 0.21 and a match ratio of 0.67.

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[185] The analysis holds total passenger miles traveled constant at BAU levels. As a result, increased occupancy decreases P3 miles. To be conservative, staff assumed no changes in P1 and P2 miles due to increased pooling.

[186] Staff is not explicitly using the values derived from the 2018 TNC data to avoid issues presenting confidential business information.

[187] Brown, A.E. (2020), Who and Where Rideshares? Rideshare travel and use in Los Angeles, Transportation Research Part A, 136: 120-124. doi: 10.1016/j.tra.2020.04.001.

[188] City of Chicago, 2020. Transportation Network Providers – Trips. Chicago Data Portal. https://data.cityofchicago.org/Transportation/Transportation-Network-Providers-Trips/m6dm-c72p. Data downloaded 5/2/20.

Table 54: Assumed Pool-Request and Pool-Match Ratios by Pooling Market in 2018

Pooling Market	$N_{pool\ requested}/N_{total}$	$N_{matched}/N_{pool\ requested}$
Los Angeles	0.3	0.7
San Diego	0.3	0.5
San Francisco	0.4	0.7

Staff is assuming the 2030 values for pool-request and pool-match increase in an optimistic but feasible manner, as shown in Table 55.

Table 55: Assumed Pool-Request and Pool-Match Ratios by Pooling Market in 2030

Pooling Market	$N_{pool\ requested}/N_{total}$	$N_{matched}/N_{pool\ requested}$
Los Angeles	0.5	0.85
San Diego	0.5	0.7
San Francisco	0.5	0.85

Measure D Impact from Pooling

Measure D imposes a fee per trip depending on whether the trip is non-pooled (3.25%) or pool-requested (1.5%). To estimate the impact of increased pooling, a sensitivity analysis was done taking into account the increased match rate discussed in the previous section. Staff compared the business as usual case utilizing the 2018 pooling values (Table 54) through 2031 to the case of increasing pooling by 2030 to the values listed in Table 55. Staff also utilized the same TNC vehicle miles traveled growth rates utilized throughout this analysis.

The TNC trip fare is also important to determine the impact on Measure D fees. Due to lack of TNC fare data from California, staff used the publicly available Chicago TNC data[189] to estimate the trip fares normalized by Period 3 miles. The average non-pool fare was $2.03 per mile and the average pool-requested fare was $1.39 per mile. Staff analyzed two cases with respect to fares to study the impact: 1) these fares were kept constant over time, and 2) decreased the pool-requested fare per mile starting in 2023 by half and kept constant over time.

To calculate the impact on Measure D fees, staff divided the estimated P3 miles for each of the three pooling regions (Los Angeles, San Diego, and San Francisco) into those that are due to non-pool, pool-requested unmatched, and pool-requested matched trips based on the 2018 TNC data and expected changes in pooling services, as explained in the previous section. The non-pool P3 miles were multiplied by the average non-pool fare per mile and

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[189] City of Chicago, 2020. Transportation Network Providers – Trips. Chicago Data Portal. https://data.cityofchicago.org/Transportation/Transportation-Network-Providers-Trips/m6dm-c72p. Data downloaded 5/2/20.

also the Measure D non-pool fee. Similarly, the pool-requested unmatched P3 miles were multiplied by the average pool fare per mile and also the Measure D pool fee.

For the pool-requested matched P3 miles, staff assumed an average of 1.4 parties being in the same vehicle during a trip matched trips. Therefore, for the pool-requested matched case, the impact on Measure D was estimated based on the pool-requested unmatched calculation, but also including the 1.4 factor.

The resulting revenue from each of the three types of trips was summed together and compared to the official estimated revenue of $30 to $35 million per year. The percent different between the official estimated revenue due to Measure D in 2030 taking pooling into account is shown in Table 56.

Table 56: Impact of Increasing Pooling on Measure D Fees

Pool-requested fare per mile	Impact on Measure D Fees
$1.39	1.2%
$0.70	1.0%

BAU Inventory

Basic Methodology

In general, the forecast inventory is developed in the following steps:

- The zip-code based 2018 base year TNC activity data were mapped to geographic classification including sub-area and urbanicity based on trip-start zip code. The base year TNC activity and emission development is discussed in detail in the 2018 Base-year Emissions Inventory Report (CARB, 2019[190]). The sub-area, or Co-Ab-Dis, is the cross-classification of county, air district and air basin boundaries. Staff also classified the activities by EMFAC2017 vehicle classification and fuel type based on VIN number.
- The TNC activities were projected into future years using P3 growth assumptions, deadheading ration assumption, and occupancy assumptions. We also adjust the percent eVMT based on growth assumptions.
- Lastly, we developed the emission rates specified by calendar year, Co-Ab-Dis, vehicle class, fuel type and model year, using a combination of EMFAC2017 emission rates and 2018 base year emission rates, so that these emission rates reflect TNC conditions.

To calculate the gCO2/PMT in the BAU forecast scenario, we applied the following formula using the data components developed above:

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[190] CARB, 2019. Clean Miles Standard 2018 Base-year Emissions Inventory Report. Technical Documentation. https://ww2.arb.ca.gov/resources/documents/2018-base-year-emissions-inventory-report.

Equation 1

$$\frac{g\ CO_2}{PMT} = \frac{\sum(Total\ VMT\ \times\ Adjusted\ CO2\ Emission\ Rate)}{\sum(P3\ VMT \times Occupancy) + zPMT}$$

Where

- **P3 VMT** is the VMT that is associated with the P3. This is the VMT that is grown from base year using the TNC growth assumption.
- **Total VMT** represents the total forecasted vehicle miles traveled by TNCs in all three periods in a particular year. It reflects the growth assumption as well as the deadheading fraction.
- **Adjusted CO2 Emission Rate** is developed by adjusting the light duty vehicle emission rate from EMFAC2017 model with a correction factor, so that it reflects real world TNC driving. The correction factors are developed by comparing real world TNC emission rates against EMFAC2017 emission rates of the same region, vehicle class, fuel type and model year in 2018.
- **Occupancy** represents an average occupancy for pooled and non-pooled rides (excluding driver). When occupancy changes between scenarios, we assume that the total PMT stays the same.
- **zPMT** is the total number of passenger-miles from other travel modes such as walking, bike, scooter and public transportation. Active/Transit PMT tends to lower the trip gCO2/PMT. Under the Proposed Regulation, zero-emission PMT credit that can be earned through connected transit trips or active transportation trips facilitated by TNCs.

Forecast Activity

First, the base year P1, P2, and P3 VMT is geographically mapped to a Co-Ab-Dis and an urbanicity group based on trip start zip code. The urbanicity classification classified each census track to a specific urbanicity group. Staff used the zip-census track crosswalk table from U.S. Department of Housing and Urban Development[191] to relate each zip code to one or more census tracks, and thus the urbanicity designation. Therefore, each zip code consists of one or more urbanicity groups. Later staff aggregated the VMT of each period by Co-Ab-Dis and urbanicity group.

Meanwhile, the TNC activities are also mapped to a vehicle class, fuel type and model year. This is necessary because future fleet's emission rates are usually specified by vehicle class, fuel type and model year. This is done using a combination of VIN decoding and matching the vehicle's VIN to DMV database. As a result, the base year TNC VMT is summarized by period, vehicle class, fuel type, model year, and geographic classifications.

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[191] https://www.huduser.gov/portal/datasets/usps_crosswalk.html

To project future TNC VMT, staff analyzed the CPUC historical TNC data. Similar to the base year TNC data processing, historical P3 TNC VMT data provided by CPUC was aggregated by Co-Ab-Dis and urbanicity group. Staff then categorized regions based on differing levels of market maturation, and developed region-specific growth trends using each region's historical P3 VMT data. On aggregated level, it is estimated that statewide TNC P3 VMT increases approximately 40% between 2018 and 2030. We assume that the total passenger miles serviced by TNC fleets will grow following these P3 VMT growth trends. In other words, the P3 VMT will grow as assumed when occupancy is assumed constant. The total VMT will be calculated as a function of P3 VMT and deadheading ratio:

Total VMT = P3 VMT/(1- %deadheading)

Emission Rates

To estimate LDV emissions in future in California, EMFAC model is a major source of emission rates. For CO2 emission rate and fuel consumption rate, in order to reflect TNC real world driving, staff adjust the EMFAC2017 emission rates with a correction factor, which reflects the difference between TNC driving and CA LDV in general, when the vehicle class, fuel type and model year is already specified.

Staff develop this correction factor by comparing the emission rates from the 2018 base year TNC fleets and those from EMFAC2017 for calendar year 2018 for the same fleet in the same region. The 2018 base year TNC CO2 emission rates or fuel consumption rates are developed based on each vehicle's EPA's Federal Fuel Economy Data[192] , and then adjusted for TNC driving condition using speed correction factors developed from instrumented vehicle data collection. Therefore, this set of emission rates reflects TNC real world driving.

Staff first compute the ratio of these two kinds of emission rates for each GAI, vehicle class, fuel type, and model year. These ratios are used as data points in regression analysis. The statistical analysis shows that the ratio of emission rates primarily vary by vehicle class and fuel type. Therefore, we fitted an ANOVA model:

Ratio of CO2 emission rates (ER) ~ *f* (vehicle class, fuel type)

We use the fitted value as correction factors to apply to EMFAC2017 CO2 emission rates and fuel consumption rates.

For criteria emission rates, staff applied the EMFAC2017 emission rates specified by calendar year, Co-Ab-Dis, vehicle class, fuel type and model year.

Occupancy

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[192] EPA FuelEconomy.Gov database accessible through https://www.fueleconomy.gov/feg/download.shtml

Staff reviewed multiple recent studies that provide estimates on occupancy associated with ride-sharing businesses in California and other locations. The estimated average occupancy from these studies ranges from 1.3 to 1.9. Staff also reviewed the most recent CARB data logger study where 31 vehicle trip diaries were collected over a two-week period. This study concluded an occupancy of 1.54 for non-pooled trips and 1.57 for pooled trips, leading to an estimated average occupancy of 1.55 (CARB, 2019). For this round of analysis, staff use this value as TNC average occupancy and assume that the average occupancy stays constant in future years in the BAU scenario.

Deadheading

As discussed in the Base-year Report, TNC trip data reveal approximately 38.5 percent of deadheading (i.e. miles traveled with no passenger in the vehicles). Existing studies and literature suggest that the deadheading fractions vary by land use type (e.g. urban, suburban, rural).[193;194] Staff discover from the base year data that fraction of deadheading vary primarily by subarea and urbanicity as shown in Table 57. In both BAU and compliance scenario, it is assumed that the fraction of deadheading will stay constant in the forecasted inventory.

Table 57: Deadheading Fractions by Urbanicity

Urbanicity Group	Deadheading fraction (P1+P2)%
Urban Core	36%
Urban	43%
Urban Skirt	48%
Suburban	52%
Suburban Skirt	57%
Rural	65%

Age Distribution

In the BAU scenario, staff assumed that the VMT-weighted age distribution of vehicles employed in the TNC service would stay the same as in the 2018 base year. As a result, the BAU emissions of the TNC fleet reflects anticipated improvements in vehicle efficiency that result from CARB's Advanced Clean Cars regulation.

California ZEV Population

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[193] M. Boarnet, S.Handy 2014 Impacts of Residential Density on Passenger Vehicle Use and Greenhouse Gas Emissions https://ww3.arb.ca.gov/cc/sb375/policies/density/residential_density_brief.pdf

[194] Steven Spears, M. Boarnet, S.Handy, C.Rodier, 2014 Impacts of Land-Use Mix on Passenger Vehicle Use and Greenhouse Gas Emissions https://ww3.arb.ca.gov/cc/sb375/policies/mix/lu-mix_brief.pdf

Table 58 describes the California ZEV populations consistent with minimum compliance with the Zero Emission Vehicle Regulation, based on DMV registration data and the EMFAC2017 model. CARB is in the process of developing a new release of the EMFAC model which will update the California vehicle population forecasts. However, to remain consistent with the baseline of compliance with existing enforceable state and federal regulations, this analysis relies on the most recent Board approved version of the EMFAC model.

Table 58: Zero Emission Vehicle Regulation ZEV Populations

Year	California ZEV Population	Compliance Scenario TNC ZEV Population	Percent of CA ZEV Fleet
2023	271,585	10,504	4%
2024	322,872	15,466	5%
2025	379,866	23,905	6%
2026	436,446	45,795	10%
2027	491,454	71,888	15%
2028	545,045	133,178	24%
2029	597,118	168,267	28%
2030	647,507	257,485	40%

Macroeconomic Modeling Inputs

Table 59: REMI Inputs for Modeling the Proposed Regulation

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Production Cost	Lagged Market Share Response: Transit and ground passenger transportation (485)	Million 2018$	0.00	0.03	1.47	3.80	9.24	21.71	36.96	61.76	80.20	114.85	109.82
Proprietors' Income	Transit and ground passenger transportation (485)	Million 2018$	0.00	0.00	2.06	8.27	21.79	64.53	102.28	204.80	250.89	394.56	485.67
Consump. Reallocate.	All Consumption Categories	Million 2018$	0.00	0.00	0.82	0.84	-0.17	-15.92	-25.73	-92.42	-107.87	-207.76	-302.78

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Consumer Spending	Reallocate Consumption: Hospitals	Million 2018$	0.00	0.00	0.00	0.00	-0.01	-0.03	-0.04	-0.05	-0.07	-0.08	-0.08
Exogenous Final Demand	Petroleum and coal products manufacturing (324)	Million 2018$	0.00	0.00	-2.23	-7.96	-17.74	-36.47	-53.36	-68.05	-83.56	-95.39	-95.67
Exogenous Final Demand	Electric power generation, transmission and distribution (2211)	Million 2018$	0.00	0.00	1.56	5.81	13.04	26.60	39.03	50.45	61.03	70.21	69.78
Exogenous Final Demand	Automotive repair and maintenance (8111)	Million 2018$	0.00	0.00	-0.80	-3.21	-7.72	-17.08	-25.30	-33.06	-40.32	-46.80	-47.21
Exogenous Final Demand	Management, scientific, and technical consulting services (5416)	Million 2018$	0.00	0.03	0.06	0.05	0.03	0.05	0.03	0.05	0.03	0.03	0.03
State and Local Gov't Employ.	State Government	Jobs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
State and Local Gov't Spending	State Government	Million 2018$	-0.16	-0.16	-0.50	-1.34	-2.79	-5.56	-7.98	-10.16	-12.26	-14.09	-14.09
State and Local Gov't Spending	Local Government	Million 2018$	0.00	0.00	-0.11	-0.56	0.01	0.02	0.03	0.06	0.04	0.07	0.05

Table 60: REMI Inputs for Modeling Alternative 1

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Production Cost	Lagged Market Share Response: Transit and ground passenger transportation (485)	Million 2018$	0.00	0.03	8.06	38.43	90.20	140.43	220.21	256.02	341.96	705.95	573.17
Proprietors' Income	Transit and ground passenger transportation (485)	Million 2018$	0.00	0.00	8.46	44.13	98.34	199.20	261.36	371.44	418.99	558.33	687.23
Consump. Reallocate.	All Consumption Categories	Million 2018$	0.00	0.00	5.21	16.39	33.95	1.78	35.94	-32.48	13.00	239.28	-20.78
Consumer Spending	Reallocate Consumption: Hospitals	Million 2018$	0.00	0.00	0.00	-0.02	-0.04	-0.06	-0.08	-0.09	-0.10	-0.11	-0.11
Exogenous Final Demand	Petroleum and coal products manufacturing (324)	Million 2018$	0.00	0.00	-8.98	-35.08	-63.53	-85.00	-108.22	-115.54	-123.41	-124.35	-124.91
Exogenous Final Demand	Electric power generation, transmission and distribution (2211)	Million 2018$	0.00	0.00	6.83	28.43	50.85	65.07	83.31	88.83	92.74	93.36	93.18
Exogenous Final Demand	Automotive repair and maintenance (8111)	Million 2018$	0.00	0.00	-3.52	-15.49	-29.44	-40.67	-52.21	-56.27	-59.40	-60.70	-61.59
Exogenous Final Demand	Management, scientific, and technical consulting services (5416)	Million 2018$	0.00	0.03	0.06	0.05	0.03	0.05	0.03	0.05	0.03	0.03	0.03
State and Local Gov't Employ.	State Government	Jobs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
State and Local Gov't Spending	State Government	Million 2018$	-0.16	-0.16	-0.15	-5.37	-9.56	-12.73	-16.01	-17.14	-18.02	-18.32	-18.35

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
State and Local Gov’t Spending	Local Government	Million 2018$	0.00	0.00	-0.51	-3.12	0.18	0.15	0.20	0.21	0.15	0.15	0.13

Table 61: REMI Inputs for Modeling Alternative 2

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Production Cost	Lagged Market Share Response: Transit and ground passenger transportation (485)	Million 2018$	0.00	0.03	1.47	0.37	2.37	5.78	9.94	17.87	27.26	55.14	51.36
Proprietors' Income	Transit and ground passenger transportation (485)	Million 2018$	0.00	0.00	2.06	1.00	7.11	22.60	37.97	81.38	117.50	252.41	297.49
Consump. Reallocate.	All Consumption Categories	Million 2018$	0.00	0.00	0.82	0.06	-0.04	-4.31	-8.23	-33.06	-48.88	-142.18	-190.73
Consumer Spending	Reallocate Consumption: Hospitals	Million 2018$	0.00	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.06	-0.06
Exogenous Final Demand	Petroleum and coal products manufacturing (324)	Million 2018$	0.00	0.00	-2.23	-1.04	-6.57	-16.64	-26.15	-40.24	-54.17	-72.11	-71.62
Exogenous Final Demand	Electric power generation, transmission and distribution (2211)	Million 2018$	0.00	0.00	1.56	0.66	4.54	11.46	18.17	28.69	38.28	51.96	51.17
Exogenous Final Demand	Automotive repair and maintenance (8111)	Million 2018$	0.00	0.00	-0.80	-0.36	-2.69	-7.39	-11.85	-18.95	-25.50	-34.97	-34.97

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Exogenous Final Demand	Management, scientific, and technical consulting services (5416)	Million 2018$	0.00	0.03	0.06	0.05	0.03	0.05	0.03	0.05	0.03	0.03	0.03
State and Local Gov't Employ.	State Government	Jobs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
State and Local Gov't Spending	State Government	Million 2018$	-0.16	-0.16	-0.50	-0.32	-1.13	-2.62	-3.99	-6.08	-8.00	-10.70	-10.59
State and Local Gov't Spending	Local Government	Million 2018$	0.00	0.00	-0.11	-0.11	-0.01	-0.01	-0.02	0.00	-0.02	0.01	0.00

Table 62: REMI Inputs for Modeling the Proposed Regulation under the Delayed Growth Scenario

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Production Cost	Lagged Market Share Response: Transit and ground passenger transportation (485)	Million 2018$	0.00	0.03	1.05	3.13	8.33	20.72	36.73	60.73	79.93	113.63	108.83
Proprietors ' Income	Transit and ground passenger transportation (485)	Million 2018$	0.00	0.00	1.49	6.85	19.70	60.92	99.50	198.35	244.31	382.67	472.45
Consump. Reallocate.	All Consumption Categories	Million 2018$	0.00	0.00	0.59	0.59	-0.24	-14.81	-25.27	-88.83	-103.22	-198.85	-292.90
Consumer Spending	Reallocate Consumption: Hospitals	Million 2018$	0.00	0.00	0.00	0.00	-0.01	-0.02	-0.04	-0.05	-0.06	-0.08	-0.08
Exogenous Final Demand	Petroleum and coal products manufacturing (324)	Million 2018$	0.00	0.00	-1.64	-6.50	-15.98	-34.45	-50.52	-65.60	-81.36	-93.06	-92.57

REMI Policy Variable	Detail	Units	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031
Exogenous Final Demand	Electric power generation, transmission and distribution (2211)	Million 2018$	0.00	0.00	1.14	4.77	11.81	25.17	37.03	48.69	59.51	68.66	67.56
Exogenous Final Demand	Automotive repair and maintenance (8111)	Million 2018$	0.00	0.00	-0.59	-2.64	-7.00	-16.17	-24.04	-31.93	-39.34	-45.82	-45.73
Exogenous Final Demand	Management, scientific, and technical consulting services (5416)	Million 2018$	0.00	0.03	0.06	0.05	0.03	0.05	0.03	0.05	0.03	0.03	0.03
State and Local Gov't Employ.	State Government	Jobs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
State and Local Gov't Spending	State Government	Million 2018$	-0.16	-0.16	-0.41	-1.15	-2.59	-5.39	-7.75	-10.05	-12.24	-14.10	-13.99
State and Local Gov't Spending	Local Government	Million 2018$	0.00	0.00	-0.11	-0.56	0.01	0.02	0.03	0.06	0.04	0.07	0.05

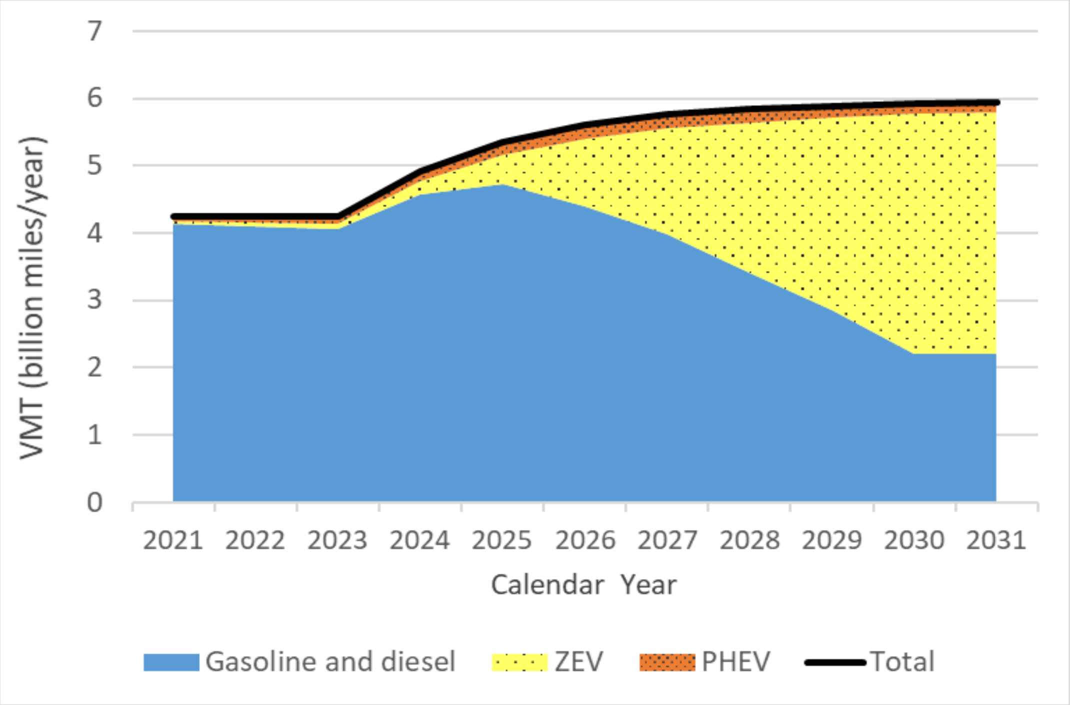
H. APPENDIX: DELAYED GROWTH SENSITIVITY SCENARIO

In the main SRIA document, the Proposed Regulation was analyzed under assumptions that TNCs would continue their historical trend of rapid, but gradually declining growth. These assumptions resulted in statewide Market growth for the TNC industry relative to the 2018 base year of 37 percent and 42 percent by 2023 and 2030, respectively. Due to the uncertainty surrounding impacts of the COVID-19 pandemic, the subsequent economic recession, and implementation of AB 5, CARB developed this sensitivity analysis to further explore the potential range of environmental and economic impacts that could result from the Proposed Regulation.

Each of the events listed above has potential to delay growth of the TNC industry. Due to the COVID-19 pandemic, TNCs have suspended pooled rides and in general, overall travel tends to decrease during economic recessions. While the impacts of AB 5 on the TNC industry in California are uncertain, it also has the potential to delay TNC growth if costs to employ drivers increases significantly. To capture the potential impacts of the events listed above, this sensitivity analysis delays market growth until 2023 (delayed growth scenario). For example, the 2023 market size for the TNC industry is assumed to be the same as in the 2018 base year and the 2024 TNC VMT and fleet size is estimated based on the 2019 market growth estimates used in the main SRIA analysis. In other words, the delayed growth scenario forecasts TNC market grows to back to the 2020 BAU levels by 2025.

Under the delayed growth scenario, the TNC industry would be smaller in 2023 and then experience rapid growth starting in 2024. The growth takes a concave shape, rapid at first but declining slightly each subsequent year. Figure 35Figure illustrates the aggregated statewide market growth assumed under the Sensitivity Scenario.

Figure 35: Statewide TNC VMT by Fuel Types under the Sensitivity Scenario



The delayed growth scenario maintains the same assumptions regarding input costs as the main SRIA analysis. Capital costs such as incremental vehicle costs and home charger costs, along with operating costs and savings are assumed to be the same as in the main SRIA analysis. However, in the delayed growth scenario, TNC VMT and populations are estimated to be smaller than in the main SRIA document. As a result the number of vehicles that switch to ZEVs to comply with the Proposed Regulation are smaller. This leads to emissions benefits, cost savings, and costs that are smaller than what is estimated in the main SRIA analysis. Table 63 provides a comparison between the number of vehicles that switch to ZEVs under the main SRIA analysis and the delayed growth scenario.

Table 63: Number of Vehicles Switching to ZEVs Under the Proposed Regulation

Year	Main SRIA Analysis	Delayed Growth Scenario
2023	479	346
2024	2,996	2,597
2025	9,061	8,274
2026	30,167	28,558
2027	53,478	53,332
2028	112,842	110,187
2029	146,310	144,244
2030	234,224	229,989
2031	243,738	240,270

Criteria Pollutants and GHG Emissions Benefits

In the delayed growth scenario, TNC VMT in each year is estimated to be smaller than in the main SRIA analysis. With other assumptions staying the same, the delayed growth scenario results in slightly smaller emission reductions. Table 64 summarizes the expected annual NOx, PM.25, and CO2 reductions in the delayed growth scenario in 2031 when compared to the BAU scenario.[195]

Table 64: Delayed Growth Compliance Scenario WTW NOx, PM2.5, and GHG Emission Benefits Relative to Business-as-Usual

Calendar Year	NOx(tpd)	$PM_{2.5}$ (tpd)	CO2(MMT/yr)
2031	0.12	0.07	0.26

The NOx and PM2.5 emissions reduction of the delayed growth scenario relative to the BAU, in short tons per day (tpd), are presented in Figure 36 and Figure 37 respectively.

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[195] The BAU used in this sensitivity analysis is different from the BAU in the main SRIA analysis in that, it reflects the same delayed TNC growth as in the delayed growth scenario (but without the electrification compliance).

Figure 36. Projected WTW NOx Emission Reduction from Delayed Growth Scenario

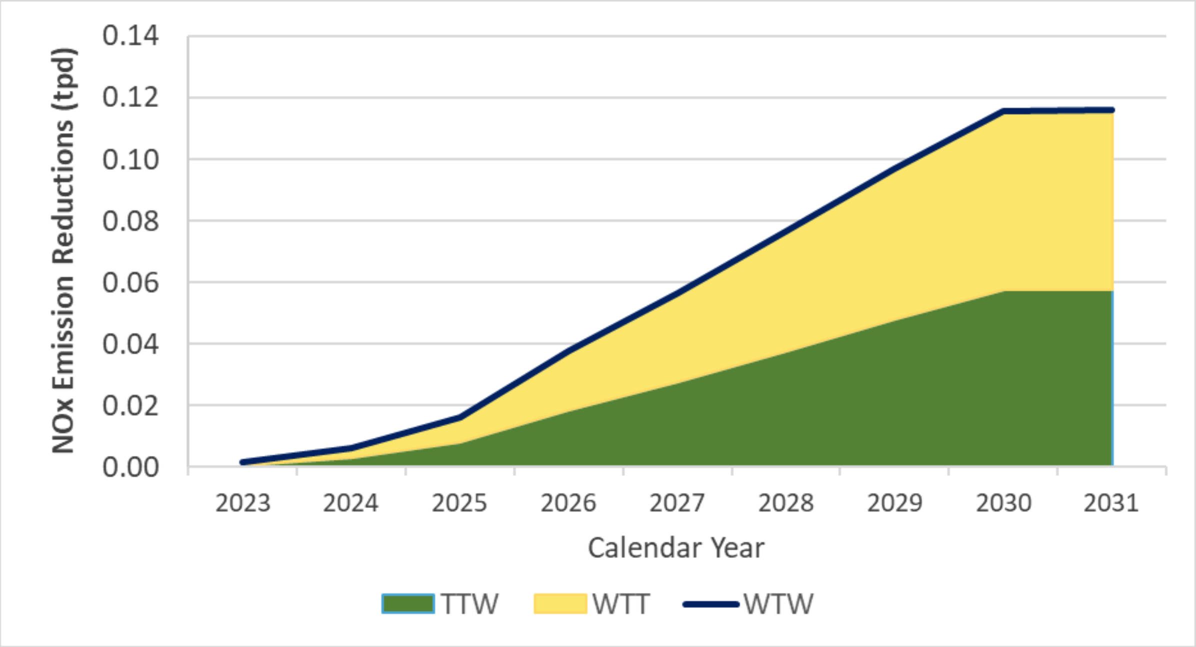


Figure 37: Projected WTW PM2.5 Emission Reduction from Delayed Growth Scenario

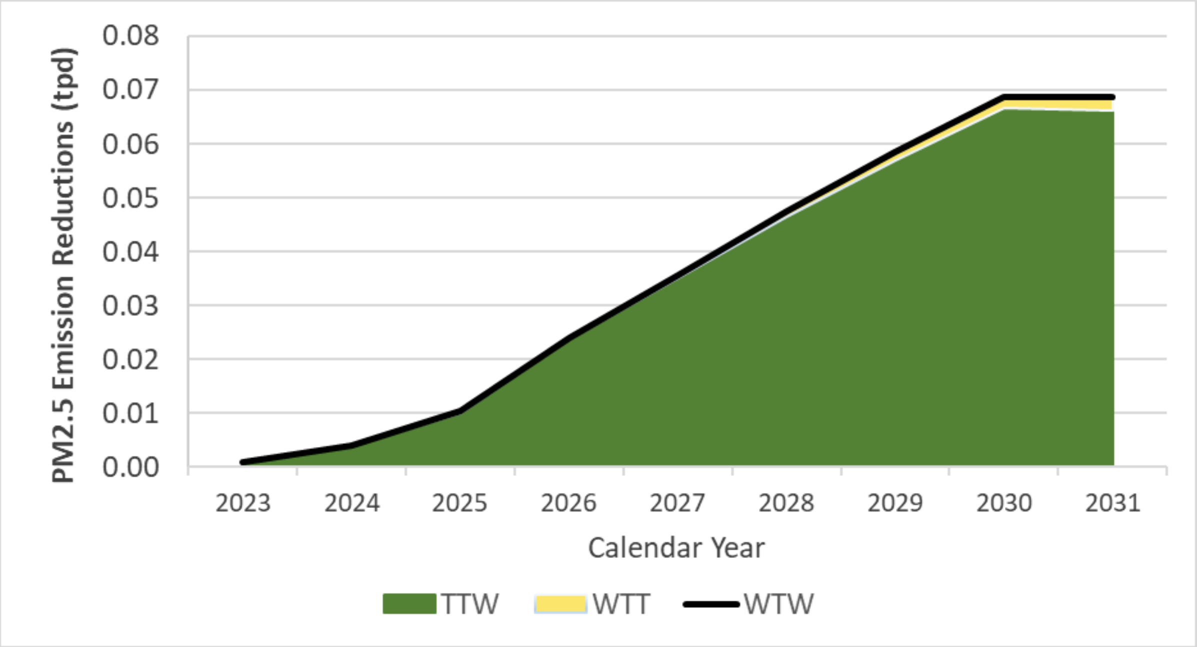
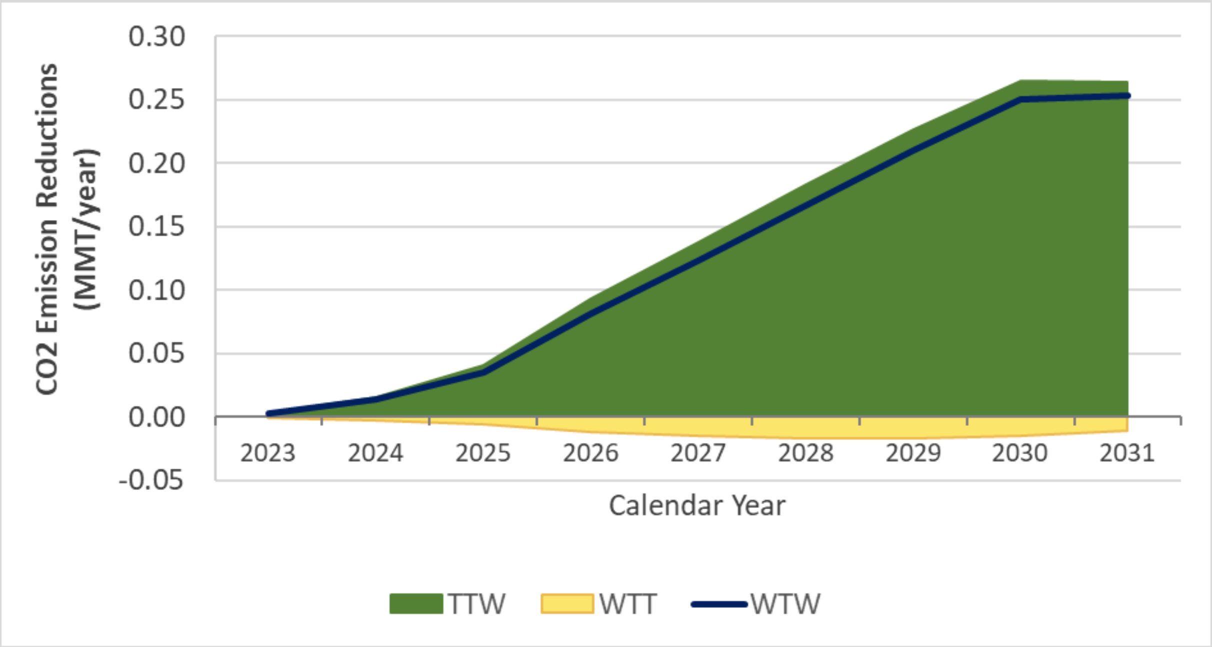


Figure 38 presents the TTW, WTT and WTW GHG emission reductions in million metric tons per year (MMT/year).

Figure 38: Projected WTW CO2 Emission Reduction from Delayed Growth Scenario



Health Benefits

The health benefits due to the Proposed Regulation under the delayed growth scenario are shown in Table 65. The number of avoided incidents is almost identical to the impacts estimated in the main SRIA analysis. Under the delayed growth scenario, there 1 fewer avoided emergency room visit between 2023 and 2031.

Table 65: Statewide Valuation from Avoided Health Outcomes for Delayed Growth Scenario

Outcome	Avoided Incidents*	Valuation (Million 2018$)
Avoided Premature Mortality	20	$188.80
Avoided Cardiovascular Hospitalizations	3	$0.17
Avoided Acute Respiratory Hospitalizations	4	$0.17
Avoided Emergency Room Visits	10	$0.01
Total		**$189.15**

* Avoided Incidents rounded to the nearest whole number

Total Costs to TNCs, Drivers, and Riders

In the delayed growth scenario, TNC VMT and populations are estimated to be smaller than in the main SRIA analysis. As a result cost savings and costs will also be smaller.

Figure 39 illustrates the costs to TNC's drivers, and riders that would be borne under the Proposed Regulation with the delayed growth assumptions and Table 66 describes the costs more specifically. The distribution of costs and cost savings across the various categories is similar under the delayed growth scenario.

From 2021 through 2031, the total cost to the TNC industry under the delayed growth scenario is estimated to be $-763 million, compared to $-797 million presented in the main SRIA analysis. Similar to the main SRIA analysis, the Proposed Regulation would result in cost savings in every year, relative to the BAU. However, the cost savings under the delayed growth scenario would be smaller in magnitude than those estimated in the main SRIA analysis. The cost savings under the delayed growth scenario are, on average, 7 percent smaller than those estimated in the main SRIA analysis. The largest differences in cost savings come from 2023 through 2025, when there are the largest differences in market growth assumptions.

Figure 39: Costs for TNC Industry to Comply with Proposed Regulation under the Delayed Growth Scenario

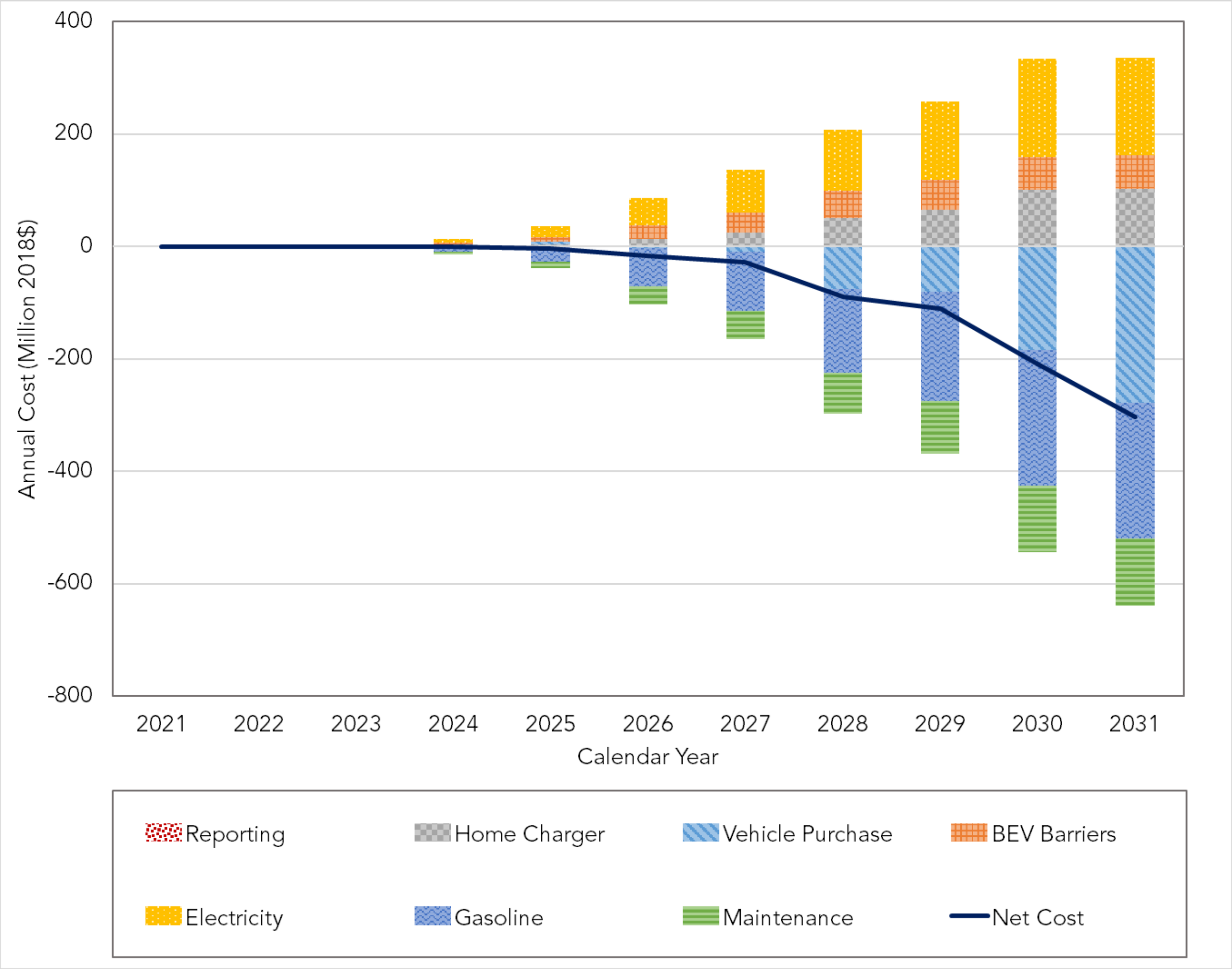


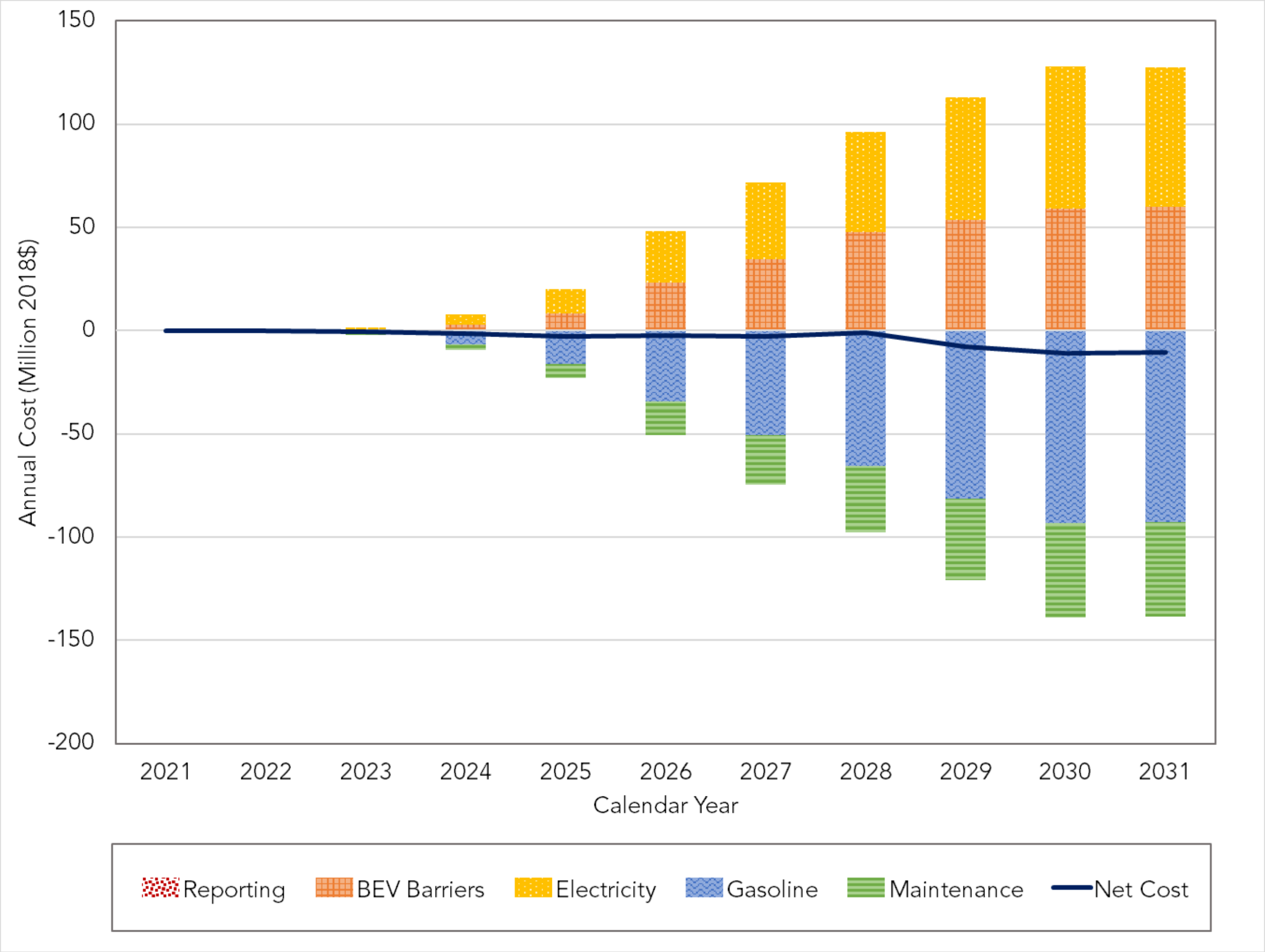
Table 66: Costs for TNC Industry to Comply with Proposed Regulation under the Delayed Growth Scenario

Year	Vehicle Purchase	BEV Barriers	Home Charger	Electricity	Gasoline	Maintenance	Reporting Costs	Total Cost
2021	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2022	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2023	0.8	0.5	0.2	1.5	-2.2	-0.8	0.1	0.0
2024	1.8	2.9	1.3	7.4	-10.1	-4.1	0.1	-0.8
2025	3.5	8.2	4.1	19.8	-26.9	-11.8	0.0	-3.2
2026	-3.7	23.1	13.8	49.0	-67.4	-31.8	0.1	-17.1
2027	-8.7	34.7	25.1	76.8	-105.4	-50.5	0.0	-28.1
2028	-75.9	47.7	50.5	109.7	-149.0	-73.0	0.1	-89.9
2029	-81.2	53.5	64.4	140.2	-193.6	-94.1	0.0	-110.9
2030	-184.7	59.2	100.0	175.3	-240.8	-118.8	0.0	-209.8
2031	-278.3	60.1	101.6	173.4	-241.3	-119.1	0.0	-303.5
Total	-626.6	289.9	360.9	753.1	-1036.8	-504.1	0.4	-763.2

Total Costs to California

The total costs to California between 2021 and 2031 under the delayed growth scenario is $-41 million, compared to $-46 million presented in the main SRIA analysis. Similar to the results for the TNC industry, the magnitude of costs and cost savings under the delayed growth scenario are smaller due to fewer vehicles and less VMT, relative to the main SRIA analysis.

Figure 40: Costs to California under the Delayed Growth Scenario



Macroeconomic Impacts

California Employment Impacts

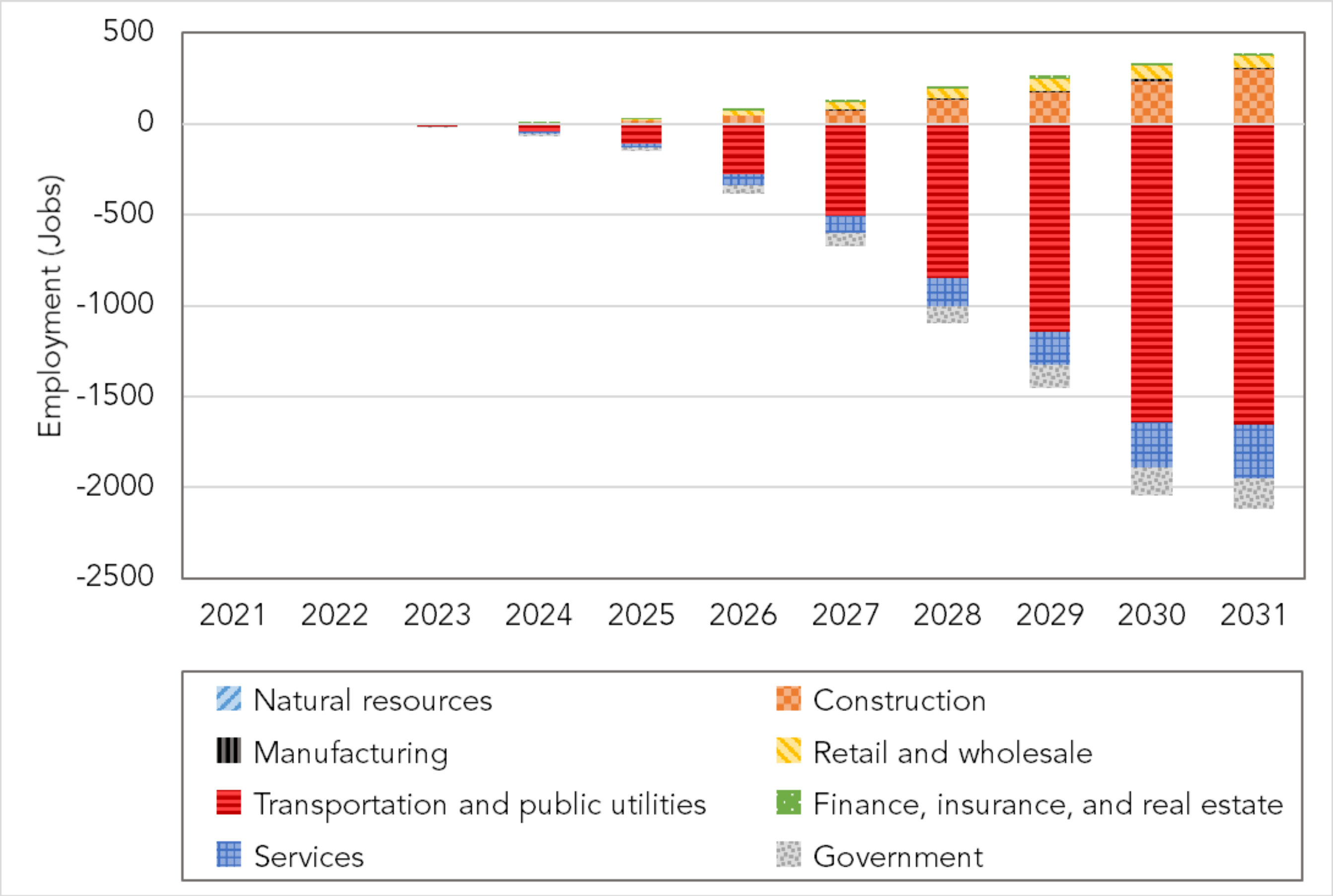
Table 67 presents the impacts of the Proposed Regulation on total employment in California under the delayed growth scenario. The statewide employment impacts of the Proposed Regulation are estimated to be slightly negative in all years of the assessment but there are also some industries that are estimated to have positive impacts. Similar to the main SRIA analysis, the changes in statewide employment represent less than a 0.01% change relative to baseline California employment in all years of the assessment. Relative to the main SRIA analysis, there would be slightly small impacts to California employment under the delayed growth scenario. In 2023, it is estimated that the delayed growth scenario would have 6 fewer changes in jobs, and 10 fewer changes in jobs in 2031, relative to the main SRIA analysis. Relative to the total California statewide employment, these differences are negligible.

Table 67: Change in California Employment by Industry under the Delayed Growth Scenario

Industry	Units	2021	2023	2025	2027	2029	2031
California Statewide	Total employment	21,063,397	22,603,895	23,781,336	24,725,153	24,752,485	24,763,651
	Percent Change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change in jobs	-1	-19	-120	-542	-1,186	-1,735
Petroleum and coal products manufacturing (324)	Percent change	0.00%	0.00%	-0.01%	-0.04%	-0.07%	-0.07%
	Change in jobs	0	0	-2	-6	-9	-10
Electric power generation, transmission and distribution (2211)	Percent change	0.00%	0.00%	0.02%	0.07%	0.11%	0.13%
	Change in jobs	0	1	10	28	44	48
Transit and ground passenger transportation (485)	Percent change	0.00%	0.00%	-0.02%	-0.11%	-0.23%	-0.33%
	Change in jobs	0	-15	-119	-528	-1182	-1699
Management, scientific, and technical consulting services (5416)	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in jobs	0	0	0	-1	-2	-4
Automotive repair and maintenance (8111)	Percent change	0.00%	0.00%	-0.03%	-0.11%	-0.17%	-0.20%
	Change in jobs	0	-4	-51	-188	-306	-353
State and Local Government	Percent change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change in jobs	0	-4	-21	-69	-124	-166

Figure 40 illustrates the estimated employment impacts by major sector. As in the main SRIA analysis, the greatest decreases in employment occur in the transportation and public utilities, services, and government sectors. The greatest increases in employment are estimated to occur in the construction, retail, and wholesale sectors. These increases result from overall increases in personal income that come from additional fuel and operational savings of operating ZEVs.

Figure 40: Change in California Employment by Major Sector Under the Delayed Growth Scenario



California Business Impacts

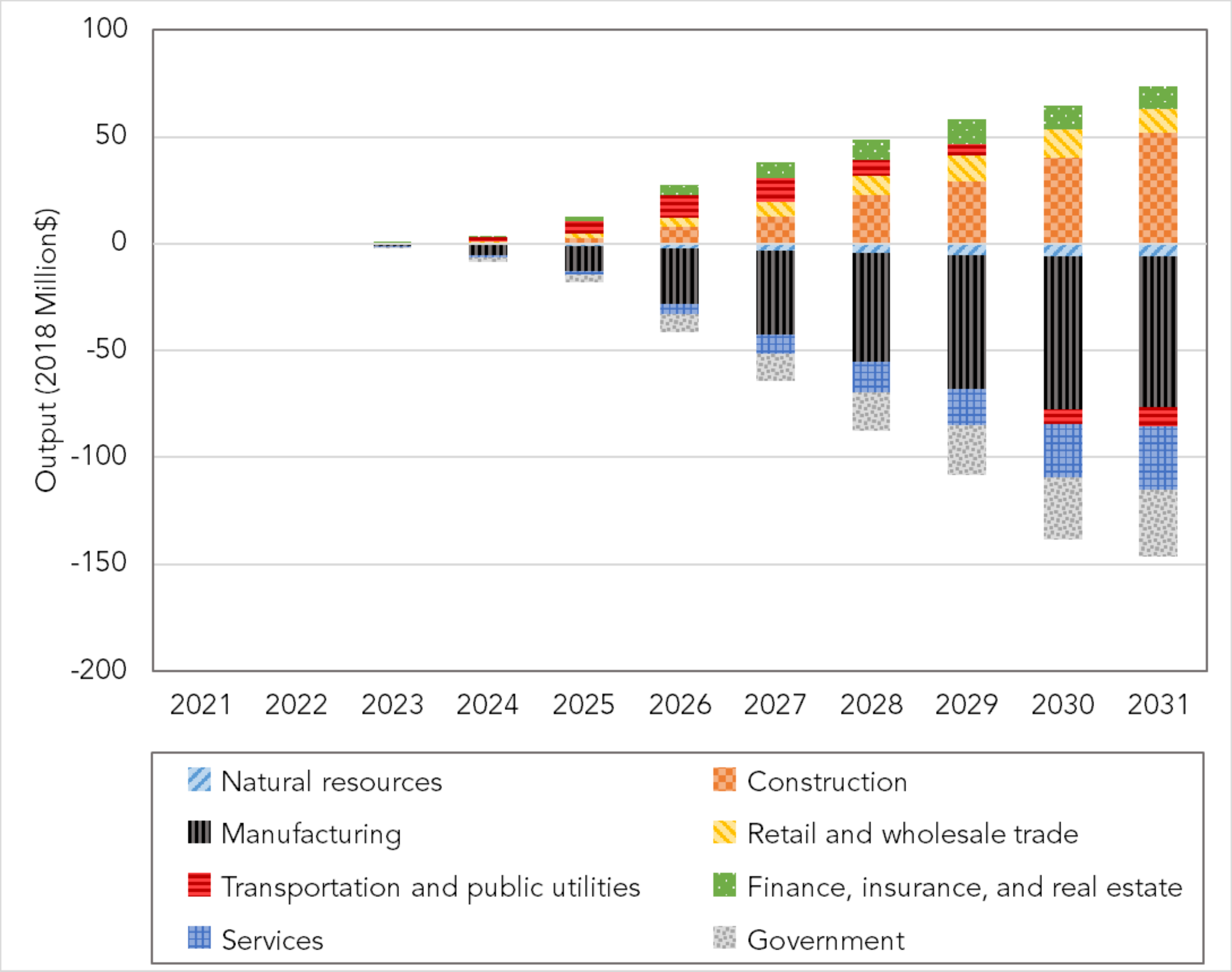
As illustrated in Table 68, the Proposed Regulation is estimated to result in a decrease in statewide output of $2 million in 2023, the first year of electrification and GHG targets, and a decrease in output of $73 million in 2031, one year after full implementation of the Proposed Regulation. In all years of the analysis, the Proposed Regulation is estimated to result in less than a 0.01% change in statewide output. The impacts of the Proposed Regulation on California output under the delayed growth scenario are virtually identical to those estimated in the main SRIA analysis. In the early years of the analysis (i.e. 2023 and 2025), the impacts to the petroleum and coal products manufacturing, electric power generation, transmission and distribution, automotive repair and maintenance, and transit and ground passenger transportation industries are all slightly smaller in magnitude, relative to the main SRIA analysis. This reflects the slightly smaller size of the TNC fleet under the delayed growth scenario and lower overall direct costs and direct cost savings, particularly in the early years of the regulation.

Similar to the employment impacts, all industries that are anticipated to face production cost increases, decreases in demand, or decreased revenue are anticipated to have corresponding decreases in output while industries that are anticipated to see increases in demand are estimated to have increases in output.

Table 68: Change in California Output by Industry under the Delayed Growth Scenario

Industry	Units	2021	2023	2025	2027	2029	2031
California Statewide	Total Output	4,533,842	4,781,839	5,150,807	5,443,778	5,576,320	5,725,268
	Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in Output	0	-2	-5	-26	-50	-73
Petroleum and coal products manufacturing (324)	Percent change	0.00%	0.00%	-0.01%	-0.04%	-0.07%	-0.07%
	Change in Output	0	-1	-12	-42	-69	-78
Electric power generation, transmission and distribution (2211)	Percent change	0.00%	0.00%	0.02%	0.07%	0.12%	0.13%
	Change in Output	0	1	10	30	49	55
Transit and ground passenger transportation (485)	Percent change	0.00%	0.00%	-0.02%	-0.11%	-0.23%	-0.33%
	Change in Output	0	0	-4	-18	-42	-62
Management, scientific, and technical consulting services (5416)	Percent change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in Output	0	0	0	0	0	-1
Automotive repair and maintenance (8111)	Percent change	0.00%	0.00%	-0.03%	-0.11%	-0.17%	-0.20%
	Change in Output	0	0	-5	-19	-31	-36
State and Local Government	Percent change	0.00%	0.00%	0.00%	0.00%	-0.01%	-0.01%
	Change in Output	0	-1	-4	-13	-23	-31

Figure 41: Change in California Output by Major Sector Under the Delayed Growth Scenario



Impacts on Investments in California

The relative changes to growth in private investment for the Proposed Regulation are shown in Table 69 and show an increase of private investment $94 million in 2031. This is slightly lower than the increase off private investment of $97 million in 2031, estimated under the main SRIA analysis.

Table 69: Change in Gross Domestic Private Investment under the Delayed Growth Scenario

	2021	2023	2025	2027	2029	2031
Private Investment (2018M$)	323,535	365,613	423,690	468,402	482,363	494,861
Percent Change	0.00%	0.00%	0.00%	0.01%	0.01%	0.02%
Change (2018M$)	0	0	6	27	57	94

Impacts on Individuals in California

Table 70 shows annual change in real personal income across all individuals in California under the Delayed Growth Scenario. Total personal income has no noticeable changes in 2023 and increases by $372 million in 2031 as a result of the Proposed Regulation. In the main SRIA analysis, personal income increased by about $1 in 2023 and $384 million in 2031. When assessed on a per captia metric, the increase in personal income growth is estimated to by about $9 per person in 203, the same as in the main SRIA analysis. The slight differences between the Delayed Growth Scenario and the main SRIA analysis are a result of the smaller TNC fleet size. Personal income growth increases reflect the operational cost savings that were modeled as going to drivers. In the main SRIA analysis, where the overall TNC fleet is larger, there would be greater cost savings.

Table 70: Changes in Personal Income Growth Under the Delayed Growth Scenario

	2021	2023	2025	2027	2029	2031
Personal Income (2018M$)	2,468,200	2,568,660	2,722,313	2,861,805	2,960,455	3,076,877
Percent Change	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
Change (2018M$)	0	0	14	69	177	372
Personal Income Per Capita (2018$)	61,228	63,087	66,113	68,745	70,391	72,465
Percent Change	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%
Change (2018$)	0	0	0	2	4	9

Impacts on Gross State Product (GSP)

Table 71 shows the annual change in gross state product estimated as a result of the Proposed Regulation under the Delayed Growth Scenario. Under the Proposed Regulation GSP is anticipated to decrease by about $1 million in 2023 and $21 million in 2031, relative to the baseline. These changes do not exceed 0.01 percent of baseline GSP. Relative to the main SRIA analysis, the change in GSP is greater in magnitude by $1 million in the years 2027, 2029, and 2031.

Table 71: Change in Gross State Product Under the Delayed Growth Scenario

	2021	2023	2025	2027	2029	2031
Gross State Product (2018M$)	2,680,879	2,833,581	3,058,931	3,246,314	3,342,962	3,444,701
Percent Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Change (2018M$)	0	-1	1	-3	-10	-21

Summary and Agency Interpretation of the Assessment Results

Under the delayed growth scenario, CARB estimates the Proposed Regulation is unlikely to have a significant impact on the California economy. Overall the changes in growth of jobs, output, private investment, income, and GDP are projected to not exceed 0.01 percent of the baseline. The Proposed Regulation results in increased costs to TNC companies and decreases in demand for gasoline and automotive repair, but also results in increased income for TNC drivers and additional demand for electricity as a transportation fuel. The analysis also shows the negative impact estimated for state and local government output and employment due to tax revenue decreases, without any offsetting revenues.

Relative to the main SRIA analysis, the impacts under the Delayed Growth Scenario are generally smaller in magnitude. This is because the TNC fleet is estimated to be smaller under the Delayed Growth Scenario. As a result, the total direct costs and cost savings of the regulation are also smaller, as fewer vehicles are estimated to switch to ZEVs.

Under the delayed growth scenario, the Proposed Regulation is still estimated to result in net benefits and a benefits-cost ratio that is greater than 1. Specifically, total costs of the Proposed Regulation are estimated to be $614.7 million, health benefits are estimated to be $189.2 million, total cost savings are estimated to be $654.9 million, and tax revenues are estimated to decrease by $68.4 million. The net benefits of the Proposed Regulation under the delayed growth scenario is estimated to be $161.0 million, with a benefits-cost ratio of 1.26.